Evaluation of cookies with inclusion of different levels of barred sorubim *(Pseudoplatystoma fasciatum)* flour

Avaliação de biscoitos de milho e polvilho com inclusão de diferentes níveis de farinha de surubim (*Pseudoplatystoma fasciatum*)

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ABSTRACT
The objective of this work was to elaborate a corn biscuit with inclusion of different levels of barred sorubim head flour, and to evaluate it for its physico-chemical, sensory and microbiological characteristics. Four treatments were elaborated with inclusion levels of 0%, 5%, 10% and 15% of barred sorubim head flour, in relation to the biscuit formulation flour. Microbiologically, flour and cookies were within the standard for human consumption. Barred sorubim head flour promoted the enrichment of corn flour cookies, as a function of increasing protein, lipid and mineral contents, especially calcium with reduced carbohydrates in the product. The lightness of the cookies decreased and the fracturability increased as the inclusion levels increased. It is concluded that the inclusion of up to 10% of barred sorubim head flour in the floured corn cracker is feasible while, above this level, the sensory acceptance of the product decreases.

Keywords: by-product optimization; filleting waste; fish technology.

RESUMO
O objetivo do trabalho foi elaborar um biscoito de milho com inclusão de diferentes níveis de farinha de cabeça de surubim, e avaliá-los quanto às suas características físico-químicas, sensoriais e microbiológicas. Foram elaborados 4 tratamentos com níveis de inclusão 0%, 5%, 10% e 15% de farinha de cabeça de surubim, em relação ao polvilho da formulação do biscoito. Microbiologicamente, a farinha e os biscoitos estavam dentro do padrão para consumo humano. A farinha de cabeça de surubim promoveu o enriquecimento de biscoitos de milho com polvilho, em função de elevar os teores de proteína, lipídeos e matéria mineral, em especial o cálcio com a redução de carboidratos no produto. A luminosidade dos biscoitos diminuiu e a fraturabilidade aumentou conforme houve acréscimo nos níveis de inclusão. Conclui-se que é viável a inclusão de até 10% de farinha de cabeça de surubim no biscoito de milho com polvilho, pois acima destes níveis, a aceitação sensorial do produto diminui.

Palavras–chave: Cabeça de peixe, otimização de subproduto, resíduos de filetagem.

1 INTRODUCTION

The elaboration of a differentiated product for a consumer market of complete and ready-to-use foods demands that it is a palatable reminder and with proven nutritional supplementation.

The cornmeal cookie is traditional as an accompaniment to teas and snacks. With the intention of enriching a base recipe, commonly consumed, increasing the content of

protein, energy and minerals using an ingredient of animal origin, such as fishmeal, results in a technological innovation with good acceptance by the general population.

It is known that the development of techniques for transforming disposable and polluting materials into value-added co-products is the basis for the sustainable development of the industrial sector (Honma et al., 2021). Residues from fish processing are available in large quantities in Brazil and freshwater fish are rich in essential amino acids (Goes et al., 2016a). In fishmeal composition there are high concentrations of protein associated with high amounts of good quality minerals and fatty acids (Souza et al., 2017).

Several works have been carried out to develop fish meal of different species for human consumption (Godoy et al., 2013; Souza et al., 2017), through their inclusion in food products such as cookies and crackers (Franco et al., 2013), snacks (Justen et al., 2016), pasta and cake (Goes et al., 2016a, b), among others. This inclusion has been shown to be viable to increase the nutritional value of the products. Thus, the development of products with the inclusion of fish and their derivatives is a way to encourage the consumption of this food and to increase the fish production chain. The use of fishery by-products is increasingly used in economically viable products, with relevant biological values in animal protein and considerable levels of essential amino acids (Centenaro et al., 2007).

The objective of this work was to elaborate corn biscuits with inclusion of different levels of barred sorubim head meal, and to evaluate them for their physico-chemical, sensory and microbiological characteristics.

2 MATERIAL AND METHODS

To prepare the flour, barred sorubim *(Pseudoplatystoma fasciatum)* heads were washed, weighed, sanitized (0.1 mg / kg peroxitane) and cooked in an antioxidant butylated hydroxytoluene pressure cooker - BHT - 0.5 mg / kg) for 60 minutes. They were pressed (10-ton capacity hydraulic press) and ground in a meat grinder. A homogeneous mass was obtained which was dehydrated in a drying oven at 50 ºC for 24h. The dehydrated product was ground and re-ground in a knife mill (Willye - model TE-650, Tecnal, Piracicaba, Brazil), the flour was vacuum packed and frozen (-18 °C) until cookies were prepared.

Cornmeal cookies were formulated with the inclusion of 0, 5, 10 and 15% of barred sorubim head flour, according to the formulation presented in Table 1. The

inclusion percentages were from the substitution of 5, 10 and 15% of the total sweet flour by barred sorubim head flour. After weighing and mixing the ingredients by hand, they were cut evenly and baked in a gas oven for 30 minutes.

Table 1: Formulation of corn crackers with inclusion of barred sorubim head flour.

Inclusion levels	*Ingredients (g)*								
	Eggs	Sugar	Vegetable fat	Chemical yeast	Wheat flour	Grated coconut	Cornflour	Sweet powder	Fish flour
0%*	150,0	270,0	125,0	5,0	160,0	50,0	200,0	250,0	0,0
5%	150,0	270,0	125,0	5,0	160,0	50,0	200,0	237,5	12,5
10%	150,0	270,0	125,0	5,0	160,0	50,0	200,0	225,0	25,0
15%	150,0	270,0	125,0	5,0	160,0	50,0	200,0	212,5	37,5

* Formulation used for substitution levels of 0, 5, 10 and 15% of fishmeal in the cookie.

Moisture and mineral matter of corn flour and crackers, with different levels of barred sorubim head meal replacement, were determined in duplicate, and carbohydrate determination was obtained through the difference of the other nutrients analyzed (AOAC, 2005). For the determination of total lipids, the Bligh & Dyer (1959) extraction method was employed; crude protein was determined by the Kjeldahl method (Silva & Queiroz, 2002).

Caloric value (CV) was obtained by summing the values obtained by crude protein (CP), total lipid (LT) and carbohydrate (CB) contents, multiplied by the factors 4, 9 and 4, respectively (Souci et al., 2000).

The pH of the biscuits with barred sorubim flour inclusion was determined by homogenizing the crushed sample with distilled water (1:10 sample / water) and analyzing the solution with the pH meter (DM 22, Digimed, São Paulo, Brazil). The water activity of the samples from each treatment was determined using the Aw Sprint - Novasina TH-500 (Novasina Co. Ltd., Talstrasse, Switzerland) apparatus.

About 100 g of barred sorubim head flour and 100g of corn crackers from each treatment were used for microbiological analysis, according to the protocol recommended by the Sanitary Surveillance (BRASIL, 2001). Were analyzed the most probable number (MPN) of coliforms at 35 ºC and 45 ºC, positive coagulase *Staphylococcus* count in colony forming unit (CFU / gram) and *Salmonella* spp. to 25 g of sample.

The parameters of colour were measured using a colorimeter (Minolta CR-10, Minolta Co., Ltd., Osaka, Japan), where L * defines the lightness (0 = black and 100 = white), redness index a* (- = green and + = red) and yellowness index b* (- = blue and + = yellow).

The Texture Analysis Profile (TAP) of the biscuits was performed on day 4 of refrigerated storage (7°C), using a Brookfild texturometer (CT3, Middleboro, MA, United States), using a 30 mm gauge long-stemmed P / 35 aluminum probe and the following parameters: target = 10.0 mm; force load = 20 g; pre-test speed = 2 mm / s; test speed = 2 mm / s; post-test speed = 2 mm / s; adhesion force = 5 g; distance = 5 mm with measured compressive strength, load cell = 50000 g. The texture analysis was performed in ten repetitions for each treatment, by compressing the probe in the cookie, centered and arranged on the platform.

Texturometer adjustment was performed according to the technique described in the manufacturer's manual. It was considered the factors fracturability (g) and hardness work (j). T en samples from each treatment were also weighed in a semi-analytical balance and then the cookies were measured on two sides to determine the area. Results were expressed in N and represent the arithmetic mean number of breaking strength determinations of the samples from the same assay.

Sensory analysis of biscuits was performed with 75 untrained panellists who assessed the sensory attributes of aroma, color, taste, texture, and the overall impression of the products. The members of the panel received the samples randomly coded with a form with the 9-point hedonic scale (1 = very disliked and 9 = very much liked), for purchase intention a 5-point hedonic scale was used (1 = certainly not would buy and 5 = would certainly buy) (Dutcosky, 2011).

The experimental design was completely randomized and the results of the analyzed variables were presented as mean ± standard deviation for each treatment analyzed. To compare the treatments was applied the ANOVA followed by regression test with 5% probability, using the Statistical Analysis System (SAS, SAS Inst. Inc. Cary, NC, USA).

3 RESULTS AND DISCUSSION

The head meal was produced from barred sorubim filleting by-products, which presented high nutritional value, being considered a solution to waste disposal problems, as well as an ingredient that can be incorporated in different food product formulas with the purpose of enrichment, as performed on salty crackers (Ibrahim, 2009).

The barred sorubim head meal analyzed presented 10.39% moisture, 50.67% crude protein, 6.0% lipids, 28.93% ash, 4.07% carbohydrate and a caloric value of 272.575 Kcal. / 100g of flour. These values are considered nutritionally high when

compared with results of fish meal of other species. Stevanato et al. (2007) prepared the tilapia head meal that presented 6.0% moisture, a value lower than that observed in this experiment with head of barred sorubim, being in agreement with the Regulation of Industrial and Sanitary Inspection of Animal Products (RIISPOA, 1997) which affirms that fishmeal should contain no more than 12% moisture.

Ash, protein and lipid values found in tilapia head meal reported by Stevanato et al. (2007) were 19.4%, 38.4% and 35.5%, respectively While barred sorubim head meal presented 9.53% more ash content and 12.27% protein, but lipid levels were much lower by 29.5%. Other authors observed variation in lipid content of fish head meal, as reported by Guilherme et al. (2007), that obtained a lipid content of 12.5% in head shrimp meal. Several factors can interfere in this expressive difference, characteristic of the species used in the flour production.

The contents of ash, crude protein and lipids were considered high in barred sorubim flour and, when it was utilised in the preparation of corn flour cookies, there were changes in nutrients of the product. There was a gradual increase in the levels of mineral matter, crude protein and lipids, as the inclusion levels of barred sorubim flour increased (Table 2). In detail, the increase in mineral matter or ashes was 19.15% for biscuits with 5% fish meal compared to those without flour, which translates into greater mineral input through fish biscuits. An increase in values was observed as the level of inclusion of fishmeal increased (Table 2), and the same was reported by Haj-Isa and Carvalho (2011) when studying the inclusion of hake in salty crackers.

Table 2: Proximate composition, caloric value (CV), calcium and phosphorus contents of corn cookies including sorubim head flour at different percentages.

Parameters	Inclusion levels (%)				P value
	0	5	10	15	
Moisture	5.07±0.02[1]	5.73±0.64	4.45±0.64	5.11±0.02	0.0600
Crude protein	3.21±2.47	5.71±0.03	6.28±0.60	7.53±1.84	0.0000[1]
Total lipids	1.18±1.42	1.34±1.25	1.73±0.86	6.13±3.53	0.0010[2]
Ashes	0.94±0.56	1.12±0.38	1.73±0.23	2.21±0.71	0.0044[3]
Carbohydrates	89.56±4.46	86.07±0.97	85.77±0.67	79.00±6.10	0.0001[4]
CV (Kcal/100g)	381.85±4.75	379.31±7.29	383.89±2.71	401.35±14.75	0.0056[5]
Ca	0.05±0.22	0.20±0.07	0.36±0.09	0.47±0.2	0.0000[6]
P	0.46±0.01	0.48±0.00	0.48±0.01	0.48±0.01	0.4946

Means ± standard deviation. Linear regression: [1]$Y = 2.30 + 1.35\ x$ ($R^2 = 92.57\%$); [2]$Y = 4.075 + 3.76\ x + 1.05\ x^2$; [3]$Y = 0.395 + 0.442\ x$ ($R^2 = 96.24\%$); [4]$Y = 93.102 - 3.200\ x$ ($R^2 = 87.45\%$); [5]$Y = 395.8237 - 18.68\ x + 4.99\ x^2$ ($R^2 = 99.45\%$); [6]$Y = 0.05 + 0.143\ x$ ($R^2 = 99.53\%$).

The carbohydrate content had a negative linear effect, and with the increase of flour inclusion there was a decrease in its value. For the caloric value, a negative quadratic equation was observed. There was no significant difference between inclusion levels for moisture and phosphorus (P) contents, observing average levels of 5.09% and 0.48%, respectively (Table 2).

The low moisture content associated with the results obtained in the microbiological analyses favor the shelf-life conditions of the product, and according to Haj-Isa and Carvalho (2011) if the product is packed in a moisture-tight packaging, gases and preferably with light barrier, the product shelf life will be much longer.

Franco et al. (2013) evaluated crackers with the inclusion of different levels (0%, 6%, 12%, 18%, 24% and 30%) of tilapia flour. These authors reported that the biscuits presented from 10.00% to 10.99% moisture, 9.95% to 17.71% crude protein, 9.27% to 10.15% ether extract, 0.76% to 6.56% ash and a carbohydrate reduction from 69.68% to 55.58% due to the various fishmeal inclusions in the biscuits. There was an increase in protein, lipid, mineral content and a marked reduction in carbohydrate content. The results of cornmeal cookies with barred sorubim head flour corroborate those reported by Franco et al. (2013).

Delgado-Vidal et al. (2013) elaborated crackers enriched with marine fish (black tuna, *Euthynnus lineatus*) and obtained a variation of protein content from 8.81 to 14.25% and of lipids from10.31 to 16.77%. Barred sorubim head meal, because it is a species of tropical fish, has a lower amount of omega-3 fatty acids than tuna evaluated by Delgado-Vidal et al. (2013).

The quality and acceptability of including fishmeal in a product depends on several factors, the fat content of flour is a critical point because, when it oxidizes, it produces a strong and often rancid taste. The protein content of flour depends on the raw materials, number and quantity of additives and moisture content. Deterioration of fishmeal during storage is avoided by decreasing moisture content and eliminating oxygen from packaging.

Calcium contents increased significantly with the addition of barred sorubim head flour, which shows the high concentration of calcium in this ingredient. Guilherme et al. (2007) reported that shrimp head silage had levels of 4.49 mg / g calcium and 0.40 mg / g phosphorus. According to Sathe et al. (1984), these differences in mineral content are due to operations in food processing due to direct or indirect reactions, the level or chemical form of minerals or the association of minerals with other food components.

According to the physical and chemical characteristics defined by the National Agency for Sanitary Surveillance and Inspection (ANVISA), the fixed mineral residue levels must respect the maximum of 3.0% w / w and the maximum humidity of 14.4% w / w (BRAZIL, 1978), which indicates that the corn crackers in this work are within the standards required by.

Considering that fish proteins are of high biological value due to their adequate profile of essential amino acids, their incorporation in cookies would be a way of complementing the proteins present in the other ingredients used, which are based on cereals, thereby increasing their nutritional value (Delgado-Vidal et al., 2013).

The results obtained in the microbiological analysis of corn flour and biscuits with barred sorubim head flour inclusion indicated a low level of coliforms at 35 ºC and at 45 ºC (<3 MPN/g), *Sthapylococcus aureus* (<1 × 10^2 MPN/g) and the absence of *Salmonella* spp. (Table 3), being within the microbiological standards required by the Brazilian legislation (BRASIL, 2001).

According to the microbiological characteristics required by ANVISA, cookies and crackers must comply with the following standard: maximum of coliform bacteria 5×10/g; absence of fecal coliform bacteria in 1g; maximum of 2×10^2/g for *Staphylocoocus aureus*and the absence of *Salmonella* in 25 g (BRAZIL, 2001). Thus, the low counts of microorganisms in this experiment are related to the good hygienic-sanitary conditions of the environment in which the fish were caught, as well as to the good handling practices during the elaboration process of flour and cookies prepared in the experiment.

Table 3: Microbiological analysis of corn crackers with barred sorubim head flour inclusion.

Inclusion levels (%)	Fecal coliforms at 35 °C (NMP[1]/g)	Fecal coliforms at 45 °C (MPN/g)	Coagulase Positive Staphylococci Count (CFU[2]/g)	*Salmonella* spp in 25 g
0	< 3	< 3	1×10^2	ABSENT
5	< 3	< 3	1×10^2	ABSENT
10	< 3	< 3	1×10^2	ABSENT
15	< 3	< 3	1×10^2	ABSENT
Sorubim Head Flour	< 3	< 3	1×10^2	ABSENT

[1]MPN = Most Probable Number; [2]UFC = Colony Forming Unit.

Water activity (WA) is a very important property in food in general, but in dehydrated food this parameter determines the degree of chemical, biochemical, microbiological and physical changes that occur during the storage of the product and

may change its shelf life. In the present study, it was observed that the AW was extremely low (Table 4), ranging from 0.13 to 0.14 (Table 4). Water activity of all cookies was unfavourable for growth of molds (0.80) bacteria (0.90) or yeast (0.85–0.88) (Shafi et al., 2016). The WA of cookies enriched with tuna varied from 0.25 to 0.42, depending on the formulation used in the experiment, according to the authors, due to the link of sugars with the system water (Delgado-Vidal et al., 2013).

Positive linear behavior was observed for the pH results (Table 4), expressing that increasing the level of inclusion of barred sorubim head flour in the cookie increased also pH, resulting in pH value near the neutrality (pH 6.94) with 15% inclusion which was the highest level of inclusion of barred sorubim head meal. This was due to the buffering effect of fish meat proteins.

The lightness (L*), a* and b* index values in cookies with barred sorubim flour inclusion were determined using a digital colorimeter and the values registered showed differences as a function of the level of inclusion of the flour in the product (Table 4).

Table 4: Color parameters, pH and water activity (AW) of corn crackers with barred sorubim head flour inclusion.

Inclusion levels (%)	Aw	pH	L*	a*	b*
0	0.13±0.03	6.75±0.03	79.18±2.33[1]	6.41±0.65	37.30±4.1
5	0.13±0.03	6.86±0.14	78.24±1.39	6.10±0.34	33.13±0.07
10	0.14±0.01	6.88±0.16	74.53±2.32	5.67±0.09	30.75±2.45
15	0.14±0.01	6.94±0.22	75.45±1.4	4.87±1.18	31.63±1.57
P value	0.9765	0.0434[1]	0.0006[2]	0.0003[3]	0.000[4]

Means ± standard deviation. Regression equations [1]$Y = 6.72 + 0.05x$ ($R^2 = 80.13$); [2] $Y = 82, 901 - 3,817X + 0.465X^2$ ($R^2 = 81.44\%$); [3] $Y = 7.0224 + 0.50461X$ ($R^2 = 95.22\%$); [4]$Y = 44.361 - 8.2504X + 1.262X^2$ ($R^2 = 99.58$).

As the level of inclusion of barred sorubim head flour in the corn crackers increased, there was a decrease in lightness, explained by the negative quadratic equation $Y = 82, 901 - 3,817X + 0.465X^2$ ($R^2 = 81.44\%$), therefore the cookies appeared darker. Chromaticity indexes a* and b* values decreased with the addition of fishmeal, reducing the intensity of the red color (a*) as well as of the yellow color (b*). The equations that explain these results are negative linear for a*: $Y = 7.0224 + 0.50461X$ ($R^2 = 95.22\%$), and for b*: $Y = 44.361 - 8.2504X + 1.262X^2$ ($R^2 = 99.58$). This characteristic can be directly associated with the inclusion of the flour, because the oven time and temperature used for baking were the same.

The characteristic color of the formulations (treatments) is also associated with the effect of temperature and cooking time as a function of sugar, lipid, protein and starch content, which express the typical coloring of Maillard reactions, according to Delgado-Vidal et al. (2013), because the greater the amount of sugars present, the darker the brown color of the cookie surface. In biscuits with tuna inclusion, these authors reported L* values from 48.56 to 59.16, from 6.44 to 10.74 for redness index (a*) and from 23.13 to 28.69 for yellowness index (b*). The lightness values were much lower than in this experiment and could be directly associated with the color characteristic of tuna included in the formula of the crackers. Tuna is a fish that has dark flesh compared to barred sorubim. The value of a* index was also higher in the tuna crackers than in our trial.

The results of the Texture Analysis Profile, evaluating the fracturability (g), compression extensibility (mm), hardness work (j), deformation of the reference (mm), adhesion force (g), completed workforce (J) and deformation force (mm), are shown in Table 5. Only for fracturability there was a significant difference due to the inclusion of fish meal in the cookies.

The fracturability parameter had a negative linear behavior, as the regression equation $Y = 2746.50 - 233.60x$ ($R^2 = 96.08\%$) showed that with the increased inclusion of barred sorubim head flour, increase the tendency to break. Fishmeal can break the gluten net formed in the dough, making it easier to break after baking. Delgado-Vidal et al. (2013) stated that the differences in texture are attributed to the protein content of crackers, where the higher protein crackers (14.25%) needed higher strength (78.34 N) to break, while those with 8.81% of protein presented 35.30 to 37.66 N for the break. In this experiment, we worked with the inclusion of fish meal, particles of high mineral matter, while Delgado-Vidal et al. (2013) worked with tuna meat in the inclusion of crackers.

Table 5: Texture Analysis Profile parameters (means ± standard deviation) of corn cookies with inclusion of barred sorubim head flour.

Parameters	Inclusion levels (%)				P
	0	5	10	15	value.
Friability (g)	2477.50±315.00	2358.00±195.50	2176.00±13.5	1638.00±524.50	0.0296[1]
Compression extensibility (mm)	15.20±0.73	14.43±1.50	17.03±1.10	17.06±1.13	0.6566
Hardness work (J)	0.008±0.01	0.008±0.01	0.009±0.03	0.005±0.10	0.1012
Reference deformation (mm)	9.84±0.01	9.83±0.02	9.85±0.03	9.85±0.03	0.8431
Bond strength (g)	9.00±1.25	7.00±0.75	8.50±0.75	6.50±1.25	0.4861
Workforce Completed (J)	0.007±0.003	0.005±0.002	0.018±0.012	0.002±0.001	0.2850
Force deflection (mm)	0.34±0.06	0.45±0.05	0.49±0.09	0.33±0.07	0.7705

[1]Regression equation Y = 2746.50 - 233.60x (R^2 = 96.08%)

The shape and thickness of cookies is another important parameter to evaluate the product, depending on the results obtained regarding the appearance (visual) and its texture or crispness (Szczesniak, 2002). A correlation was found between protein content and texture of cookies, showing that sensory acceptance is related to the change in protein included in the dough, affecting the geometry and texture of cookies (Delgado-Vidal et al., 2013).

The diameter measurement indicates the spherical uniformity and the longitudinal growth of the cookie. It can be seen that as there was an increase in the inclusion of barred sorubim head flour, there was an increase in the biscuit area (Table 7), resulting in a positive quadratic equation.

Table 7: Area and weight measurements (means ± standard deviation) of corn crackers with inclusion of barred sorubim head flour.

Inclusion levels (%)	Weight (g)	Area (mm)
0	8.67±0.68	1376.95±290.00
5	9.57±0.21	1617.87±49.08
10	9.84±0.48	1822.11±155.15
15	9.34±0.01	1850.89±183.92
P value	0.2359	0.0000[1]

[1] Quadratic equation Y = 995.25 + 427.79x + 53.03x^2 (R^2 = 99.33%).

In the sensory analysis, corn cookies made with the inclusion of barred sorubim head flour showed significant differences for the attributes of color, flavor, global impression and for the purchase intention test, as the results were explained by the negative linear equations Y = 7.813333 - 0.1778667X (R^2 = 73.05%), Y = 7.82 - 0.276X (R^2 = 98.72%), Y = 7.82 - 0.276X (R^2 = 99.15%), Y = 7.82 - 0.2222667X (R^2 = 95.85%)

and Y = 4.22 - 0.190667X (R^2 = 75.92%), respectively, for these analyzed attributes. The aroma and texture attributes did not show significant differences due to the different formulations (Table 8).

For all the formulations, the tasters' grades were above 6.75, a value corresponding to slightly to moderately liked, therefore, the sensory analysis indicates that the cookies were well accepted by consumers.

Table 8: Sensory analysis results (means ± standard deviation) of corn cookies with inclusion of barred sorubim head flour.

Sensory Aspects	Inclusion levels (%)				P value
	0	5	10	15	
Color[1]	7.75±0.38	7.35±0.12	7.25±0.02	7.12±0.02	0.0221[3]
Aroma[1]	7.47±0.42	6.93±0.12	7.01±0.04	6.79±0.02	0.0631
Texture[1]	7.51±0.34	7.08±0.09	7.03±0.14	7.05±0.12	0.1760
Flavor[1]	7.56±0.43	7.27±0.14	6.95±0.18	6.75±0.38	0.0151[4]
Global impression[1]	7.65±0.39	7.29±0.03	7.15±0.11	6.96±0.30	0.0266[5]
Purchase intention[2]	4.13±0.39	3.76±0.02	3.59±0.15	3.49±0.25	0.0050[6]

[1]Hedonic scale between 1 and 9; [2]Hedonic scale between 1 and 5; [3]Y = 7.813333 - 0.1778667X (R^2 = 73.05%); [4]Y = 7.82 - 0.276X (R^2 = 98.72%); [5]Y = 7.82 - 0.2222667X (R^2 = 95.85%); [6]Y = 4.22 - 0.190667X (R^2 = 75.92%)

Several authors have studied the inclusion of fish and derivatives in food products for the purpose of nutritional enrichment and obtained good results, both for chemical composition and for sensory acceptance, like chocolate and carrot cakes with Nile tilapia fillet (Veit et al., 2013), and spinach cake with the inclusion of different levels of dehydrated fish mix (Goes et al., 2016a). Centenaro (2007) observed the use of dried fish pulp (DFP) and moist fish pulp (MFP) for bread enrichment and obtained satisfactory acceptance.

Pérez-Chavarría et al. (2017), evaluating biscuits with addition of *Pterygoplichthys pardalis* fish meal, reported that the taste and texture of biscuits enriched with 3% of fish meal was similar to the control, however the addition of 5% fish meal improved appearance, aroma and color of cookies, being the treatment with greater acceptance by consumers. Lopez and Davila (2002) observed the possibility of adding up to 10% of hake flour in cookies, but above this level of inclusion the tasters reject the product. This high inclusion of fishmeal in the cookie, according to the authors, is related to the previous treatment of pH adjustment of fishmeal, providing similar characteristics to wheat meal. They reported that there is a decrease in the pH of the pasta with the addition of 10% of fishmeal. Another factor that interfered in the sensory analysis was the presence of corn, indeed Florence et al. (2014) reported that

the addition of cornmeal to the biscuits produced a better sensory profile compared to the biscuits without corn, related to the sticky and brittle texture.

Coradini et al. (2015) included up to 30% of fishmeal flavored in onion sticks (crackers), without the tasters finding significant difference for the attributes evaluated in the sensory analysis. Assuming that cookies or crackers are foods of daily consumption, the protein ratio in the formulations can be advantageous for food quality when compared to cookies of different brands found in the market, because the protein source is of animal origin. If they were sporadic foods, it would not make much difference, but cookies and snacks are consumed daily by adults and adolescents, who could also acquire the habit of indirectly eating fish, consequently benefiting from its nutritional qualities and especially for the quality of the fatty acids.

Fishmeal is a raw material that can be applied as a functional ingredient for the development of products formulated with the intention of improving consumer health.

4 CONCLUSIONS

It was concluded that cookies had good microbiological quality, being suitable for consumption. From the nutritional point of view, the inclusion of barred sorubim (*Pseudoplatystoma fasciatum*) head flour promotes the enrichment of cookies, as it increases the protein, lipid and mineral contents, especially the calcium level with the reduction of carbohydrates in the product. However, as the inclusion content increases the crackability of cookies increases, being indicated up to 10% of inclusion, because the higher percentages affect the purchase intention of the product.

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