



## EVALUATION OF THE QUALITY OF WHITEMOUTH CROAKER (*Micropogonias furnieri*) SOLD AT OPEN MARKETS IN CITIES OF THE RECÔNCAVO REGION OF BAHIA

Luana de Santana Correia<sup>1</sup>, ORCID: 0009-0003-9839-4094  
Vinicius Pereira Vieira<sup>1</sup>, ORCID: 0000-0001-9654-6400  
Joadson dos Santos Reis<sup>1</sup>, ORCID: 0000-0002-0297-4402  
Sarah Carvalho de Araújo<sup>1</sup>, ORCID: 0000-0002-2474-7788  
Carlos Eduardo de Oliveira<sup>1</sup>, ORCID: 0000-0002-4844-3527  
Robson Bahia Cerqueira<sup>1</sup>, ORCID: 0000-0001-5054-0353  
Tatiana Pacheco Rodrigues<sup>1</sup>, ORCID: 0000-0003-1542-8619

### ABSTRACT

Fish is a highly perishable food due to its high water activity and protein content. This study aimed to evaluate the quality of whitemouth croakers (*Micropogonias furnieri*) sold at open markets in the Recôncavo region of Bahia. The municipalities of Cruz das Almas, Muritiba, Cachoeira, Maragogipe, and Santo Amaro were analyzed between November 2017 and January 2018. To assess hygienic-sanitary conditions, a compliance and non-compliance checklist for good practices in food services was used, revealing that 100% of the municipalities had open markets classified as poor. Fish samples underwent physicochemical analyses, including temperature, pH, ammonia, hydrogen sulfide, and a cooking test, which were not statistically effective as freshness indicators for whitemouth croakers. Microbiological analyses for quantification of mesophilic aerobes, psychrotrophic aerobes, *Staphylococcus aureus*, *Enterococcus* spp., molds and yeasts, as well as the most probable number of total coliforms, thermotolerant coliforms, and the presence of *Salmonella* spp., showed non-compliance with RDC 12/2001 in 100% of the fish samples. It was concluded that the whitemouth croakers (*Micropogonias furnieri*) sold at open markets in the studied municipalities do not comply with federal regulations and are considered unfit for consumption. These findings underscore the need to adopt good handling practices and promote sanitary education programs for handlers and consumers.

**Keywords:** Physicochemical Analyses; Microbiological Analyses; Good Practices; Fish.

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<sup>1</sup>Center for Agricultural, Environmental, and Biological Sciences, Federal University of Recôncavo da Bahia (UFRB), Cruz das Almas, Bahia, Brazil. E-mail: [luanamedicaveterinaria@gmail.com](mailto:luanamedicaveterinaria@gmail.com); [sr.vieira.v@gmail.com](mailto:sr.vieira.v@gmail.com); [joadsonking@gmail.com](mailto:joadsonking@gmail.com); [sarahcarvalho.arba18@gmail.com](mailto:sarahcarvalho.arba18@gmail.com); [carlosramos@ufrb.edu.br](mailto:carlosramos@ufrb.edu.br); [robsonba@ufrb.edu.br](mailto:robsonba@ufrb.edu.br); [tatiana\\_pacheco@ufrb.edu.br](mailto:tatiana_pacheco@ufrb.edu.br)



## INTRODUCTION

Fish falls into the category of highly perishable foods, requiring proper handling from capture to delivery to the final consumer or processing industry. Rich in easily digestible proteins, low in fat, and high in fatty acids, fish, despite its numerous qualities, is an extremely vulnerable food source to microbial spoilage. This susceptibility is associated with its high water activity, easily oxidizable fat content, near-neutral pH (6.6-6.8), and natural microbiota. These factors promote bacterial growth, making humans vulnerable to foodborne diseases (Bressan & Perez, 2000; Silva et al., 2008).

When quality control measures are neglected in the fish production chain, the product reaching the final consumer often exhibits inferior microbiological quality, potentially serving as an important vehicle for foodborne illnesses (FBI)s).

Fishing activities in the cities of the Recôncavo region of Bahia hold significant social and economic importance, involving fishing families who rely on this activity as their main source of income and contribute to the local economy. Informal trade, which predominates in open markets, demands a critical analysis regarding the safety and quality of the products sold. Based on this context, this study aimed to evaluate the quality of whitemouth croakers (*Micropogonias furnieri*) sold at open markets in the Recôncavo region of Bahia through physicochemical and microbiological analyses.

## MATERIALS AND METHODS

Samples of whitemouth croaker (*Micropogonias furnieri*) were obtained from open markets in the municipalities of Cruz das Almas (CDA), Muritiba (MUR), Maragogipe (MAR), Cachoeira (CAH), and Santo Amaro (SAA), located in the Recôncavo region of Bahia, between November 2017 and January 2018. At the time of collection, the fish were eviscerated to obtain samples similar to those purchased by final consumers. Collections were conducted on Saturdays, always in the morning. The samples were properly labeled with information about the supplier and the municipality of origin and transported in isothermal containers with reusable rigid ice packs to maintain proper refrigeration (5°C). Under these conditions, the samples remained until processing at the Laboratory of Infectious Diseases of the University Veterinary Hospital at the Federal University of Recôncavo Baiano.

At the time of sample acquisition, the temperature of the fish was measured by inserting a waterproof digital probe thermometer into the fish musculature, which had been previously sanitized with 70% alcohol, to record the measured value.

For ammonia detection using the Éber test, the methodology described in the Manual of Physical-Chemical Methods for Food

Analysis by the Adolfo Lutz Institute (2008) was employed. Analyses of hydrogen sulfide, pH determination, and cooking tests followed the standards of the manual of analytical methods for the control of products of animal origin and their ingredients published by the Ministry of Agriculture, Livestock, and Supply (Brasil, 1981).

The microbiological quality of the croaker samples was assessed by enumerating mesophilic aerobic microorganisms, psychrotrophic aerobes, *Staphylococcus aureus*, *Enterococcus* spp., molds, and yeasts, as well as determining the Most Probable Number of total coliforms, thermotolerant coliforms, and detecting the presence of *Salmonella* spp.. The methodology followed the guidelines of the Manual of Methods for Microbiological Analysis of Foods by Silva et al. (2007), as outlined by the American Public Health Association (APHA).

For this study, ten samples were analyzed: two from CDA, one from MUR, two from MAR, two from CAH, and three from SAA, corresponding to the total number of stands selling the target species, representing 100% of the markets.

To evaluate the hygienic and sanitary conditions of the sales points in the five open markets, a checklist adapted from RDC No. 275, dated October 21, 2002, by the National Health Surveillance Agency (ANVISA), was used. The checklist assessed 26 items divided into five categories: 1) general aspects of buildings, facilities, equipment, furniture, and utensils; 2) handlers; 3) food hygiene; 4) integrated vector and urban pest control; and 5) waste management.

The classification of items followed three criteria: "compliant," when they met RDC 275/2002; "non-compliant," when they did not comply with the standards; and "not applicable," when the items were not relevant to the local context. "Not applicable" items were excluded from the calculation of compliance percentages. To calculate the overall compliance averages, a basic proportion was used, following the formula below:

$$\% \text{ total compliance} = (\text{items evaluated} - \text{not applicable items}) \div \text{compliant items} = 100\% \div x$$

For classifying the open markets, the following criteria were defined: GOOD: 76% to 100% compliance with the items; FAIR: 51% to 75% compliance with the items; and POOR: 0% to 50% compliance with the items, based on the criteria established by ANVISA (Brasil, 2002).

For the statistical analysis of hydrogen sulfide and ammonia variables, Generalized Linear Models were used, considering a binomial distribution with a logit link function to calculate the probability of positive or negative events as a function of the localities. For the pH and temperature variables, the same methodology was applied, but with a normal distribution and identity link function, accounting for the variation in pH and temperature across localities. The statistical analysis of microbiological variables was performed using Generalized Linear Models with a normal distribution and logarithmic link function, considering the variation in microorganism groups



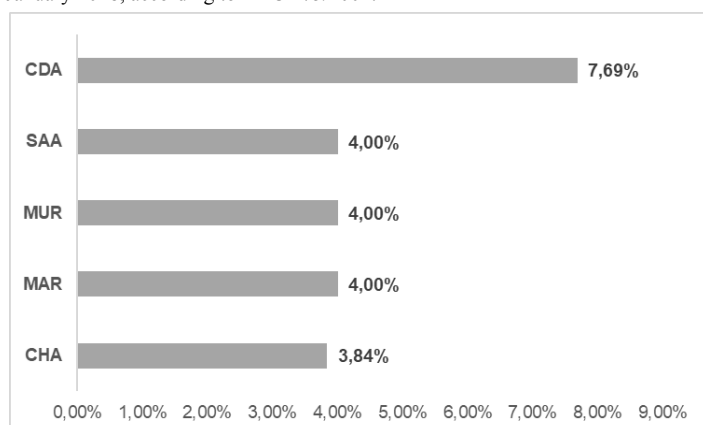
across localities. Checklist items were tabulated using Microsoft Excel, and descriptive data analysis was conducted.

## RESULTS AND DISCUSSION

### Hygienic and Sanitary Aspects of Open Markets

Using the checklist (BRASIL, 2002), the open markets in the municipalities of Cruz das Almas (CDA), Muritiba (MUR), Cachoeira (CAH), Maragogipe (MAR), and Santo Amaro (SAA) were classified. It was observed that 100% of the open markets were rated as poor, falling into Group III of ANVISA's classification under RDC 275 (Graph 1). None of the evaluated municipalities achieved even 10% compliance with the assessed items.

**Graph 1.** Percentage of total compliance of open markets in five municipalities of the Recôncavo region of Bahia, evaluated between November 2017 and January 2018, according to RDC 275/2002.



CAH: Cachoeira, CDA: Cruz das Almas, MAR: Maragogipe, MUR: Muritiba, SAA: Santo Amaro

To ensure the good quality of fish, sellers must wear proper uniforms, including clean, light-colored aprons, hairnets or caps, and closed-toe shoes. Stalls should be made of stainless steel, kept clean, well-maintained, and at a temperature of up to 4°C. It is essential that fish be stored under refrigeration between 0°C and 3°C, and vendors must use ice in a 1:1 ratio—one kilogram of ice per kilogram of fish. Knives and cutting boards should be clean and in good condition, and there must be a proper disposal site for waste. Additionally, suitable detergents and disinfectants, duly registered, should be used, along with fine mesh screens to protect against insects and rodents (Rosa, 2001).

Regarding building structure, facilities, equipment, furniture, and utensils, it was observed that, among the five studied markets, only one (Muritiba) was located on a public street, which made it impossible to assess wall and ceiling conditions. These elements, in theory, should have smooth, impermeable, and washable coatings, kept intact, well-maintained, and free of cracks, leaks, seepage, mold, and peeling (Brasil, 2004). In four of the five

regions evaluated, whitemouth croaker was handled on wooden slabs, commonly known as "cepos," or on wooden tables covered with cardboard or plastic.

These inappropriate surfaces retain liquids, making them damp and promoting the growth of microorganisms that come into contact with the fish. Additionally, the fish were cut using oxidized knives or machetes, as well as an improvised tool made of wood and nails to remove scales. The polystyrene insulated boxes used to store the fish were broken and/or dirty, in extremely poor condition. These conditions are entirely non-compliant with Brazilian regulations, which mandate that equipment, furniture, and utensils have smooth, intact, impermeable, corrosion-resistant surfaces that are easy to clean and made of non-contaminating materials (Brasil, 2002).

There were no dedicated sinks for hand hygiene in the handling areas, equipped with odorless liquid antiseptic soap or odorless liquid soap and antiseptic products, paper towels, or another hygienic and safe system for hand drying, as well as a hands-free paper waste bin. The sinks were used for both hand washing and fish cleaning, with only two municipalities (Cruz das Almas and Cachoeira) having sinks available. Two other municipalities used containers with stagnant water, and one had no means for hand hygiene. The availability of sinks is crucial for ensuring food safety, as hands are easily contaminated. This aligns with Snyder's (2010) assertion that microorganisms settle on the skin through direct contact or aerosols, particularly on the palms, fingers, and under the nails.

Another notable issue was the precarious condition of sanitary facilities, with no such installations observed in two regions (Muritiba and Cachoeira). Additionally, deficiencies in water distribution services were found, with no water provided at the markets in Muritiba, Maragogipe, and Santo Amaro. The use of stagnant water in containers such as buckets, basins, and barrels was common, representing a critical point as it does not ensure proper hygienic practices in the absence of treated water. Silva (2008) reported a similar situation when studying the sanitary aspects of fish commercialization in open markets in São Paulo-SP, noting the lack of sanitary facilities and inadequate water supply. Even when water was available, the same container was used for cleaning fish, utensils, and hands, compromising hygiene.

Food handlers did not wear appropriate uniforms and showed poor personal hygiene, often wearing accessories and engaging in conversations while handling food. Observed habits included smoking and the presence of hand injuries. Notably, the handlers not only worked with food but also handled money and performed fish evisceration without gloves, making them potential disseminators of microorganisms. Yamamoto (2012) observed similar practices while evaluating fish sold in the municipality of Santos-SP. Such practices compromise fish quality and violate the guidelines established by RDC ANVISA 216/2004 (BRASIL, 2004).

The hygienic conditions of the fish sold were inadequate, as they were exposed to the environment without protection against insects, dust, and heat. There was a lack of refrigeration methods during sales, which negatively impacted the microbiological quality of the fish. According to Oetterer (2010), refrigeration in fish reduces microbial activity in tissues and viscera, while also controlling the mesophilic microbiota typical of tropical fish. This reinforces Barros' (2014) findings, who, when evaluating the microbiology of fresh beef sold at open markets in the Recôncavo region of Bahia, noted the sale of perishable products without refrigeration, attributing product deterioration to the high temperatures typical of the region. An important finding in this study was the sale of frozen whitemouth croakers as if they were fresh; however, these were displayed without being placed on ice, making them prone to thawing at ambient temperature. Unsold fish were returned to the freezer, a practice prohibited by the Industrial and Sanitary Inspection Regulation for Products of Animal Origin (RIISPOA).

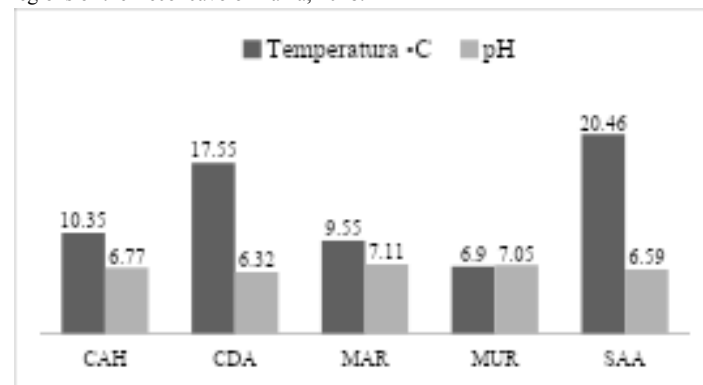
Regarding waste management and integrated pest control, 100% of the evaluated regions lacked areas for waste storage. None of the trash bins observed were equipped with pedal-operated lids, and all waste was discarded on the ground, attracting insects and domestic animals, which pose significant contamination risks and are undesirable in food handling and storage areas. Holanda et al. (2013), while assessing the hygienic and sanitary conditions of fish markets in the city of Caxias-MA, observed similar conditions, where fish viscera were accumulated under the stalls, attracting animals and compromising the overall sanitation of the area.

The conditions of the markets evaluated in the Recôncavo region of Bahia were inadequate in all analyzed aspects. Holanda et al. (2013) noted that products sold at open markets pose potential health risks to consumers, with unsatisfactory conditions and numerous non-compliances in various food handling parameters. These findings are not restricted to the open markets of the Northeastern states. Silva (2008), when analyzing the sanitary conditions of fish sales in open markets in São Paulo-SP, concluded that the practices in these markets were precarious, both in terms of product handling and the maintenance and cleanliness of utensils.

### Physicochemical Analysis of Samples

Among the evaluated samples, 100% exhibited temperature abuse (Graph 2). It was observed that the fish sold in the five studied open markets were stored in freezers but were displayed for sale without any form of cold preservation, leading to critical temperature readings. As fresh whitemouth croakers, their temperature should be close to the melting point of ice (0°C), as the Industrial and Sanitary Inspection Regulation for Products of Animal Origin (2017) defines fresh fish as those preserved solely by the action of ice or similar means. Being a highly perishable food item, fish must be kept at low temperatures to reduce microbial multiplication, thereby preventing or delaying the undesirable process of bacterial degradation.

**Graph 2.** Mean temperature values in °C and pH determination of fish sold in regions of the Recôncavo of Bahia, 2018.



CAH: Cachoeira, CDA: Cruz das Almas, MAR: Maragogipe, MUR: Muritiba, SAA: Santo Amaro

The analyzed whitemouth croakers showed 60% compliance with the determined pH values, with average levels ranging from 6.32 to 7.11 (Graph 2), meeting the requirements of federal legislation as stated in the Industrial and Sanitary Inspection Regulation for Products of Animal Origin (RIISPOA). Article 211 stipulates that fresh fish must have a flesh pH below 7.00 (Brasil, 2017). A similar percentage was found in the study by Miguel et al. (2017), where fish sold in the municipality of Dracena and its region were deemed suitable for human consumption concerning pH values.

Although elevated temperatures were recorded, the referred study found no association with the pH parameter. Santos (2008) argues that pH determination is not a reliable indicator to confirm fish freshness or the onset of spoilage. He explains that pH values vary between samples and fluctuate during the storage period. On the other hand, Andrés-Bello et al. (2013) suggest that pH determination may indicate the preservation status of fish, noting that spoilage alters pH levels due to amino acid decomposition. However, the author emphasizes the necessity of combining this analysis with other parameters.

Tests for ammonia and hydrogen sulfide aim to qualitatively determine the presence of these compounds in the tested samples. The release of these substances indicates the onset of protein degradation (Instituto Adolfo Lutz, 2008). These tests are considered indicative of fish freshness, with positive results suggesting spoilage. It was observed that samples sold in the municipality of Cachoeira showed positive results for both variables (Table 1), suggesting that the whitemouth croakers sold in this municipality were unfit for consumption.

**Table 1.** Results of ammonia, hydrogen sulfide, and cooking tests on whitemouth croakers (*Micropogonias furnieri*) sold at open markets in regions of the Recôncavo of Bahia, 2018.

Municipality	Ammonia	Hydrogen sulfide	Cooking
CAH	-/+	+	OC
CDA	-	+	OC
MAR	-	+	OC
MUR	-	+	OC
SAA	-	+	OC

Obs 1. - Negative, + Positive, CO - Characteristic Odor



Obs 2. CAH: Cachoeira, CDA: Cruz das Almas, MAR: Maragogipe, MUR: Muritiba, SAA: Santo Amaro

Regarding the cooking test, it was observed that the presence of ammonia and hydrogen sulfide in the whitemouth croakers did not alter their odor, which remained characteristic of the species. This can be explained by the stage of decomposition, as a more advanced stage would be required to cause noticeable odor changes in the fish. It is important to note that, based on this study, it is recommended that these tests be conducted in conjunction with other analyses.

### Microbiological Analyses

It was found that 100% of the fish samples from the five regions of the Recôncavo of Bahia were contaminated by seven of the eight microorganisms analyzed, with samples from two regions testing positive for *Salmonella* spp. (Table 2).

**Table 2.** Mean values of the standard plate count for psychrotrophic aerobes, mesophilic aerobes, molds and yeasts, *Staphylococcus aureus*, *Enterococcus* spp., in Log Colony Forming Units (CFU/g); Most Probable Number (MPN) of total coliforms and thermotolerant coliforms in Log/g; and the presence of *Salmonella* spp. in whitemouth croakers (*Micropogonias furnieri*) sold at open markets in regions of the Recôncavo of Bahia, 2018.

Municipality	PSC	MSF	BEL	CLT	CTR	STA	ENT	SML
CAH	5,159 <sup>a</sup>	5,452 <sup>a</sup>	6,623 <sup>a</sup>	0,458 <sup>a</sup>	0,661	3,446 <sup>c</sup>	3,187 <sup>b</sup>	Aus.
CDA	5,655 <sup>a</sup>	5,658 <sup>a</sup>	6,191 <sup>b</sup>	0,637 <sup>a</sup>	0,556	4,327 <sup>ab</sup>	3,729 <sup>ab</sup>	Aus.
MAR	5,697 <sup>a</sup>	4,424 <sup>b</sup>	6,584 <sup>a</sup>	0,882 <sup>a</sup>	0,556	3,524 <sup>bc</sup>	3,247 <sup>b</sup>	Aus.
MUR	5,509 <sup>a</sup>	5,708 <sup>a</sup>	6,513 <sup>ab</sup>	0,452 <sup>a</sup>	0,430	4,274 <sup>abc</sup>	4,182 <sup>a</sup>	Pres.
SAA	5,590 <sup>a</sup>	5,980 <sup>a</sup>	6,660 <sup>a</sup>	0,545 <sup>a</sup>	0,447	4,764 <sup>a</sup>	4,389 <sup>a</sup>	Pres.

CAH: Cachoeira, CDA: Cruz das Almas, MAR: Maragogipe, MUR: Muritiba, SAA: Santo Amaro

Obs 1. Cachoeira, CDA: Cruz das Almas, MAR: Maragogipe, MUR: Muritiba, SAA: Santo Amaro.

Obs 2. PSC: Psychrotrophic aerobes, MSF: Mesophilic aerobes, BEL: Molds and yeasts, CLT: Total coliforms, CTR: Thermotolerant coliforms, STA: *Staphylococcus aureus*, ENT: *Enterococcus* spp., SML: *Salmonella* spp.

According to RDC No. 12/2001, *Salmonella* must be absent in 25 g of this type of food. This result indicates that fish sold in the open markets of Muritiba and Santo Amaro do not comply with Brazilian legislation, meaning they are unfit for human consumption. The presence of these microorganisms may indicate fecal contamination, as the habitat of this genus is the gastrointestinal tract of humans and warm-blooded animals (Germano & Germano, 2008). The data diverged from those found by Silva (2008) and Evangelista-Barreto et al. (2017), who evaluated fish market conditions in São Paulo-SP and Cachoeira-BA, respectively, and did not detect *Salmonella* spp., thus indicating compliance with legislation.

The Ministry of Health, through RDC Resolution No. 12, dated January 12, 2001, establishes a limit of 3.0 log CFU/g for coagulase-positive *Staphylococcus*, primarily *Staphylococcus aureus*, in fresh, refrigerated, or frozen fish, crustaceans, and bivalve mollusks. Based on this regulation, 100% of the municipalities analyzed in the Recôncavo of Bahia presented values above the acceptable tolerance limit (Table 2). Consequently, the whitemouth croakers are deemed unfit for

consumption. Similar results were observed in research by Rocha et al. (2013), who analyzed the presence of coagulase-positive *Staphylococcus* in fish sold in the market of Currais Novos/RN. Meanwhile, Soares (2014) reported the absence of *Staphylococcus aureus* in fish during ice storage. Humans and warm-blooded animals are considered reservoirs for this bacterial group, which inhabits the mucosa of the upper respiratory tract, throat, human intestines, hair, and skin. The presence of this bacterium in food indicates handling failures (Silva, 2007).

*Staphylococcus aureus* is sensitive to high temperatures but releases heat-resistant toxins, making it a pathogenic bacterium responsible for foodborne intoxications (Germano & Germano, 2008). It is classified as a causative agent of foodborne diseases (FBDs). The International Commission on Microbiological Specifications for Foods (ICMSF, 2002) categorizes this FBD within risk group III—diseases with moderate risk and duration, without threat of death or sequelae, and with self-limiting symptoms causing significant discomfort. Barros (2014) highlighted that both *Salmonella* spp. and *Staphylococcus aureus* are potential pathogenic agents associated with fish consumption.

No federal legislation establishes microbiological standards for mesophilic and psychrotrophic microorganisms; thus, the values found cannot be compared to a specific standard. These microorganisms indicate deficiencies in the hygienic and sanitary quality of food (Franco & Landgraf, 2008). Mesophilic microorganisms also indicate the presence of pathogens, as most foodborne pathogenic bacteria are mesophilic (Jay, 2005). Bordignon et al. (2010) emphasized that psychrotrophic microorganisms are essential contributors to the spoilage of refrigerated fish, as they proliferate under such conditions, reducing the product's shelf life. These microorganisms carry out proteolytic and lipolytic activities and can grow and multiply at refrigeration temperatures (Lanzarin et al., 2011).

Mesophilic counts exceeding 6.0 log CFU/g are considered critical regarding the freshness of whitemouth croakers (ICMSF, 2002). Mesophilic counts (Table 2) ranged from 4.424 to 5.980 log CFU/g, while psychrotrophic counts ranged from 5.159 to 5.697 log CFU/g, which fall within normal ranges according to international standards. Similar findings were reported by Barreto et al. (2012), who, when assessing the hygienic and sanitary conditions of fish sold in Cruz das Almas, Bahia, found maximum psychrotrophic aerobic counts below the ICMSF's suggested limit. Conversely, Montanari et al. (2015), evaluating the quality of salmon sashimi prepared and sold in Ji-Paraná-RO, reported high levels of mesophilic bacterial contamination. In the present study, no variation in psychrotrophic microorganism counts was observed across the five regions studied, while only one region (Maragogipe) exhibited variations in mesophilic counts compared to the others.

In the present study, 40% of the samples showed a high load of total coliform bacteria, corresponding to the municipalities of Cruz das Almas and Muritiba, with 6.370 log MPN/g and 8.820 log MPN/g, respectively (Table 2). No statistically significant



difference was observed among the regions analyzed (Table 2). Although no specific microbiological standards exist for this bacterial group, total coliforms are indicators of unsatisfactory hygienic-sanitary conditions. Soares (2014) reported low levels of these microorganisms and attributed the reduction to their low resistance to refrigeration temperatures. Conversely, Viana (2016), when analyzing fish from the municipal market of Ariquemes in the state of Rondônia, found high counts of total coliforms in some samples, attributing this finding to the ice used for preservation and improper handling practices. These microorganisms are not part of the fish's intestinal microbiota but are indicators of the microbiological conditions of the water where the fish were caught and the handling conditions (Guzmán, 2004).

Thermotolerant coliforms are a subgroup of total coliforms, inhabiting the intestines of humans and warm-blooded animals (Silva, 2007). They are used as indicators of fecal contamination due to their origin. Rall (2008) detected thermotolerant coliforms in 21.2% of fresh fish samples sold in Botucatu/SP, while only 10.8% of frozen fish samples tested positive. These findings differ from the present study, where thermotolerant coliforms were present in 100% of the whitemouth croaker samples, with values ranging between 4.300 log MPN/g and 6.610 log MPN/g (Table 2). As with total coliforms, the thermotolerant coliform counts in the samples were low, which could be attributed to freezing, which inhibits the multiplication of these microorganisms. Soares (2014) reported no growth of thermotolerant coliforms during the storage of Nile tilapia fillets, attributing this to the good hygienic-sanitary conditions of the environment where the fish were caught and the likely adoption of proper handling practices. Silva (2007) associates the presence of thermotolerant coliforms with inadequate sanitization of equipment and utensils, noting that these bacteria are inactivated by sanitizers and easily destroyed by heat. Additionally, their presence may indicate fecal contamination when the food is raw.

Bacteria of the genus *Enterococcus* spp. were detected in 100% of the samples (Table 2), posing a health risk to consumers. The presence of this microorganism is linked to the presence of pathogens (Evangelista-Barreto et al., 2017), particularly *Enterococcus faecalis* (Yang et al., 2015), classifying the whitemouth croakers sold in these regions as unfit for consumption.

According to the legislation in effect at the time of the study, RDC No. 12 of the National Health Surveillance Agency (BRASIL, 2001) did not establish limits for the presence of *Enterococcus* spp. in fresh fish. In this assessment, the variation patterns were similar, with the highest count recorded in Santo Amaro (4.389 log CFU/g) and the lowest in Cachoeira (3.187 log CFU/g). Yang et al. (2015) identify these microorganisms as indicators of fecal contamination. They can grow at temperatures ranging from 10°C to 45°C, are resistant to heat treatments, high concentrations of NaCl and bile salts, and pH variations (SILVA, 2007; KAYSER, 2013).

The analyses for the quantification of molds and yeasts revealed high average values, ranging from 6.191 log CFU/g to 6.660 log CFU/g (Tab. 2), which may be attributed to inadequate cleaning of surfaces in contact with the raw material, improper handling, and unsatisfactory conditions. Diverging results were reported by Oliveira et al. (2014), who, when analyzing pirarucu (*Arapaima gigas*) stored in Styrofoam boxes with ice, did not observe mold and yeast growth. This is likely because the samples were not sourced from the market but were instead cultivated in masonry tanks specifically for research purposes. Bordignon (2010) explains that improper handling of fish is associated with excessive presence of these microorganisms, posing a public health risk due to the production of mycotoxins by molds. As with other microorganisms, no legislation establishes limits for the amount of molds and yeasts. Silva (2014) attributes the presence of fungi in food to the use of wooden utensils for processing, as they absorb moisture and contaminate the food.

Battagline (2012), when analyzing the microbiological quality of the environment, food, and water in restaurants on Ilha do Mel, Paraná, found that all the facilities and equipment analyzed were contaminated by molds and yeasts. For instance, plastic cutting boards initially appeared clean but became contaminated over time, likely due to cross-contamination. Additionally, dishcloths showed high levels of fungi, highlighting deficiencies in the cleaning process, as these microorganisms require 5 to 7 days to grow. Thus, it can be concluded that the high levels of molds and yeasts in the whitemouth croaker samples sold at street markets in the Recôncavo region of Bahia may be linked to the use of inadequate tools, such as wooden counters, and insufficient cleaning of the utensils used during handling.

## CONCLUSION

Considering the results obtained in this study, significant hygienic-sanitary issues were identified that pose potential health risks to consumers, resulting from inadequate facilities, improper fish preservation, insufficient utensil sanitation, and, most notably, handling deficiencies. These unsanitary conditions contribute to high microbial density. Street markets do not provide suitable conditions for fish commercialization, underscoring the need for structural intervention. The physicochemical analyses were not statistically effective as indicators of freshness for whitemouth croaker (*Micropogonias furnieri*) in this study. Microbiological analyses revealed that the object of this research did not meet the standards established by legislation. Therefore, it can be concluded that whitemouth croaker (*Micropogonias furnieri*) sold in street markets of these municipalities in the Recôncavo region of Bahia are of poor quality, do not comply with federal regulations, and are thus considered unfit for consumption.

It became evident that regulatory authorities have been negligent, allowing the sale of fish under unsanitary conditions. Therefore,



promoting sanitary education programs is essential to inform handlers, vendors, and consumers about the importance of proper care during food handling and storage.

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