Natural thickener in raw and cooked fish-derived: microbiological, physicochemical and sensorial acceptance

Espessante natural em derivados de pescado crus e cozidos: análises microbiológicas, físico-químicas e aceitação sensorial

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Abstract

The development of fish derived products is different from fishery itself, and contributes to the local economy. Products such as fish burger and nuggets, made of fish as raw material, have been in the spotlight of the market in recent decades due to its nutritional properties and the increase in fish deriving activity. For some decades, the functional properties of polysaccharide gums have been studied in food industries. One of its main functions is the increase of viscosity, working as a thickener in aqueous solutions. This research aims to study the use of galactomannan from the seeds of *Caesalpinia pulcherrima,* commonly known as "flamboianzinho" in fish derived products prepared with the specie *Oreochromis niloticus*, known as Nile tilapia. Microbiological, physicochemical and sensory tests were conducted to evaluate the product and its acceptance and purchase intent of consumers. The results show that the three formulations of nuggets and hamburgers prepared with tilapia using *Caesalpinia pulcherrima* seeds as the thickener are within the microbiological standards required by Brazilian legislation. The physicochemical composition of the products was not affected by the addition of the gum and the products were well accepted as the appearance, odor, flavor, texture and global aspect, which obtained scores notes within the acceptance zone in all analyzed aspects. Most panelists declared that they would certainly buy or possibly buy the nuggets and hamburger prepared with tilapia, being, therefore, a good way of utilization of this species of fish and the *Caesalpinia pulcherrima* as thickeners in this type of product.

Additional keywords: fish burger; galactomannan; nuggets; sensorial analysis.

Resumo

A produção de derivados de pescado é uma atividade diferenciada ao da pesca propriamente dita e contribui para a economia local. Produtos como o *fish burger* e *nuggets* produzidos com o pescado como matéria-prima têm ganhado enfoque no mercado, nas últimas décadas, pelo crescimento da atividade e por suas propriedades nutricionais. Há algumas décadas, vêm-se estudando as propriedades funcionais das gomas de polissacarídeo nas indústrias de alimentos. Uma de suas principais funções é no aumento da viscosidade, agindo como espessante em soluções aquosas. Este estudo tem como objetivo o uso de galactomanana das sementes de *Caesalpinia pulcherrima*, conhecida popularmente como "flamboianzinho", em derivados de pescado preparados com a espécie *Oreochromis niloticus*, conhecida como Tilápia-do-Nilo. Testes microbiológicos, físico-químicos e sensoriais foram conduzidos para avaliar o produto, sua aceitação e a intenção de compra dos consumidores. Os resultados obtidos mostram que as três formulações de *nuggets* e de hambúrguer preparadas com a tilápia, utilizando como espessante as sementes de *Caesalpinia pulcherrima*, estão dentro dos padrões microbiológicos exigidos pela legislação brasileira. A composição físico-química dos produtos não foi afetada pela adição de goma, e os produtos foram bem aceitos quanto à aparência, odor, sabor, textura e aspecto global, tendo obtido notas dentro da zona de aceitação do produto em todos os aspectos analisados. A maioria dos provadores declarou que certamente comprariam e possivelmente comprariam os *nuggets* e o hambúrguer de tilápia, sendo, portanto, uma boa forma de utilização dessa espécie de pescado e das sementes de *Caesalpinia pulcherrima* como espessante neste tipo de produto.

Palavras-chave adicionais: análise sensorial; *fish burger*; galactomanana; *nuggets*.

Introduction

In 2010, the global production of cultivated edible aquatic species was 59.9 millions of tons with Brazil producing 479.399 tons, being 82.2% from continental aquaculture (FAO, 2012; MPA, 2012). Seafood is an important part of healthy diet (Trondsen et al., 2003), due the presence of fatty acids from n-3 and n-6 series which are precursors of prostaglandins, thromboxanes and leukotrienes, that have important functions in the body (Moreira et al., 2001). Among the species of fish consumed in Brazil, there is the Nile tilapia which is a specie that easily adapts to brackish waters (Machado, 1984) and possesses low level of cholesterol (Vila-Nova et al., 2005).

Lately, the use of gums extracted from plant seeds (galactomannans) has been studied in several products of the food industry. Galactomannans are often used for human consumption. With their diverse physicochemical properties, they are a versatile material with many applications. In simple aqueous systems, they are not only effective viscosifiers and thickeners, but also excellent stiffeners and stabilizers of emulsions (Silveira & Bresolin, 2011). *Caesalpinia pulcherrima* is widely distributed in tropical and sub-tropical regions like India, Myanmar, Vietnam, Sri Lanka, and Malay Peninsula (Thombre & Gide, 2013). The properties of galactomannans extracted from seeds of *Caesalpinia pulcherrima* have being studied in several work (Cerqueira et al., 2009; Braga et al., 2011; Thombre & Gide, 2013).

The sensory analysis, done through human senses, aims to check the acceptance of food products. Thus, the sensations are used to develop new products in researches and to evaluate the food quality by the interaction of the human organs with the food. Besides, the sensations also evaluate the acceptability of the consumers (Stone & Sidel, 2004).
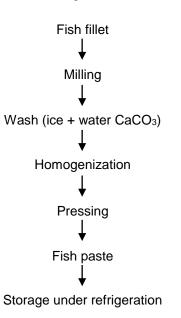
This research aims to study the use of galactomannan from the seeds of *Caesalpinia pulcherrima* in the preparation of fish derived products using the specie *Oreochromis niloticus* and to characterize the products as microbiological, physicochemical and sensorial analysis.
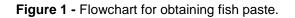
Material and methods

Two products were evaluated: fish burger and nuggets. Both prepared with a fish paste base named as surimi, obtained from the Nile tilapia fillet, which was made as described in the flowchart (Figure 1). The ingredients to prepare both products were: 1 kg of surimi; 2 g of dehydrated fried garlic; 20 g of refined salt; 3 g of flavor enhancer monosodium glutamate; 2 g of sugar; 2 g of pepper.

The galactomannan was obtained in the Chemical Laboratory, following methodology of Braga et al. (2011). Was added in three formulations for each product: F1: did not contain the gum

(control), F2: 0.3 g 100 g^{-1} of galactomannan gum, and F3: 0.5 g 100 g^{-1} of galactomannan gum. The next step consisted in mixing the ingredients and placing the mass formed in forms for each product. Microbiological and physicochemical analyses were performed. After that, nuggets were precooked in the microwave and fish burger remained raw until the sensory test. For the sensorial tests, the nuggets were fried while fish burgers were baked on grill.

Fish fillet

↓

Milling

↓

Wash (ice + water $CaCO_3$)

↓

Homogenization

↓

Pressing

↓

Fish paste

↓

Storage under refrigeration

Figure 1 - Flowchart for obtaining fish paste.

Analysis of coliforms at 45 °C was performed according to the methodology recommended by the APHA (2001) to ensure the safety of panelists.

The samples were subjected to physico-chemical analysis: Determination of pH, water activity, moisture, ash, protein and lipids, according to the methods described by the Instituto Adolfo Lutz (2008). All tests were conducted in triplicate.

Each derived product, with its respective formulation, was analyzed with the acceptance test through a nine-scored hedonic scale, with scores varying from 1 (Extremely dislike) to 9 (Extremely like) (Dutcosky, 2011).

The purchase intention of consumers towards the products, based on the consumers' impression on the products, was evaluated through a purchase intention test of five aspects: appearance, smell, flavor, texture and global aspect. Then, the purchase intention test was applied to the nugget and the fish burger. The consumers had to choose one alternative: "Certainly buy," "possibly buy", "maybe buy / maybe not buy," "possibly not buy "and" certainly not buy".

The sensory study was performed with forty untrained panelists. Samples were presented in randomized blocks, each block was considered a tester.

The analysis results were submitted to analysis of variance (ANOVA) and means were compared among themselves by Tukey Test at 5% probability.

Results and discussions

The test for coliforms at 45 °C presented as a result MPN (Most Probable Number) equal to 15 or 10^2. According to Resolution of the Collegiate Direction (RDC) 12/2001 (BRASIL, 2001) which defines the criteria and microbiological standards for food, the product is considered within the microbiological standards of identity and quality which is 10^3 MPN for products based on chilled or frozen fish (hamburgers and similar). Therefore, the results of this research are satisfactory.

As to composition, Ogawa & Maia (1999) state that the fish muscle may contain 60-85% of moisture, 20% of protein, 1-2% of ash, 0.3-1.0% of carbohydrate and 0.6-36% of lipids. Lipid shows greater variation, depending on the type of body muscle in the same species. In Table 1 are presented the obtained values of physicochemical analysis of tilapia nuggets made with natural thickener in formulations F1, F2 and F3.

Table 1 – [*]Results obtained for the analysis of pH, water activity, moisture, protein and lipid in nuggets formulated with natural thickener.

Formulation	pH	[**]Water Activity	Moisture (%)	Protein (%)	Lipids (%)	Ash (%)
F1	6.76a	1.02a	78.20a	16.82a	3.40a	0.68a
F2	6.89a	1.03a	79.12a	16.59a	3.46a	0.69a
F3	6.82a	1.01a	77.72a	9.87b	3.76a	1.28a

[*]Averages with the same letter in the same column do not present statistically significant differences ($p>0.05$); [**]Water activity at 24.2 °C.

The pH values were similar for the three formulations, with values of 6.76, 6.89 and 6.82 for F1, F2 and F3, respectively. According to Ogawa & Maia (1999) much of the fresh food, such as meat, fish and plant products, is slightly acidic (pH 5.0 to 6.5).

According to Bordignon et al. (2010), the moisture of tilapia croquettes made with mechanically separated meat was 79.05% and the croquettes made with shavings 'V' was 81.27%. The moisture content in the present study was 78.2 and 77.72 in formulations F1 and F3, respectively, and 79.12 in formulation F2. The processing methodology used may have influenced these results, since the washing step of the base folder (Figure 1), may be the cause of high moisture content and water activity (Table 1). According to Souza et al. (2010) in formulations of nuggets with concentrated shrimp "beef marine" and meat, moisture values were lower than the formulated product yielding 59.8 and 59.7%, respectively. Another factor that may have contributed is the intrinsic characteristics of the fish and their own natural habitat.

Protein content ranged from 9.87 to 16.82%, being similar to those found by Bordignon et al (2010), who obtained 15.11 and 15.34 in croquettes made with tilapia mechanically separated meat and meat trimmings, respectively. Pointing out that the gum polysaccharide does not negatively interfere on the physicochemical characteristics, neither the changes, what is observed is a thickening function regarding the malleability of mass, positively improving the modeling of nuggets in processing. The discrepancy in lipid value with the values found in this study is related to the base washes folder (Figure 1), in which fat globules are carried. According to Oetterer (2002) the underlying technology of the production of protein concentrates for fish process, is the concentration of its protein and remove fat fish through the extraction of lipids.

The physicochemical results found for fish burger are shown in Table 2.

Table 2 – [*]Results obtained for the analysis of pH, water activity, moisture, protein and lipids in fish burger made with natural thickener.

Formulation	pH	[**]Water Activity	Moisture (%)	Protein (%)	Lipids (%)	Ash (%)
F1	6.57c	1.03a	80.37a	13.38a	3.73a	0.70a
F2	6.65a	1.03a	82.05a	12.65a	3.75a	0.67b
F3	6.60b	1.03a	79.86a	13.38a	4.05a	1.09c

[*]Averages with the same letter in the same column do not present statistically significant differences ($p>0.05$); [**]Water activity at 28.0 °C.

Silva & Fernandes (2010), in a study on preparation of fish burger with Corvina (*Argyrosomus regius*), observed 6.55 for analysis of pH, similar to the results found in this study, which ranged from 6.57

to 6.65 (Table 2). The refereed authors also observed values of 68.11% and 1.54% for moisture and ash, respectively, being these values similar to those found in the present study, and protein of 22.75% which is higher than those observed in this study. The lipid content of 0.92% was lower than those found in this study and may be due to the type of fish used which was Corvina (lower lipid content than Tilapia).

The minimum and maximum values of moisture in four different formulations of fish burger prepared with mechanically separated meat of tilapia by Marengoni et al. (2009) were 71.05 and 76.86% being quite similar to those in the present study (Table 2). The referred authors also observed results ranging from 15.50 to 17.74%, 1.2 to 2.44% and 1.73 to 10.28% of proteins, ash and ether extract, respectively. According to Ogawa & Maia (1999) the physical and chemical composition of the edible portion of fish and shellfish varies between 60 and 85% of moisture.

The acceptance of the nugget, concerning the evaluated criteria, is exposed in Table 3. The smell, flavor and global aspect features did not show any significant difference ($p > 0.05$) between the samples. While the appearance and texture characteristics showed significant difference ($p < 0.05$), since the polysaccharide revealed high thickening potential. Oliveira et al. (2012), studying the acceptance of meat balls prepared with tilapia, did not observed difference in the appearance, flavor, smell, color and global acceptance among the different formulations.

To the smell and flavor attributes in the fish burger, there was no significant difference ($p > 0.05$), whereas the appearance, texture and global aspects showed difference in their values (Table 4).

Table 3 – (*)Averages of the sensory characteristics in the acceptance test of the hedonic scale for the three tilapia nugget formulations.

Characteristics	F1	F2	F3
Appearance	7.77a	7.57b	7.30c
Smell	7.60a	7.30a	7.27a
Flavor	7.67a	7.42a	7.17a
Texture	7.12a	7.82a	7.42a
Global Aspect	7.72a	7.60a	7.35a

(*) Averages with the same letter in the same line do not present statistically significant differences ($p > 0.05$).

Table 4 – (*)Averages of the sensory characteristics in the acceptance test of the hedonic scale for the three tilapia fish burger formulations.

Characteristics	F1	F2	F3
Appearance	6.25b	6.77b	7.40a
Smell	7.07a	7.15a	7.12a
Flavor	7.02a	7.17a	7.22a
Texture	5.70b	6.65ab	6.70a
Global Aspect	6.90c	7.22b	7.37a

(*) Averages with the same letter in the same line do not present statistically significant difference ($p > 0.05$).

Simões et al. (1998), studied fish burgers prepared with fish protein basis and added pork and chicken flavors. For each flavor, three formulations were made. Then, difference and acceptance tests were applied, being the latter analyzed through hedonic scale, which presented nine options varying from "Extremely dislike" to "Extremely like". The participants mentioned the consistency and texture as important factors in the product. In this research, the product showed significant difference ($p \leq 0.05$) in formulation F2, more specifically in relation to texture. That confirms the consumer's thought about this aspect mentioned in Simões et al (1998) research.

The result of the nugget purchase intention test pointed satisfactory result, in which 57.5% of consumers said they would certainly buy the product; 27.5% would possibly buy it; 12.5% may or may not buy the nuggets; 0% would not possibly buy it and 2.5% would surely not buy. Souza et al. (2010), studying the physicochemical, sensorial characterization and development of formulated nuggets with concentrated fish protein – marine beef, obtained good product acceptance, with no significant difference between the tested formulations. The result was also satisfactory for fish burger, where 32.5% of the participants reported that will certainly buy the

product; 45% will possibly buy; 20% may or not buy; 2.5% will not possibly buy and 0% will not certainly buy. The sensorial acceptance, the intention to purchase or the rejection of a product may be related to several factors. Among them, we can highlight the cultural habits and patterns, in addition to the individual perceptions, loyalty to certain brands, age, place of consumption, number and type of accompanying consumers at the time they acquire the product (Dasso, 1999). That was also shown by Noronha et al. (2005), in a study about the consumer's expectations and their effects in the sensorial evaluation and acceptance of food items.

These authors reported that the expectation is between the factors that influence in the perception of food products, which may be related to several individual reasons, which interact with physiological, behavioral and cognitive aspects.

Marengoni et al (2009) in their study about the microbiological, sensorial and centesimal characterization of tilapia fish burgers mechanically separated, observed inferior results to the ones obtained in the present research, with averages for the purchase intention standard, ranging from 3.86 to 3.98, which point to results "maybe/maybe not buy" and "possibly buy" the product (Figure 2).
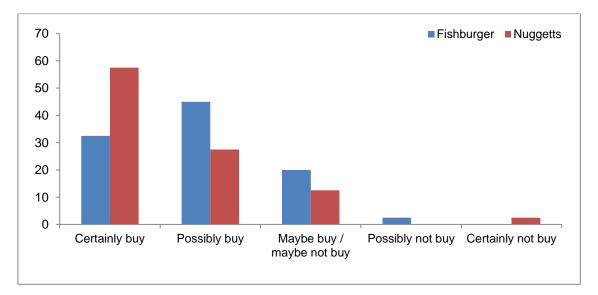

Figure 2 – Percentage of responses on the attitude of consumers to purchase fish derived products: fish burger and nuggets.

Sensory analysis is used as a tool for evaluating the sensory quality of foods by measuring and analyzing reactions in relation to their characteristics, which may be differentiated by human evaluation. In the fish meat we find several characteristics that influence the choice of purchasing a food concerning sensory quality and storage capacity. The chemical composition of a fish species has large variation, this will depend on the age of the animal, season, habitat, nutritional status and sexual maturation, body area and muscle type (light or dark) and even sex (Gonçalves, 2011).

Conclusions

According to the physicochemical analysis, it is concluded that tilapia nuggets and fish burger prepared with polysaccharide gum do not interfere in their chemical composition. For the sensory characteristics, the three formulations of nuggets and hamburgers prepared with tilapia using *Caesalpinia pulcherrima* seed as the thickener were well accepted by the panelists, which declared to have intention to buy these products.

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