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Increase in the nutritional quality of tilapia mechanically separated meat and application in fish patties

Aumento da qualidade nutricional da carne mecanicamente separada de tilapia e aplicação em empanados de peixes

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ABSTRACT
The objective of this study was to develop a mechanically separated fish meat patty (MSM) of Nile tilapia using pressed MSM with the addition of a fish-based condiment to improve consumer acceptability. The MSM was chemically characterized before and after the pressing process in order to evaluate this process. Two formulations were evaluated – F1 without fish-based condiment and F2 with the fish-based condiment. Centesimal composition, shear force, pH, Aw, microbiological analyses, and sensorial analyses were performed. The results showed that the pressing process led to significant effects on the chemical characteristics of Nile tilapia MSM with reduced values of moisture, carbohydrates, and pH and increased values of protein and lipids. The microbiological

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quality of patties is within the sanitary standard required by the legislation. The F2 formulation presented higher lipid and mineral contents than F1 ($p<0.01$). The sensory evaluation showed that F2 had a greater score in acceptance ($p<0.05$) and a greater score in purchase intent ($p<0.05$) than F1. It can be concluded that the pressing process improved the chemical and nutritional characteristics of tilapia MSM patties and that the addition of fish-based condiment enhanced product acceptance.

Keywords: patty; nutritional quality of mechanically separated meat; restructured products; acceptability

RESUMO

O objetivo deste estudo foi desenvolver um empanado de carne mecanicamente separada de peixe (CMS) de tilápia do Nilo usando CMS prensado com a adição de um condimento à base de peixe para melhorar a aceitabilidade do consumidor. O CMS foi quimicamente caracterizado antes e após o processo de prensagem, a fim de avaliar esse processo. Duas formulações foram avaliadas - F1 sem condimento à base de peixe e F2 com condimento à base de peixe. Composição centesimal, força de cisalhamento, pH, Aw, análises microbiológicas e análises sensoriais foram realizadas. Os resultados mostraram que o processo de prensagem levou a efeitos significativos nas características químicas da tilápia do Nilo CMS, com valores reduzidos de umidade, carboidratos e pH e valores aumentados de proteínas e lipídios. A qualidade microbiológica dos empanados está dentro do padrão sanitário exigido pela legislação. A formulação F2 apresentou maiores teores de lipídios e minerais que F1 ($p <0,01$). A avaliação sensorial mostrou que F2 obteve maior pontuação na aceitação ($p <0,05$) e maior na intenção de compra ($p <0,05$) que F1. Pode-se concluir que o processo de prensagem melhorou as características químicas e nutricionais dos empanados de tilápia e que a adição de condimento à base de peixe aumentou a aceitação do produto.

Palavras-chave: qualidade nutricional da carne mecanicamente separada; produtos reestruturados; Aceitabilidade.

1 INTRODUCTION

Despite that the Nile tilapia is cultivated all over the world, the interest in this cultivation has grown rapidly in recent years due to the species' tolerance to a wide range of environmental conditions and high resistance to stress, disease, and captivity (El-SAYED *et al*., 2005; KUBITZA, 2000). Its extensive geographical distribution and great market acceptance have provided a wide range of research worldwide focused on the need to know the species' biology in order to explore its' potential (AZEVEDO *et al*., 2012). This is the main fish species produced in Brazil, accounting for 51.7% of the national production in 2017 (FISH-BR, 2018). The expansion of the fishing industry in Brazil allows it to respond to consumers' demands towards a swelling interest in the acquisition of healthy foods with high nutritional value and easy preparation VIERA *et al.* (2015).

When compared to the whole fish, tilapia fillet is the most commercialized product. However, its yield varies between 28.9 and 33.6% PINHEIRO *et al*. (2006). Therefore, the residue (viscera, skins, fins, scales, head, and carcass) generated in the fish processing industry reaches an average of 68.75% and is destined to the production of fish meals and oil used in animal feed rations.

The residues have high nutritional value and are rich in proteins, minerals, and lipids including fatty acids in the omega-3 series such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Therefore, these residues can be used in the development of products for human consumption (FELTES *et al*., 2010; OLIVEIRA FILHO *et al*., 2010), which could reduce the environmental impact from their discharge and increase the profitability of fish industries (BOSCOLO and FEIDEN, 2007). New technologies have been developed, aiming at the transformation of this residue into new by-products that are high-quality protein foods (FELTES *et al*., 2010). After the filleting process, carcass residues made up of meat and fish bones are subjected to the mechanical separation process known as mechanically separated meat (MSM), which serves as the basis for the preparation of several products of interest worldwide (VIDAL *et al*., 2011).

Changes in lifestyle have led current consumers into searching for products that facilitate the daily preparation of meals (OURIVEIS *et al*., 2020). Changes in lifestyle have led current consumers into searching for products that facilitate the daily preparation of meals. Patties have been an interesting alternative because of their practicality in meal preparation. In addition, these products allow adding nutritional value and convenience that serve the interests of both producers and consumers. The shelf-life of these products is higher than that of fresh fish as the result of delayed fat oxidation (DILL *et al*., 2009). Patties are considered restructured products based on MSM and other condiments; a fish-based condiment is one of these condiments; it contains ground seasoned tuna fish and is used as a flavor enhancer.

Thus, the objective of the present work was to develop MSM patties made of Nile tilapia from pressed MSM and with and without the addition of a fish-based condiment.

2 METHODS

The study was conducted at the Fish Technology Laboratory of the Instituto Federal do Paraná Foz do Iguaçu. The study was approved by the Committee on Ethics in Research with Human Beings of the Paraná Midwest State University Unioeste under project nº 61654016.9.0000.0107.

The mechanically separated fish flesh was obtained from the Consolata Agroindustry Cooperative - Copacol in Nova Aurora, PR, Brazil. Other ingredients were: pre-gelatinized starch (GTfoods, Quatro Pontes, PR, Brazil), fish-based condiment (Ajinomoto, São Paulo, SP, Brazil), sodium erythorbate (Pryme Foods), sodium chloride (Cisne, São Paulo, SP, Brazil), tripolyphosphate (Saber Química, Barueri, SP, Brazil), dehydrated onion and garlic, white pepper (Kitano, São Paulo, SP, Brazil), and white flour for dough preparation (Baptistella, Itatiba, SP, Brazil).

Preparation of the raw material

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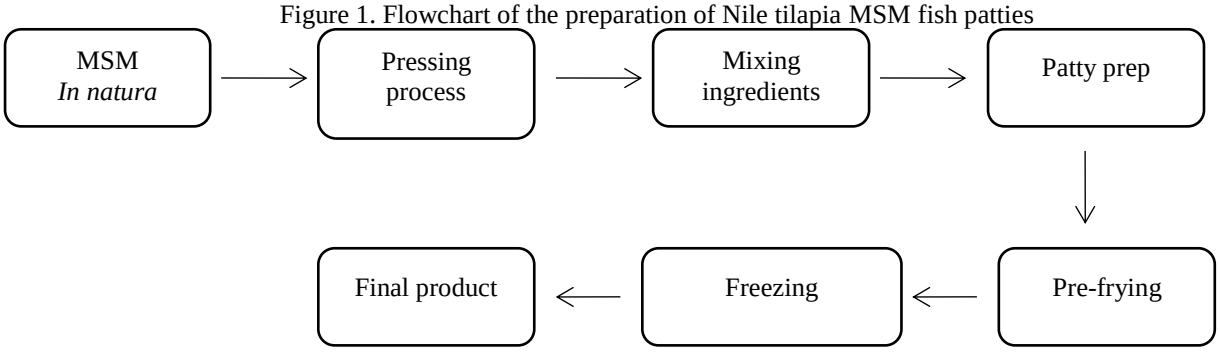
The Nile tilapia MSM was kept frozen at -18 ºC. The MSM is produced from the carcass with chips and fins and subjected to washing after the extraction according to the methodology employed by the industry.

In this study, the MSM was thawed in the refrigerator (4 ± 2 °C) for 12 hours; 1.5 kg batches were submitted to the pressing process using a press (Etiel Gramado, Rio Grande do Sul, Brazil). The pressing force was applied initially for 5 minutes until the beginning of water and blood loss, followed by another five minutes.

Preparation of Nile tilapia MSM fish patties

The Nile tilapia MSM fish patties were prepared following the adapted formulation of Lima *et al*. (2015) (Figure 1).

Figure 1. Flowchart of the preparation of Nile tilapia MSM fish patties



An electric processor (RI7620-71, Philips, Barueri, SP, Brazil) was used to mix the ingredients by following the formulation (Table 1). Initially, the textured soy protein was processed with the ice; after homogenization, sodium erythorbate, tripolyphosphate, onion, garlic, rosemary, dehydrated parsley, white pepper, sodium chloride, and fish-based condiment were added. Subsequently, pregelatinized starch was added and homogenized manually for 5 minutes. Patties were molded with the aid of cast (1.1x2.5x6 cm).

Table 1. Formulation of Nile tilapia fish patties with and without the fish-based condiment.

Ingredients	Patty (%)	
	F1	F2
MSM	77.94	76.44
Ice	16.00	16.00
Pre-gelatinized starch	2.00	2.00
Textured Soy Protein	2.00	2.00

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Fish-based condiment	-	1.50
Sodium Chloride	1.30	1.30
Sodium erythorbate	0.20	0.20
Tripolyphosphate	0.15	0.15
Dehydrated onion	0.15	0.15
Dehydrated garlic	0.10	0.10
Parsley	0.08	0.08
White pepper	0.05	0.05
Rosemary	0.03	0.03

Note = MSM mechanically separated fish meat. F1 without the fish-based condiment; F2 with the fish-based condiment.

The patties were coated with a proprietary flour (Baptistella brand, Itatiba, SP, Brazil) by first coating with prenex (pre-flouring) followed by liganex (which promotes the ligation between the substrate to the covering flour), finishing with a coat of bread flour (M granulated 2). The minimum and maximum percentages of added coverage (pick-up) were pre-defined for purposes of weight standardization GONÇALVES (2011), is defined by Equation 1.

$$\text{Pick} - \text{up} = \frac{P_f - P_i}{P_f} x100 \quad (1)$$

Where P_f is the final weight with coverage (g), and P_i is the initial weight without coverage (g).

The pre-frying stage was carried out in soybean oil (180 ± 5 °C) for 30 seconds in a frying pan with a screen; a skewer thermometer (TP 3001, digital thermometer, Guangdong/China) was used to monitor the oil temperature. The pre-frying process was performed to promote coating adhesion and prevent losses during freezing, transportation, and handling. After pre-frying, the samples were packed in polyethylene packaging and stored frozen (-10 to -8 °C).

Characterization of the MSM and fish patties

The MSM *in natura*, the CMS submitted to the pressing process, and patties' samples, prepared with and without the addition of the fish-based condiment, were characterized through centesimal analyses, pH, water activity, and microbiological profile. The texture was also analyzed in the patties' samples.

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Centesimal Analysis

The analysis of centesimal composition followed the methodology recommended by the AOAC (2000). The following analyses were carried out: moisture at 55 ºC in an oven (ASL 102, Solab, Piracicaba/SP, Brasil) for 72 hours; dry matter at 105 ºC in an oven (ASL102, Solab, Piracicaba, SP, Brazil) for 8 hours; mineral matter at 550 ºC by muffled incineration (0318m25T, Quimis, Diadema, SP, Brazil); lipids in a Soxhlet extractor (TE-044-5, Tecnal, Piracicaba, SP, Brazil); determination of total nitrogen by the Kjeldahl method (MA036, Marconi, Piracicaba, SP, Brazil); and nitrogen conversion into protein factor 6,25.

Analysis of pH and water activity

The pH determinations were performed in a suspension prepared as follows: 40 mL of distilled water and 10 g of MSM and 50 mL of distilled water and 10 g of fish patty (pH meter, mPA 210, Tecnopon, Piracicaba, SP, Brazil) (LIMA *et al*., 2015). The water activity (Aw) was measured through a water activity analyzer (Labswift, Novasina, São José dos Campos, SP, Brazil).

Microbiological Analyses

The microbiological analyses performed were: maximum Staphylococcus coagulase positive 10^2UFC-g^{-1} (NF EM ISSO 6888-1-A1, January 20 04); absence of Salmonella *sp*. in 25 g (NF EM ISSO 6579, December of 2002); Coliforms at 45 °C under the limit of 10^2 NMP-g^{-1} (IN MAPA/DAS N. 62, August 26 of 2003); and Escherichia coli counting $3x10^6$ UFC-g^{-1} (PETRIFILM 3M COLI COUNTING, AOAC 998.08).

Texture Analysis

The texture profile analyses were performed on samples cooked at room temperatures. The shear force was determined through a texturometer (TAHD pluse, TATX-2i, Itatiba, SP, Brazil) with a Warner Bratzler probe and a 5 kg load cell was used to evaluate the patties shear force, at a shear rate of 2.0 mm, sec, with a 35.00 mm thickness and the results were expressed in Newtons (N).

Sensorial Analysis

The sensory analysis was conducted in patties removed from the freezer and placed in a gas oven while still frozen (FLG 700, G. PANIZ, Caxias do Sul, RS, Brazil) they were roasted for 15 minutes on each side at 200 °C ± 5 °C. A pin thermometer was used to ensure that the cooking temperature in the geometric center of the product reached a minimum and maximum temperature of 72 °C and 75 °C, respectively.

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The sensorial evaluation of the MSM fish patties was carried out to verify which formulation had the best taster acceptance through the use of the Hedonic scale test of 1 to 9 points, (from 'I highly disliked it' to 'I liked it a lot') and purchase intent through a scale of 1 to 5 points ('I would certainly not buy the product' to 'I would certainly buy the product'). The group of 71 untrained tasters determined their preference according to DUTCOSKY (2015).

Data Analyses

Data analysis for the MSM characterization (*in natura* and subjected to pressing) included the Permutational multivariate analysis of variance (PERMANOVA) and average comparisons with 95% confidence interval in the Statistica version 8.0 (StatSoft INC., USA) statistical software. Permanova followed by the t-Test with assumptions of homogeneity and heterogeneity were used to verify the effect of the addition of the fish-based condiment on the breading formulation, the characterization data, and the sensory analysis data.

The results were expressed through means and standard deviation; the experiments were performed with six replicates.

3 RESULTS

Characterization of MSM pressed and MSM in natura

The MSM pressing process resulted in a 34.5% loss of water and blood in the product, reducing the moisture content and concentrating the content of crude protein and lipids (Table 2). Pressed MSM showed 51.84% increase in crude protein content, 41.66% in lipids, 42.04% in the mineral matter, and 12.50% decrease levels of carbohydrates and 13.09% in pH values.

Table 2. The chemical composition of tilapia MSM of *in natura* submitted to the pressing process. Note = MSM: mechanically separated meat.

Parameters	Treatment		Nutrients concentration *(%)	p-value
	MSM *in natura*	Pressed MSM		
Humidity (%)	84.78± 0.22	77.20 ± 0.41	- 9.81	0.00**
Crude protein (%)	13.02 ± 0.20	19.77± 0.41	+ 51.84	0.00**
Lipids (%)	0.96± 0.01	1.36± 0.06	+ 41.66	0.00**
Mineral Matter (%)	0.88± 0.21	1.25± 0.23	+ 42.04	0.270^{ns}
Carbohydrates*** (%)	0.24± 0.02	0.21± 0.02	- 12.50	0.017**
pH	7.33± 0.03	6.37± 0.01	- 13.09	0.040**
Water activity	0.99± 0.00	0.99± 0.00	-	0.621^{ns}

*The nutrients concentration was calculated considering the raw material *in natura* as 100%
**Significant at the 95% confidence level; treatments are statistically different. ^{ns}Non-significant at the 95% confidence level; treatments are statistically similar.
***calculation by calculation difference.

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Table 3 shows that the results of the microbiological analyses of coagulase-free, MSM, *Staphylococci*, *Salmonella* ssp., Thermotolerant coliforms, and *Escherichia coli* (UFC-g^{-1}) remained below those preconized by the legislation.

Table 3. Microbiological analyses of tilapia MSM *in natura* and submitted to the pressing process. Note: MSM: mechanically separated meat; NMP: most probable number of microorganisms in the sample

Parameters	Treatment		Maximum limits
	MSM *In natura*	Pressed MSM	Brasil b(2001)
Coagulase positive Staphylococci	<1.0 x 10^1	<1.0 x 10^1	Max. 10^2CFU-g^{-1}
Salmonella ssp.	absent	absent	absent in 25 g
Thermotolerant coliforms	<1.0 x 10^1	<1.0 x 10^1	Max. 10^2 NMP-g^{-1}
Escherichia coli (UFC-g^{-1})	<1.0 x 10^1	<1.0 x 10^1	Max. 3x10^6 CFU-g^{-1}

Characterization of patties

The statistical analysis of the chemical composition of patties (Table 4) showed that the lipid and mineral matter contents presented a significant difference (p-value < 0.01). The Pick-up levels (minimum and maximum percentage of coverage) were 24.61% and 18.33% for F1 and 26.12% and 18.44% for F2 in the cooked product.

Table 4. The p-values for chemical composition, with and without fish-based condiment in tilapia MSM patties. Note: Treatment: F1 without fish-based condiment; F2 with the fish-based condiment.

Parameters	Treatment		p-value
	F1	F2	
Humidity (%)	55.78 ± 0.52	56.47 ± 0.43	0.020^{ns}
Crude protein (%)	15.40 ± 0.06	15.44 ± 0.86	0.889^{ns}
Lipids (%)	7.01± 0.07	7.30± 0.08	< 0.001*
Mineral matter (%)	2.35± 0.29	2.93± 0.27	0.003*
Carbohydrates (%) **	19.44± 0.62	17.85± 1.24	0.011^{ns}
Water activity	0.97± 0.01	0.96± 0.00	0.017^{ns}
pH	6.55± 0.06	6.50± 0.01	0.038^{ns}
Texture (N)	7.60± 0.11	7.72± 0.17	0.206^{ns}

*Significant at the 99% confidence level; treatments are statistically different. ^{ns}Non-significant at the 99% confidence level; treatments are statistically similar.
**Carbohydrates by calculation difference.

The Table 5 shows that the results of the microbiological analyses of coagulase, *Staphylococci*, *Salmonella* ssp., Thermotolerant coliforms, and *Escherichia coli* (UFC-g^{-1}) in the F1 and F2 treatments remained below those preconized by the legislation.

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Table 5. Microbiological analyses of Nile tilapia patties, with and without the fish-based condiment. Note: Treatment: F1 without fish-based condiment; F2 with the fish-based condiment.

Parameters	Treatment		Maximum Limits
	F1	F2	Brasilb (2001)
Coagulase positive Staphylococci	<1.0 x 10^1	<1.0 x 10^1	Max. 10^2UFC-g^{-1}
Salmonella ssp.	Absent	Absent	Absent in 25 g
Thermotolerant coliforms	<1.0 x 10^1	<1.0 x 10^1	Máx. 10^2 NMP-g^{-1}
Escherichia *coli* (UFC-g^{-1})	<1.0 x 10^1	<1.0 x 10^1	Máx. 3x10^6 UFC-g^{-1}

Sensorial analysis

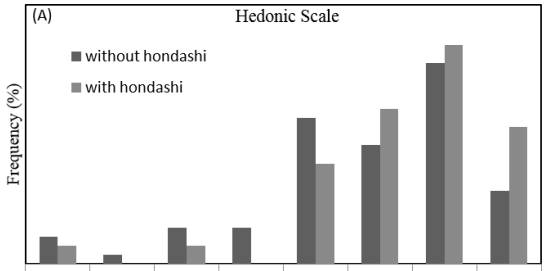
The sensorial analysis was performed with 71 untrained tasters at the mean age of 31.07 ± 11.65 years. The results are shown in Table 6. The mean values attributed by the tasters for the F1 and F2 formulations presented a significant difference ($p > 0.05$) in both hedonic scale and purchase intent evaluation (Figure 2).

Table 6. Sensorial analysis of the Nile tilapia MSM patties. Note: Treatment: F1 without fish-based condiment; F2 with the fish-based condiment.

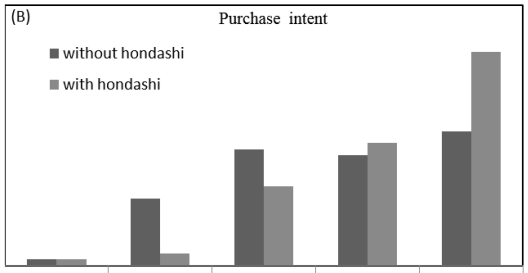
Parameters	Treatment		p-value
	F1	F2	
Hedonic Scale	6.76± 1.72	7.38± 1.47	0.023*
Purchase intent	3.69± 1.11	4.21± 0.93	0.003*

*Significant at the 95% confidence level; treatments are statistically different. ^{ns}Non-significant at the 95% confidence level; treatments are statistically similar.

Figure 2. (A) Hedonic scale the sensorial analysis of patties with and without the fish-based condiment. (B) Purchase intent the sensorial analysis of patties with and without the fish-based condiment.



	2	3	4	5	6	7	8	9
without hondashi	4,22	1,41	5,63	5,63	22,53	18,31	30,99	11,27
with hondashi	2,82	0	2,82	0	15,5	23,95	33,8	21,12



1	2	3	4	5
1,41	15,49	26,76	25,35	30,99
1,41	2,82	18,31	28,17	49,3

4 DISCUSSION

Characterization of MSM pressed and MSM in natura

The chemical composition of the MSM in natura presents a high nutritional value and can be considered an excellent protein source in several types of food that are prepared with this raw

material. The results are in agreement with the results of several studies showing that the chemical composition of tilapia MSM in natura is variable depending on residues; the following values of moisture (69 to 90%), crude protein (13 to 17.5%), lipids (2.9 to 15.42%), mineral matter (0.8 to 1.5%), and carbohydrates (0.4 to 0.8%) are reported by (SARY *et al*., 2009; REBOUÇAS *et al*., 2012; FOGAÇA *et al*., 2015).

The presence of protein in food processed products has the function of emulsifying, gelatinizing, and retaining water and fats, improving sensory characteristics and nutritional properties (RAMACHANDRAN *et al*., 2007). Thus, the MSM pressing process can be considered an important step that precedes the preparation of patties, improving the MSM technological properties.

Lipid values were well below the results reported in other studies, which is related to the MSM extraction procedure adopted by the company, increasing its stability with respect to oxidase reactions. The lipid content in fish is very variable, depending on the species, sexual cycle, body part, age, and diet (EYMARD *et al*., 2005).

The mineral matter content was significant and dependent on the body part included in the MSM extraction. Therefore, the inclusion of fins, pectorals, and fish MSM contributes to this increase (REBOUÇAS *et al*., 2012).

Other parameters that directly influence the physical and chemical modifications of foods are pH and water activity (Aw). The acidity and water activity in the food are correlated with the development of microorganisms and must be in the range between 0.90 and 0.99 (FERREIRA NETO *et al*., 2005), and with their metabolic activities, thus altering the quality and stability of the final product (CHIRIFE and BUERA, 1996).

After the pressing process, a reduction in pH levels was observed due to the loss of blood during the process, which improves the quality of the food. According to the Regulation of the Industrial and Sanitary Inspection of Animal Products - RISPOA BRASIL (2001b), the pH value observed in the pressed MSM is in agreement with the established limit of 6.8 for fish meat.

Therefore, it can be observed that a simple methodology applied in the MSM reduced humidity and improved the nutritional quality of the product, concentrating nutrients (proteins, lipids, and mineral material) and decreasing carbohydrate content and pH improving the MSM stability and increasing the potential use in new products based on MSM. Microbiological analyses were performed prior to the preparation of patties, and the results obtained remained below those recommended by the legislation, and thus, meeting the microbiological standards for food.

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Characterization of patties

The F2 patties presented higher content of mineral matter compared to the F1 patties, possibly as the result of the addition of fish-based condiment, which has in its composition various ingredients such as salt, tuna fish, sugar, maltodextrin, hydrolyzed vegetable protein, meat extract, monosodium glutamate flavor enhancer, inosinate disodium, and anti-moisture tricalcium phosphate, all of which contribute to the observed increase.

In the meat processing industry, salt is used as a flavoring agent or flavor enhancer and preservative, which has functional properties activating proteins to increase hydration and water binding capacity, and thus, facilitating the incorporation of fat and enhancing texture (DESMOND, 2006; RUUSUMEN and PUOLAMNE, 2005; FELTES *et al*., 2010).

According to WALLIS and CHAPMAN, (2012) apud RODRIGUES *et al*. (2016) food flavor enhancers, such as monosodium glutamate (MSG), mimic the perception of the salty taste and can reduce the sodium content in the final product by 40%. The levels of sodium chloride used in the formulation were 1.3%, which was below the values used in other studies such as 2% of sodium chloride used in Nile tilapia nuggets (LIMA *et al*., 2015). The reduction in sodium intake is a recommendation of the World Health Organization (WHO), which indicates the maximum adult daily intake of 5 g of NaCl (less than 2 g of sodium - daily) (ORGANIZAÇÃO MUNDIAL DA SAÚDE, 2011). The fish patties studied here comply with the guidelines established by the WHO because their salt content is below the recommended value (0.33 g).

The lipid values observed in this study were higher in the fish-based condiment patties than in those without this ingredient; however, no fat sources were used in both types of patties, except for the fat content in the MSM. Thus, it is possible to affirm that the lipid content in the patties come from the pre-frying step because evaporation of water occurs during this procedure being replaced by vegetal oil. The lipid value in the pressed MSM was low, and no fat was added in the formulation (Table 1). However, the pick-up levels and fat retention values were 2.86% in F1 and 2.64% in F2 in the patties.

The values of carbohydrates and proteins in the studied patties met the current legislation of the Technical Regulation of Patty Quality and Identity BRASIL (2001a) that emphasizes that breaded products and meat products should not exceed the maximum amount of 30% of total carbohydrates and a minimum quantity of 10% of protein. The increased carbohydrates and reduced protein levels are related to the coating flour used in the product. Carbohydrates are related to proteins; therefore, excessive meal coating must be avoided because it raises the carbohydrate levels and reduces the protein levels. The carbohydrate levels are related to the meal used for a coating, which increases the

yield levels of the product, and therefore, increases the Pick-up levels (minimum and maximum percentages of coverage) to comply with the current legislation.

BONACINA and QUEIROZ (2007) worked with different levels of milk powder and sodium lactate in washed croaker MSM patties and report results in lipids and ashes that are similar to those observed in this study, however, their protein and carbohydrate results were lower than those reported in this study. These high values observed in our study may be related to the MSM pressing process, which concentrates protein.

The Aw values observed were lower than the values found in the raw material; the inverse was observed for pH values, which improves product stability.

The values of texture may be related to the formulation and the breading process, which increases texture in the patty's surface producing crispness and crunchiness. BAINY *et al*. (2015) verified the texture profile in tilapia hamburger during storage and freezing period of six months and found values between 5.5 and 5.8N; these authors verified that hardness increased during storage because the water provided less resistance to compression.

The results of the microbiological analysis showed that the values remained below that values recommended by the legislation, and thus, meeting the microbiological standards for foods.

Sensorial analysis

Therefore, the formulation with the fish-based condiment (F2) presented better acceptance ('I liked it regularly') and purchase intent ('I would possibly buy the product') compared to the formulation without fish-based condiment (F1) (Table 6). This result is explained by the fact that this condiment is a fish flavor enhancer improving the sensorial characteristics. ANGELINE (2010) reports a similar behavior of improved consumer acceptance toward tilapia patties made with MSM and 2.0% fish-based condiment.

The results obtained from the analyzes chemical composition in the pressed MSM product indicates that the pressing process improves the physical-chemical characteristics of and sensorial analysis and that the inclusion of fish-based condiment enhances the product's flavor without changing the sensorial patterns established.

He observed that up to point 6 (Figure 2A) and up to point 3 (Figure 2B), there is a better acceptance of the product without addition of fish based condiment. When there is an increase in the intention to buy the product, it is observed a better acceptance of the empanado with fish-based condiment, demonstrating the importance of this condiment in the elaboration of the empanadas.

5 CONCLUSION

The pressing process in the production of mechanically separated meat improved the nutritional quality and texture of the raw material used for the development of fish patties.

The addition of fish-based condiment in the empanadas provided better acceptance and purchase intent as it enhanced the taste of fish in the product. In this way, it was concluded that the use of MSM pressing of tilapia is a technological alternative for the industry of fish beneficially for its use in restructured products.

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