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DRY FISH COMO ESTRATÉGIA PARA SUSTENTABILIDADE NO CONSUMO DO PESCADO DE BAIXA PRECIFICAÇÃO POR RESTAURANTE DO RIO DE JANEIRO

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ABSTRACT

Nas últimas duas décadas, houve uma mudança no estilo de vida do consumidor e nos hábitos alimentares, com preferência por alimentos de alta qualidade e alimentos *Premium* com nutrientes essenciais.Essas mudanças têm aumentado consumo e a preferência pelo pescado como opção de alimentação saudável. Entretanto, sua alta perecibilidade requer uma observância quanto ao controle de todas as etapas da cadeia produtiva para evitar que as reações enzimáticas e a ação dos microrganismos diminuam sua validade comercial. Além disso, o pescado pode se tornar um potencial veículo de transmissão de doenças, especialmente as de origem microbiológica. Estudos a respeito de novos métodos de conservação são primordiais para melhorias na qualidade e representam uma forte ferramenta para garantir a segurança alimentar e aumentar a vida útil do pescado. Uma nova abordagem da técnica de maturação, chamada de método *Dry fish*, tem sido recentemente aplicada na tecnologia do pescado por restaurantes de alta gastronomia no Estado do Rio de janeiro. O *Dry fish* consiste na perda gradativa da atividade de água livre pela redução da temperatura a seco, em câmara refrigerada a uma temperatura de 0 °C a 2 °C, com umidade média de 65%, proporcionando maciez e sabor agradável ao pescado. Assim, o presente trabalho tem como objetivo avaliar a qualidade microbiológica e a validade comercial do pescado maturado através da técnica *Dry fish*. As análises microbiológicas foram realizadas em 100 g amostras das espécies de peixe de baixa precificação: Sororoca (*Scomberomorus cavala*), Galo (*Selene setapinnis*) e Palombeta (*Chloroscombrus chrysurus*), nos intervalos de tempo de 05,13, 20, 26 e 33 dias. Foram realizados os seguintes testes: Contagem de Bactérias Mesófila heterotróficas aeróbias estritas e anaeróbias facultativas, Coliformes totais e termotolerantes, fungos filamentosos e leveduras, *Staphylococcus*coagulase-positivos e detecção de *Salmonella*spp..Os resultados indicaram uma redução progressiva da qualidade do produto com o tempo de maturação de 26 dias quando os parâmetros de contagem de bactérias mesófilas e de fungos e leveduras atingiram os limites máximos preconizados pela Instrução Normativa Nº161/2022,de 10^6 UFC/g e 10^4 UFC/g, respectivamente.

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INTRODUCTION

According to Sanitary Inspection of Animal Origin ProductsIndustrial Regulation (RIISPOA), fish are defined as fish, crustaceans, molluscs, amphibians, chelonians and freshwater or saltwater mammals, used for human consumption (BRASIL, 1997). Bearing in mind that humans need a balanced diet, fish becomes one of the main options available, since its composition has excellent nutritional value, mainly due to high levels of vitamins A and D, calcium, omega-3 and phosphorus, low quantity and considerable quality of lipids, in addition to presence of proteins of high biological value (HUNTER & ROBERTS, 2000; DOMINGO, 2007; NEIVA, 2010). Consequently, fish consumption has increased in recent decades, both due to greater demand and changes in population's eating habits, which are increasingly looking for products with an adequate nutritional profile (PIENIAK *et al*., 2010).

However, high fish perishability requires compliance with control of all stages of production chain to prevent enzymatic reactions and microbial action that reduces commercial validity. Furthermore, fish can become a potential vehicle for foodbourne diseases, especially those of bacterial origin. Studies on new conservation methods are essential for improving microbiological quality and represent a strong tool to food safety and shelf life guarantee.Regarding high food quality, there are representative methods to improve palatability and flavor, including salting, curing, smoking and aging. In this scenario, the maturation method called "Dry aged"stands out, also known as dry maturation, already applied for more than 100 years in regions such as Australia, United States and Argentina (DASHDORJ *et al*., 2016). In Brazil, Dry aged has been applied to beef for the last two decades, but it is gaining more and more space in the consumer profile and on the menu of the best country restaurants, as it promotes very high-qualitymeat. Aging is a process of storing meat at refrigerated temperatures to increase tenderness and flavor.

In general, there are two forms of aging techniques: wet and dry, depending on the degree of dehydration in the meat. In dry maturation, several microorganisms are involved that develop on the surface of the meat, affecting quality through their proteolytic and lipolytic activities, as well as their metabolic products (KIM *et al*., 2020). A new approach to Dry aged technique has recently been applied to fish maturation, called *Dry fish* Technique. *Dry fish* consists of gradual loss of fish moisture by reducing dry temperature in a refrigerated chamber at a temperature of 0 °C to 2 °C, with an average humidity of 65%, controlled ventilation, for a period of 21 to 30 days. Dry aging is used to promote the gradual decrease in water activity of skin and meat of gutted fish. As maturation occurs, the fish surface becomes dry, but internal portion acquires softness and a pleasant flavor. This technique has been applied as a gastronomic trend in restaurants around the world, and has currently been applied as an alternative for the sustainable consumption of low-priced fish species by the gastronomic market in the city of Rio de Janeiro. Since the technique adds flavor and tenderness, fish species with low market demand, but abundant on Rio de Janeiro coast, such as Sororoca, Faqueco, Guaivira, Galo, Sororoca, Pitangola, Carapeba and Palombeta, can become menu alternatives and reduce consumption pressure on classic fish species, which has consequently been depleting the marine population. This also reduces waste, as it allows maximum use of the fish, including the scales, head, viscera, skin and less noble parts. Despite being a promising technology in its application for fish consumption by restaurants, there are still few scientific studies that validate the hygienic-sanitary profile and the commercial validity that establishes the limit in days of fish consumption matured by *Dry fish*. The present study aimed to evaluate the safety consumption period of fish submitted to *Dry fish* maturation, and thus access the hygienic-sanitary profile to generate data that can contribute to dissemination and expansion of this method in the context of fish technology and food safety.

MATERIAL AND METHODS

Fish preparation to *Dry fish* Technique: The fish was captured in Tijucas Island of Rio de Janeiro coast in July/2023 and slaughter by a Spiking Technique called ikejime-killed fish in accordance to European Food Safety Authority (EFSA, 2004) and described by Polli et al. (2005) and Sperss, (2019). Evisceration was conduct as soon as fish death, in adequate hygienic kitchen condition, with the care to not to damage the skin or to break internal tissues. After that, refrigeration at 0 °C to 2 °Cinto refrigerated chamber (COPELAND LP®, CR20K6M-PFV-141), with an average humidity of 65% and controlled ventilation.Fish samples included the species captured in the littoral coast of Barra da Tijuca- Rio de Janeiro (RJ-Brazil): Sororoca (*Scomberomorus cavala,* Cuvier, 1829), Galo (*Selene setapinnis*, Mitchill, 1815) e Palombeta (*Chloroscombrus chrysurus*, Linnaeus, 1766).

Sample and Microbiological Procedures: In this study a total of 100g of the three different fish sampleswere evaluated in 05, 11, 20, 26 and 33 days of *Dry fish* maturation. The samples were transferred by Refrigeration to Microbiology Analysis at Bioqualitas Laboratory (Rio de Janeiro-Brazil) to be immediately submitted to enumeration and biochemical characterization protocols. Conventional method protocols were established initially by serial decimal dilutions in 1% peptone solution (m/v) (Difco, Detroit, MI). After, 0.1 mL of every selected dilution was inoculated on specific agar culture and subsequently incubated at 36 +/–1°C for 30 to 48 hoursto bacterial counts and at 25°C for 7 days,on potato dextrose Agar was sterilized with 10% tartaric acid assay of fungi and yeast counts, in accordance to protocols of APHA – AMERICAN PUBLIC HEALTH ASSOCIATION and ISO (INTERNATIONAL STANDARD ORGANIZATION). The Microbiological enumerations and bacterial detection analysis were stabilish to: aerobic mesophilic bacteria, yeast and mold enumerations, total and thermotolerant coliforms, *Escherichia coli*, coagulase positive*Staphylococcus*, and *Salmonella* spp. (ISO 6579-1:2021; ISO 7932:2016; ISO7251:2022; APHA 33.72:2015; ISO 6888-1:2023; APHA 9.62:2015; ISO 21527-1; ISO 11290-1; 2:2020; APHA 08:2015). The plates with counts in the range of 25–250 were used for calculating TVC in the sample as CFU/g.

RESULTS AND DISCUSSION

Table 01 presents the microbiological analyzes results of fish samples submitted to *Dry fish*technique at different maturation times. The count results detected mesophilic bacteria, fungi and yeasts, as the most significant hygienic-sanitary markers in terms of assessing microbiological quality. In accordance to Normative Instruction $N^0$161 of 1st July, 2022, the maximum limit of 10^6 CFU/g and 10^4 CFU/g for mesophilic bacteria, fungi and yeast counts, were detected in 26 days of maturation, respectively (BRASIL, 2022). In all maturation time intervals evaluated, there was no detection of *Escherichia coli*, coagulase-positive *Staphylococcus* and *Salmonella* spp. Dry aging involves growth of various microorganisms on the surface of the meat fish, affecting quality through their proteolytic and lipolytic activities, as well as metabolic products (KIM *et al*., 2020). Although there are limited studies on the effect of microorganisms on fish dry aging, some bacteria and yeast/fungi have been previously reported in dry-aged beef. Yeasts and molds, including *Thamnidium* sp., *Pilaira anomala* and *Debaryomyces hansenii*, are frequently detected in dry-aged meat, which directly affects quality by releasing proteases, breaking down myofibrils with collagenolytic enzymes and producing flavor compounds (OH *et al*., 2019).In contrast to fungal composition, most bacterial analyzes have focused on detecting pathogenic bacteria such as *Escherichia coli* O157: H7, *Listeria monocytogenes*, and *Salmonella* spp. (SILVA *et al*., 2019; TITTOR *et al*., 2011), and lactic acid bacteria, which are

Tabela 1. Microbiological analyzis of fish samples submitted to*Dry fish*Technique at different maturation times

Dry fish Maturation Time:	05 days	13 days	20days	26 days	33 days
Galo (*Selene setapinnis*)					
Mesophilic bacteria (CFU/g)	$1,5 \times 10^2$	$9,2 \times 10^2$	$9,8 \times 10^4$	$3,6 \times 10^5$	$2,0 \times 10^3$
Yeast and mold (CFU/g)	$1,0 \times 10^1$	$1,3 \times 10^3$	$2,6 \times 10^3$	$8,9 \times 10^2$	$2,0 \times 10^1$
Staphylococcus(CFU/g)	$< 10^2$	$< 10^2$	$< 10^2$	$< 10^2$	$< 10^2$
Total/Thermot.Coliforms. (MPN/mL)	<0,3	<0,3	<0,3	<0,3	<0,3
Salmonella spp.	Absence	Absence	Absence	Absence	Absence
Palombeta (*Chloroscombrus chrysurus*)					
Mesophilic bacteria (CFU/g)	$4,2 \times 10^2$	$2,5 \times 10^3$	$< 10^2$	$3,4 \times 10^2$	$4,6 \times 10^2$
Yeast and mold (CFU/g)	$2,0 \times 10^1$	$7,8 \times 10^3$	$3,9 \times 10^1$	$4,8 \times 10^2$	$5,0 \times 10^1$
Staphylococcus(CFU/g)	$< 10^2$	$< 10^2$	$< 10^2$	$< 10^2$	$< 10^2$
Total/Thermot.Coliforms. (MPN/mL)	<0,3	<0,3	<0,3	<0,3	<0,3
Salmonella spp.	Absence	Absence	Absence	Absence	Absence
Sororoca (*Scomberomorus cavala*)					
Mesophilic bacteria (CFU/g)	$2,5 \times 10^3$	$1,8 \times 10^5$	$2,2 \times 10^2$	$>10^6$	**NA*
Yeast and mold (CFU/g)	$1,9 \times 10^3$	$2,2 \times 10^3$	$9,4 \times 10^2$	$5,8 \times 10^5$	**NA*
Staphylococcus(CFU/g)	$< 10^2$	$< 10^2$	$< 10^2$	$< 10^2$	**NA*
Total/Thermot.Coliforms. (MPN/mL)	<0,3	<0,3	<0,3	<0,3	**NA*
Salmonella spp.	Absence	Absence	Absence	Absence	**NA*

**NA: Sample not available to Microbiological analysis at 33 days of maturation.*

significantly increased in food samples submitted to dry aging. The present results revealed absence of main hygienic markers detection, that are involved in outbreaks and bacterial poisonings origin. Despite current findings, there is still a lack of *Dry fish* microbial profile understanding, that justify hygienic security as fish conservation technology.The Tijucas archipelago, is formed by Alfavaca, Pontuda and Meio Islands, located between São Conrado and Barra da Tijuca beach, and are usually a spot for line fishing and trawling of various marine species to local commerce. The fish caught on these islands is sold at Mercado dos Pescadores Artesanais, in Amores Beach, Quebra Mar (RJ-Brazil), which serves residents and restaurants, mainly locatted at Gastronomic Center ofGigóia Island - Barra da Tijuca (RJ-Brazil), reaching an offer of 3.5 t/month of fish species: croaker, anchovy, dogfish, marimbá and dog's eye (JABLONSKI *et al*., 1997; BARROSO eWIEFELS, 2010**).** Most fish sold to restaurants are noble species, however the focus of the present study was lower priced species sold in this fishing center. Fish samples under study were, sororoca (family Scombridae), galo (family Zeidae) and palombeta (family Carangidae), that are sold between R$15.00 and R$28.00/Kg. Because they are bony fish species, small to medium size and have spiny flesh, these species are not often selected by local restaurants. However, with *Dry fish* technique application, these species had an increased added value, since maturation refines tenderness and flavor, allowing them to be used in haute cuisine recipes for around 26 days of conservation. This new fish technology can represent an excellent strategy for marine biome sustainability, as it prioritizes conscious, selective and local fishing. Fish consumption by restaurants that practice *Dry fish* technique requires quick logistics between capture and transportation, so that evisceration and maturation occur in the shortest possible time, and thus ensure quality throughout the entire processing chain. This fact has been an incentive for local artisanal fishing community.

CONCLUSION

In accordance to legislation current parameters, it is noteworthy that present analysis detected the most significant presence of filamentous fungi, yeasts, and mesophilic bacteria in 26 days of maturation by *Dry fish* Technique. This technology applied to low-priced fish favored its use in haute cuisine recipes, as maturation increased fish aroma and flavor, under adequate hygienic and sanitary conditions.The detection of these microbial markers of fish samples obtained in Rio de Janeiro coast points to the need of strengthen in fish quality research, that evaluates microbiota profile of Dry fish method, for its promotion and commercial validation. It also claims for public policies to apprimorate local artisanal fishing and marine biome preservation and sustainability.

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