

## Development and bacteriological, chemical and sensory characterization of fishburgers made of Tilapia minced meat and surimi

[Desenvolvimento e caracterização bacteriológica, química e sensorial de "fishburgers" de polpa e "surimi" de tilápia]

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### ABSTRACT

In this study fishburger samples obtained from tilapia minced meat and surimi retrieved from fillet frames – filleting process waste – have been assessed. Four different preparations of fishburger were made. Chemical analyses was performed for protein, lipids, moisture and ash assessments, as well as bacteriological analyses through mesophilic aerobic heterotrophic and psychrotrophic bacteria counts, isolation and identification of *Salmonella spp.*, coagulase-positive *Staphylococcus* and fecal coliforms. Instrumental measurements were also carried out for texture and tested sensory acceptance. The costs of the ingredients used in the preparation of formulas were also assessed. Microbiological standards, established by current regulations, were met by all samples. No significant gap ( $P>0.05$ ) was detected among the percentage of protein, moisture and ashes, while a significant gap ( $P<0.05$ ) was verified for lipids. A significant gap ( $P<0.05$ ) for the instrumental measurements of texture was also observed. Both surimi and minced meat fishburger presented good acceptance on sensory tests for taste, texture and overall impression. The use of smoked fish flavoring and surimi caused a considerable increase in costs due to ingredient acquisition. This study shows a positive result for the industrialization and consumption potential of fishburgers made of minced fish retrieved from fillet frames.

Keywords: minced fish, *Oreochromis niloticus*, proximate composition, fishery technology

### RESUMO

Foram avaliadas amostras de "fishburgers" elaboradas com polpa e "surimi" de tilápia obtidos a partir do espinhaço residual da linha de filetagem. Realizaram-se análises químicas de proteína, lipídios, umidade e cinzas; análises bacteriológicas de bactérias heterotróficas aeróbias mesófilas e psicrotólicas; isolamento e identificação de *Salmonella spp.*, *Staphylococcus coagulase positiva* e coliformes fecais; análises instrumentais de textura; teste de aceitação sensorial e levantamento de custo dos ingredientes utilizados na elaboração das formulações. Todas as amostras analisadas atenderam aos padrões microbiológicos estabelecidos pela legislação vigente. Não ocorreu diferença significativa ( $P>0,05$ ) entre os percentuais de proteína, umidade e cinzas, tendo sido observada diferença em relação ao percentual de lipídios entre as amostras. Observou-se diferença significativa entre as amostras avaliadas por análise instrumental, em relação à textura ( $P<0,05$ ). Tanto o "fishburger" elaborado com "surimi" quanto o elaborado com polpa, foram aceitos sensorialmente em relação ao sabor, textura e impressão global. A utilização de flavorizante à base de peixe defumado e do "surimi", resultou em aumento considerável no custo com aquisição de ingredientes. Observa-se um resultado positivo em relação ao potencial de industrialização e consumo do "fishburger" elaborado com polpa de tilápia obtida do espinhaço residual da filetagem.

Palavras-chave: *Oreochromis niloticus*, análise centesimal, tecnologia de pescado

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## INTRODUCTION

In Brasil, according to data published by the *Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis* (Brasil, 2007) fish production in 2007 was 1,072,226 tons, aquaculture alone accounting for 210,644.5 tons. Farmed Tilapia production reached 95,091 tons whereas captured Tilapia accounted for 9,978 tons, in a total of 105,069 tons.

Simões *et al.* (2007) obtained Tilapia fillet yield values of 17.4% (skinless fillets) and 21.6% (fillet with skin) and the resulting waste products totaled 55.8% in average, its use being thus important. In such a context, with the use of mechanically deboned fish meat it becomes possible to make better use of fish resources and of many fresh water fish species, such as Nile Tilapia, which may be used as raw material in the production of minced fish and surimi, as well as other food products, which in turn may be employed in different food formulations. Such fact meets the need to diversify fish-made products (Marchi *et al.*, 2000).

Under the current legislation (Brasil, 2001) limitations regarding the presence of some pathogenic bacteria spread through fish are provided for. In the case of refrigerated or frozen fish-made products, including burgers and like products, the following pathogenic bacteria limits are prescribed: coliforms at 45°C, tolerance for indicative sample ( $10^3$ ); coagulase-positive *Staphylococcus*, tolerance for indicative sample ( $10^3$ ); and in the case of *Salmonella* spp., absence in 25g of sample.

Technical regulations in the identification and quality of the burgers establish the minimum quality conditions of products and define Hamburger as a manufactured meat product obtained from ground meat with or without the addition of fat tissue and ingredients, molded and submitted to adequate technological process. The maximum fat percentage in its composition must be of 23% and the minimum protein percentage must be 15% (Brasil, 2000).

Effective tests aim to measure subjective attitudes such as acceptance or preference for products, individually or in relation to others. The determination of the acceptance of the product by consumers is an essential part of the development and improvement of products (Stone and Sydel, 1992).

According to Tokur *et al.* (2004) among ready-to-cook products, burgers made of beef and chicken meat are the most popular ones in the world and fishburgers have seen their popularity increase. According to a market survey for tilapias and frogs, carried out by SEBRAE/RJ in the cities of Rio de Janeiro and Niteroi (Weichert *et al.*, 2007), consumers associated the intake of Tilapia to a healthy and tasty diet and would be willing to consume derived products of easy preparation.

The objective of the present study was to develop and characterize fishburger made of Tilapia minced meat and surimi obtained through the processing of fillet frames from filleting process waste.

## MATERIALS AND METHODS

Minced meat and surimi were used as basic ingredients for the preparation of fishburger samples, bacteriological, chemical and sensory characteristics being assessed for each different fishburger formulation as well as the costs for acquisition and preparation of the products.

Tilapia (*Oreochromis niloticus*) minced meat and surimi were used as raw material, obtained through the mechanical separation of fish muscles, fillet frames from the filleting process waste, according to the methodology described by Kuhn *et al.* (2004) and Mello *et al.* (2010). Minced fish and surimi samples, experimentally obtained in the fish industry under the oversight of the State of Rio de Janeiro, were stored and transported at -18°C, on the day after processing, to the *Departamento de Tecnologia dos Alimentos da Universidade Federal Fluminense*. Samples were kept at -18°C for 30 days before being used. On the day before the preparation of the fishburgers, samples were kept under refrigeration overnight, at approximately 7°C, for thawing.

Four different fishburger formulations were prepared. In two of them (one of minced fish and one of surimi) smoked fish flavoring was added (Table 1). The obtained patty was hand-molded in a circular shape with the help of a domestic mold. Each fishburger unit presented 90g mean weight and 11mm approximate thickness. The product was individually packed in plastic film and frozen in a domestic freezer unit (-18°C).

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Table 1. Percentage of ingredients used in the different tilapia fishburger formulations

Ingredients	Formulation 1 (%)	Formulation 2 (%)	Formulation 3 (%)	Formulation 4 (%)
Minced fish	86.67	86.17	-	-
Surimi	-	-	86.67	86.17
Textured Soy Protein (TSP)	5	5	5	5
Salt	1.2	1.2	1.2	1.2
Powder garlic	1.5	1.5	1.5	1.5
Powder onion	1.5	1.5	1.5	1.5
Canola Oil	3	3	3	3
Fish flavor	-	0.5	-	0.5
White pepper	0.05	0.05	0.05	0.05
Nutmeg	0.03	0.03	0.03	0.03
Sodium tripolyphosphate	0.3	0.3	0.3	0.3
Sodium eritorbate	0.25	0.25	0.25	0.25
Monosodium glutamate	0.5	0.5	0.5	0.5

Chemical parameters analyzed in triplicate were: protein, through the Micro Kjeldahl method, according to the AOAC (Association..., 1995), using a TE-036 digester and distillator set (Technal Lab, Piracicaba, Brazil); lipids, through the *Soxhlet* extraction method, with electrical heating (Osipan, Rio de Janeiro, Brazil); moisture, through the sterilizer method, at 105°C, in a 315SE drying and sterilization sterilizer (Fanen, São Paulo, Brazil); ashes, through the incineration method, between 500 and 550°C, in a 5.A muffle furnace (Eletreresistex, São Paulo, Brazil). Analyses for lipids, moist and ashes were carried out according to Brasil (1981).

The bacteriological analyses carried out in triplicate were: coagulase-positive *Staphylococcus* counting and identification (Brasil, 2003); *Salmonella* spp. isolation and

identification (Brasil, 2003); counting of aerobic mesophilic heterotrophic bacteria (AMHB) and psychrotrophic aerobic heterotrophic bacteria (PAHB), according to the methodology recommended by Morton (2001) and Cousin *et al.* (2001), respectively; and determination of the most probable number (MPN) of *Escherichia coli* (Merck, 2002 modified by Franco and Mantilla, 2004).

In the texture instrumental analysis, the hardness of fishburger samples made of minced fish and surimi was assessed. Trials were carried out in the TA-TX2 texturometer (Stable Micro Systems – Texture Analyser) in EMBRAPA Sensory and Instrumental Analysis Laboratory. Samples presenting 90g mean weight and 15mm thickness were kept under refrigeration for 12 hours in order to defrost and at 10 ± 3°C temperature until the trial. A 36mm wide cylindrical probe (P/36)

was used for the compression of the sample at 2mm/s up to 10mm of its thickness. Hardness was defined as the maximum positive strength (first peak) obtained in the compression curve. Determinations in two distinct batches produced with minced fish and surimi were performed in six replicates.

An acceptance test (Stone and Sidel, 1992) was carried out with 44 randomly chosen untrained assessors, being 16 men and 28 women, aged from 19 to 60 years old, in individual booths equipped with white lighting. Portions of the four fishburger formulations were served on disposable plates codified by random three digit numbers accompanied with water and crustless bread slices. The different formulations were presented to each assessor one after the other in a random sequence. The degree of acceptance was represented by a structured 9-point hedonic scale, varying between "liked it very much" (9) and "disliked it very much" (1). Making use of a form containing a structured scale, each assessor expressed the degree of acceptance for three attributes (taste, texture and overall impression). On the same form the assessors also expressed their attitude towards consumption by means of a 9-point structured attitude scale (Fact), varying from "would eat it whenever possible" (9) to "would only eat it if forced to" (1). The assessors were informed that the test product was a "fish-made hamburger" without any specification regarding the kind of meat used in its formulation.

Results of physicochemical and sensory analyses were assessed through variance analysis, and the comparison between mean values through Tukey's test (5% probability level), using SAS software – Statistical Analytical System (Statistical, 1999).

## RESULTS AND DISCUSSION

The costs with additives and ingredients used in minced meat and surimi fishburger elaboration can be observed in Table 2. The final cost for the production of one kilo of fishburger with no added flavor was BRL\$1.15 cheaper than that of fishburger with added flavor, regardless of the raw material used (minced fish or surimi). Since the flavoring (smoked fish flavor) used in this study was imported, it was expensive. No similar national product with the appropriate specification was found in the market. When using minced fish as raw material, it was possible to reduce the cost of ingredient acquisition in BRL\$0.70/kg when compared to the use of surimi. According to Regenstein (1986), the production of surimi requires a specific technological process as well as the addition of cryoprotectants to maintain the characteristics of the final product gel. Due to this process there is an increase in production costs which can be considered a disadvantage in the transformation of minced fish into surimi.

Table 2. Cost per produced kilo (BRL\$/kg) of additives and ingredients used in the elaboration of the different fishburger formulations

Formulations	Minced fish (cost of added ingredients)	Surimi (cost of added ingredients)	Spices	Additives	Smoked fish flavor	Total
1	0.009	-	0.040	0.485	-	*0.53
2	0.009	-	0.040	0.485	1.15	*1.68
3	-	0.71	0.040	0.485	-	*1.23
4	-	0.71	0.040	0.485	1.15	*2.38

\*R\$ 1,00 = US\$ 2,17 (October 2008)

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In Table 3, results of the bacteriological analyses for frozen minced meat and surimi fishburgers, for the frozen raw materials (minced fish and surimi), and for both kinds of fishburger after

being fried for 3 minutes on each side, reaching 79°C temperature in the heart of samples, are expressed.

Table 3. Results of bacteriological analyses of frozen and fried fishburger and of raw materials used (minced fish and surimi)

Sample	AMHB (Log10 UFC/g)	PAHB (Log10 UFC/g)	Coagulase-positive <i>Staphylococcus</i> (Log10 UFC/g)	<i>Salmonella</i> spp.	Fecal coliforms (Log10 NMP)
frozen fishburger (minced fish)	8.11	9.99	absence	absence	absence
frozen fishburger (surimi)	2.3	absence	absence	absence	absence
fried fishburger (minced fish)	absence	absence	absence	absence	absence
fried fishburger (surimi)	absence	absence	absence	absence	absence
Raw material (minced fish)	6.38	7.04	absence	absence	absence
Raw material (surimi)	6.06	6.0	absence	absence	absence

AMHB: aerobic heterotrophic bacteria; PAHB: psychrotropic aerobic heterotrophic bacteria; NMP: most probable number.

Results for frozen fishburger samples AMHB and PAHB varied from 2.3 to 9.99 Log<sub>10</sub> UFC/g; there are no limits for the counting of aerobic heterotrophic bacteria for this type of product or the like in the Brazilian legislation. Vieira (2004) stressed that these analyses are used in the industry to assess the efficiency of processing, i.e., how much the number of bacteria increased or decreased during manufacturing phases.

AMHB and PAHB found for frozen fishburgers made of minced meat were relatively high. This could be associated to the kind of handling during the process of raw material retrieval. Surimi was submitted to three washing cycles with chlorinated water at 5 ppm, which probably reduced the level of contamination in relation to minced fish, which was only submitted to

one cycle (Mello *et al.*, 2010). Kirschnik and Macedo-Viegas (2009) observed a lower counting of PAHB in meat mechanically separated from fish (MDFM) that was submitted to washing, suggesting that the washing process may have a beneficial effect on the reduction of microorganisms. Aiming to ensure the safety of the assessors who took part in the sensory analysis, fishburgers were also analyzed after being fried. Both the frozen samples and fried ones complied with the limits established by RDC n° 012 (Brasil, 2001).

In the chemical analyses of samples the following mean percentages were obtained for moisture, protein, lipids, and ashes, accordingly: 75.34±0.09; 18.24±1.23; 4.70±0.09 and 2.12±0.02, for minced meat fishburger, and 74.24±0.09; 17.02±0.72; 0.48±0.06 and

1.30±0.03, for surimi fishburger. Although minced meat fishburger presented a higher protein percentage when compared to surimi fishburger, there was no significant difference between them ( $P>0.05$ ). The values observed are above the minimum protein content (15%) established for hamburgers made of livestock meat under the current legislation (Brasil, 2000). Also, no significant difference was found among the results obtained in moisture and ashes analyses ( $P>0.05$ ).

A significant difference ( $P<0.05$ ) was observed in relation to the percentage of lipid in the samples. This is explained by the kind of raw material used. During the washing cycles in the surimi processing, large amounts of supernatant fat were removed, decreasing the percentage of lipids in the product. Coelho *et al.* (2007) worked with fishburger made of Hake (*Merluccius hubsi*) surimi and found lipid percentages varying from 0.37 to 0.41, depending on the formulations adopted, close to the values found for surimi fishburger in the present study. These authors found lower lipid percentages in fishburger when compared to the percentage found in fresh fish (1.02%) before the processing of surimi, confirming once again the results of the washing process in removing fat. Marengoni *et al.* (2009) found lipid percentages between 1.7 and 10.3 in fishburgers made of mechanically deboned Tilapia meat, the highest values being observed

in formulations with 8% of vegetable fat added. Those values are higher than the maximum percentage found in the formulations elaborated in this study.

Tokur *et al.* (2004) analyzed Tilapia fishburger samples using 77.4% of fillet comminuted in a food processor and obtained values similar to those found in the present work regarding the percentage of protein, lipid and ashes, respectively (17.8%, 5.3% and 2.6%).

The mean values and standard deviation found for the instrumental analyses concerning hardness of raw and refrigerated fishburger samples made of minced fish and surimi were, respectively, 1,345.3g±647.93 and 340.4g±53.94, a significant difference being observed ( $P<0.05$ ). During the processing of fishburger it was observed that surimi became sticky and less hard than minced fish, making preparation difficult. Chen and Huang (2008) reported that the high viscoelasticity of surimi is an important quality characteristic, however, it makes processing more difficult.

Results of the sensory acceptance test can be seen in Table 4. Fishburgers made of minced fish obtained better acceptance than those made of surimi, a significant difference being observed between the samples ( $P<0.05$ ).

Table 4. Mean and standard deviation values obtained in the Acceptance Test of the four Tilapia fishburger formulations

Sample	Taste	Texture	Overall impression	Attitude
minced meat fishburger (with flavor)	7.57a±1.17	7.25a±1.14	7.40a±1.17	6.52a±1.42
minced meat fishburger (without flavor)	7.18a±1.12	6.97a±1.57	7.14a±1.19	6.32a±1.25
surimi fishburger (with flavor)	5.15b±0.33	5.81b±2.13	5.54b±2.13	4.48b±2.03
surimi fishburger (without flavor)	5.13b±1.97	5.66b±1.95	5.40b±1.92	4.36b±1.77

Mean values in the same column followed by different letters presented significant difference ( $p<0.05$ )

No significant difference ( $P>0.05$ ) was observed in relation to the addition of smoked fish flavor neither among samples made of minced fish nor among those made of surimi. However, a tendency for better acceptance of the flavored product was observed. For the flavored minced meat fishburger, 59% of panelists graded the samples eight and nine regarding the taste attribute ("Liked it very much", "Loved it", respectively); for the same, but flavorless, product, 41% graded the samples eight and nine regarding the same attribute. Both surimi and minced meat fishburger, regardless of flavoring, were sensorially accepted with regard to taste, texture and overall impression, reaching above-five means in the hedonic scale.

The sweetish taste of the surimi-made product played a role in its reduced acceptance. Twenty-two consumers, corresponding to 50% of the total, indicated that these samples presented a slightly sweet taste when explaining their lower grading. Manley and Mankoo (2004) showed that one must be particularly careful with the use of sugars as cryoprotectants in surimi. Depending on the kind of sugar used, one may obtain a sweet taste, unsuitable for such product. The surimi used in this study presented a sweetish taste, which could have been attenuated by the use of a sorbitol cryoprotectant in the place of sucrose. Nevertheless, being an imported product, the use of sorbitol cryoprotectants could raise production costs, preventing their use by small manufacturing companies. The addition of greater amounts of some additives and spices could probably help reduce the sweetish taste.

Tokur *et al.* (2004) assessed the acceptance of fishburgers made of Tilapia fillets comminuted in a food processor using the 9-point hedonic scale and obtained mean values between 7.8 and 9 for color, smell, taste, texture, and overall impression attributes. Marengoni *et al.* (2009), through the sensory testing of four different fishburger formulations elaborated with Tilapia MDM for taste, smell, smoothness and overall appearance, obtained mean values varying from 7.1 to 7.5, within the level of moderately accepted to well accepted. Results of these authors converge with those found in the present study for Tilapia minced meat fishburgers, confirming the acceptance of the product and its potential for consumption.

Regarding attitude (intention to consume), only fishburgers made of minced meat were well accepted. Those made of surimi reached lower mean values, corresponding to the term "would occasionally eat it". Marengoni *et al.* (2009) assessing the intention to consume fishburgers made of Tilapia MDM, obtained mean values ranging from 3.86 and 3.98, showing results between "maybe would buy it/maybe wouldn't buy it" and "would possibly buy the product", these values being below those of the present research.

## CONCLUSIONS

Tilapia minced meat and surimi obtained from filleting process waste fillet frames are intermediary raw materials with potential for fishburger elaboration. Both frozen fishburger samples and fried ones complied with the microbiological limits established by the current legislation. Considering the minimum protein and maximum fat standards for hamburgers made of livestock meat, both minced meat and surimi fishburgers complied with standards prescribed by legislation. The use of minced fish resulted in a reduction of ingredient acquisition cost when compared to surimi. Sensory results confirmed the acceptance of consumers regarding fishburgers made of Tilapia minced meat and surimi, minced meat fishburger presenting better acceptance and potential for consumption.

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