

Quality and acceptance of ready-to-cook dishes prepared with fillet and belly flap area of hybrid sorubim

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Abstract: Ready-to-cook dishes were prepared using the fillet and the belly flap area of hybrid sorubim. The chemical, microbiological and sensorial characteristics of the obtained products were evaluated. Four treatments were elaborated: (T1) fillet, tomato sauce and vegetables; (T2) fillet without tomato sauce or vegetables; (T3) belly flap area with added tomato and vegetables and; (T4) belly flap area without tomato sauce or vegetables. After marinating by immersion using brine, fish cuts with and without sauce/vegetables were placed in vacuum packages and cooked. Microbiological and proximate analyses showed the products were within the standards required by current legislation. Sensory analysis showed acceptance rates above 70%. The dishes prepared with fillet and belly flap area cuts with added tomato sauce and vegetables were the most acceptable according to the sensory evaluation and purchase intention, with no difference between the types of cut. Therefore, the use of the less commercially desirable meat cut (belly flap area) is feasible in the elaboration of the ready-to-cook moqueca dishes.

Keywords: moqueca, fish product, ready-to-cook, food safety, *Pseudoplatystoma reticulatum*, *Pseudoplatystoma corruscans*.

Introduction

Fish contain extremely important components for the human diet, including high quality proteins, lipids and bioactive components. The presence of polyunsaturated fatty acids in fish is attributed to confer numerous benefits to human health, including the reduction of the risk of coronary heart diseases, hypertension and diabetes, and in the prevention of certain cardiac arrhythmias and sudden death (Ramos Filho *et al.*, 2008; Cavenaghi-Altémio *et al.*, 2013; Menegazzo *et al.*, 2014).

In order to take advantage of these benefits, the fish industry provides a wide variety of consumer products, such as whole fish, fillets, slices and pulp, dried, chilled or frozen, salted, breaded or canned, as well as other treatments. However, filleted fish is the product preferred by consumers (Silva *et al.*, 2018).

Hybrid sorubim (*Pseudoplatystoma* sp.) is one of the most important native carnivorous species of great potential for aquaculture in Brazil (Honora-to *et al.*, 2015). The meat is widely accepted due to its excellent palatability and absence of intramuscular spines (Hisano *et al.*, 2013). Most of the com-

mercialised hybrid sorubim comes from the Pantanal and Amazon regions, and is consumed in the Southeast, South and Midwest regions (Crepaldi *et al.*, 2006).

In consumer food markets, sensoriality and pleasure, health and well-being, convenience and practicality, reliability and quality, and sustainability and ethics are attractive matters that promote competitiveness of the industries worldwide. Thus, ready-to-eat and semi-ready-to-eat dishes, in small portions, have had a great increase in demand (Siekierski *et al.*, 2013; Incoronato *et al.*, 2016).

Ready- or semi-ready-to-eat dishes containing products of animal origin contain processed or partially processed products including meat of different species of slaughterhouse animals and/or meat products, and/or any other product of animal origin prepared separately or combined with ingredients such as sauces, vegetables, flour and cereals, subjected to a suitable technological process (MAPA, 2001). They can be classified as traditional, continental, ethnic, vegetarian, and low-calorie. These products have culinary or recipe competences added to them by manufacturers that result in a high degree of read-

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iness, completion, and commodity. They are divided into five categories: canned, ambient, frozen, chilled, and dry (Harris & Shiptsova, 2007).

In Brazil, moqueca is a spicy stew of seafood, vegetables and palm oil, with different seasonings added, and is much appreciated by the fish-eating population. It originates from the fisheries developed by the Portuguese, to the products of which black slaves added their usual ingredients of African cuisine when they arrived in Brazil (Watkins, 2015).

The aims of this work were to develop ready-to-cook dishes using the fillet and belly flap area cuts of hybrid sorubim and to evaluate the chemical, microbiological and sensorial characteristics of the obtained products.

Materials and Methods

Cuts of hybrid sorubim

Twenty hybrid sorubim (*Pseudoplatystoma reticulatum* x *Pseudoplatystoma corruscans*) fishes were obtained from a local fish farm. They were transported to the Laboratory of Food Technology from the Federal University of Grande Dourados, Dourados, MS, Brazil, where they were slaughtered and filleted into two cuts (fillet and belly flap area), under refrigerated conditions. Each fish weighed on average 800 g, being 400 g of fillet and 150 g of belly. Thus, 8 individuals were utilised to obtain the total amount of fillet and 20 individuals were utilised to obtain the total amount of belly to carry out all the analyses (approximately 1,500 g per treatment). Figure 1 shows the body locations of the cuts used in the preparation of the ready-made dishes. The belly flap area has less commercial value than does the fillet.

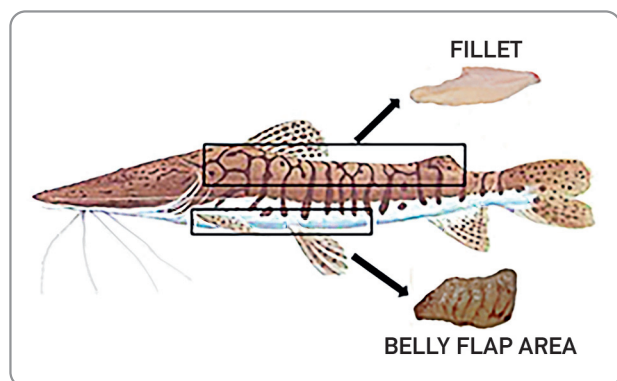


Figure 1. Body locations of the fillet and the belly flap area in hybrid sorubim (*Pseudoplatystoma reticulatum* x *Pseudoplatystoma corruscans*) fishes.

Ready-made dishes of hybrid sorubim

Four treatments were prepared with the fillet and belly flap area of hybrid sorubim. Treatment 1 (T1) was elaborated with fillet, tomato sauce and vegetables (onion, and red, yellow and green peppers); Treatment 2 (T2) with fillet without tomato sauce or vegetables; Treatment 3 (T3) with belly flap area added with tomato sauce and vegetables (onion, and red, yellow and green peppers) and Treatment 4 (T4) belly flap area without tomato sauce or vegetables. The fillets and belly flap areas of the four treatments were marinated at 4°C during 12 h by immersion using brine (1:1) of the following composition (in %): water, 95.82; sodium chloride, 3.2, citric acid, 0.4; dehydrated garlic, 0.4; and white pepper powder, 0.2. After marinating, the steaks and belly flap areas of the treatments were placed in vacuum (polyethylene and nylon) packages. For treatments T1 and T3, 50% of sauce plus vegetables in relation to the weight of the fish was also added. All treatments were sealed in a vacuum Sealer (Tecmaq model AP 450). The moqueca sauce was prepared with 60% industrial tomato sauce, 35% coconut milk, 3% refined salt and 2% palm oil. Pasteurisation was then carried out in a water bath (Quimis model Q334M-28) at 85°C up to 72°C of internal temperature of the fish. After that, thermal ice-shock was carried out and the products were immediately stored at -18°C to avoid the formation of microcrystals.

Chemical analysis

Moisture, crude protein, and crude ash contents of the ready-made dishes were determined in triplicate according to the methods described by AOAC (2012). Moisture was determined by the oven drying method at 105°C until constant weight (method 950.46B), protein by the Kjeldahl method (method 928.08) and ash by using the muffle oven technique (method 920.153). The lipid content was obtained in triplicate by the extraction method with cold organic solvent (Bligh & Dyer 1959). The carbohydrate content was estimated by difference.

Microbiological analysis

Microbiological analyses of the raw materials and ready-made dishes were performed for thermo-tolerant coliforms at 45°C, *Staphylococcus aureus* and *Salmonella* spp. in accordance with the methodology described elsewhere (USDA/FSIS, 1998).

Sensory analysis

Sensory analyses of the ready-made dishes were conducted by 48 non-trained panellists. A nine-point hedonic scale (9=like extremely; 1=dislike extremely) was used for evaluation of the attributes colour, odour, texture and taste. The treatments were heated in microwave ovens until the internal temperature reached 60°C, then they were cut into 2.0 × 2.0 × 1.5 cm cuboids and served in disposable containers kept warm for no longer than 15 min., coded with three-digit random numbers. Overall acceptance was evaluated in terms of purchase intention using a 5-point scale, where 5 = certainly would purchase, 4 = probably would purchase, 3 = perhaps would purchase / perhaps would not purchase, 2 = probably would not purchase and 1 = certainly would not purchase, which was expressed as the percentage of total score. For frequency of consumption of fish and fish moqueca, a 4-point scale was utilised, where 4 = weekly, 3 = 2 to 3 times a week, 2 = 2 to 3 times a month and 1 = annually (Cavenaghi-Altémio *et al.*, 2018). The acceptance index (AI) was calculated according to the following equation: AI = (average of the attributed grades / maximum attributed grade) × 100. The sample was considered acceptable if the value was greater than 70% (Stone & Sidel, 2004).

Statistical analysis

Results were evaluated through analysis of variance (ANOVA) and Tukey's test for comparison of means, at a level of 5% of significance, using the statistical software Statistica 8.0. The purchase intention and the consumption frequencies were analysed as percentages.

Results and Discussion

Table 1 shows the results of the proximal composition analysis carried out for the ready-to-eat dishes prepared with fillet and belly flap area cuts of hybrid sorubim. Moisture content varied from 75.91 to 83.43%, with a significant difference ($p < 0.05$) between the treatments, except between treatments T1 and T3, with sauce in the formulation. These two treatments had the highest moisture contents (Table 1), which were very similar to the 83.07% found in the study with silver catfish (*Rhamdia quelen*), steamed, and canned with tomato sauce (Cozer *et al.*, 2014).

Ash content ranged from 1.40 to 2.53%, with no significant difference between treatments ($p > 0.05$). The literature reports ash content of 2.00% for silver catfish in tomato sauce (Cozer *et al.*, 2014). This value is very similar to that found in this study (Table 1). However, these same authors found only 0.49% of ash in silver catfish fillet with tomato sauce, which is probably due to the differences between the raw materials.

There was a significant difference ($p < 0.05$) between the treatments in relation to the protein content, except between T2 and T4, corresponding to fillet and the belly flap area, both without sauce/vegetables, respectively. These treatments (T2 and T4) contained the highest protein contents, 17.50 and 17.68%, respectively (Table 1). The lower protein content in treatments with sauce/vegetables (T1 and T3) than in treatments without sauce/vegetables (T2 and T4) is easily explained by the composition of the sauce, which contains sugar, xanthan gum and modified starch, among other carbohydrates.

A protein content of 17.90% was previously reported for sorubim (*P. corruscans*) (Ramos Filho *et al.*, 2008). This value is very close to those obtained for T2 and T4, which did not have added

Table 1. Proximate composition of ready-made dishes prepared from the fillet and belly flap area cuts of hybrid sorubim

Treatment	Moisture (%)	Protein (%)	Lipids (%)	Ash (%)	Carbohydrates (%)
T1	83.32 ^a ± 0.21	8.85 ^a ± 0.67	2.12 ^a ± 0.04	1.66 ^a ± 0.12	4.05
T2	79.88 ^b ± 0.42	17.50 ^b ± 0.40	0.92 ^b ± 0.03	1.40 ^a ± 0.30	0.30
T3	83.43 ^a ± 0.67	5.30 ^c ± 0.45	5.05 ^c ± 0.10	2.53 ^a ± 0.13	3.69
T4	75.91 ^c ± 0.71	17.68 ^b ± 0.89	2.95 ^d ± 0.04	2.19 ^a ± 0.65	1.27

Legend: Means with the same letter in the same column do not differ statistically at 5% ($P > 0.05$). Treatment 1 (T1) was elaborated with fillet, tomato sauce and vegetables (onion, and red, yellow and green peppers); Treatment 2 (T2) with fillet without tomato sauce or vegetables; Treatment 3 (T3) with belly flap area with tomato sauce and vegetables (onion, and red, yellow and green peppers), and Treatment 4 (T4) with belly flap area without tomato sauce or vegetables.

Table 2. Microbiological analyses of hybrid sorubim and ready-made dishes prepared from the fillet and belly flap area cuts of hybrid sorubim

Treatment	Microbiological analyses		
	Coliforms at 45°C	<i>Staphylococcus aureus</i>	<i>Salmonella</i> spp.
Raw fish	<1.0 x 10 ¹ CFU/g est.	<1.0 x 10 ¹ CFU/g est.	Absent in 25 g
T1	<1.0 x 10 ¹ CFU/g est.	<1.0 x 10 ¹ CFU/g est.	Absent in 25 g
T2	<1.0 x 10 ¹ CFU/g est.	<1.0 x 10 ¹ CFU/g est.	Absent in 25 g
T3	<1.0 x 10 ¹ CFU/g est.	<1.0 x 10 ¹ CFU/g est.	Absent in 25 g
T4	<1.0 x 10 ¹ CFU/g est.	<1.0 x 10 ¹ CFU/g est.	Absent in 25 g

Legend: CFU: Colony forming units. Treatments (T1, T2, T3, and T4) according to Table 1.

sauce/vegetables (Table 1). Values close to those obtained in treatments T1 and T3 (with added sauce/vegetables) were reported for flitch and silver catfish fillets, both with added tomato sauce (Cozer et al., 2014). The small differences were due to different fish and preparation methods.

The lipid content significantly differed (p<0.05) between all treatments, with the highest value (5.05%) found in T3 (belly flap area with sauce/vegetables) and the lowest value (0.92%) in T2 (fillet without sauce/vegetables). The lipid content of the treatments with sauce was higher than the treatments without sauce/vegetables (Table 1) due to the inclusion of palm oil and coconut milk in the sauce.

Carbohydrates are present in minimum amounts in fishes. Thus, variations in carbohydrate contents are mainly related to the addition of tomato sauce and vegetables (onion, and red, yellow and green peppers) containing carbohydrates. This was evident when comparing T1 and T3 (fillet and belly flap area with sauce/vegetables, respectively) with T2 and T4 (fillet and belly flap area without sauce/vegetables, respectively) (Table 1).

Table 2 shows the results of the microbiological analyses carried out for the hybrid sorubim *in natura* and for the ready-to-cook dishes prepared

with the steamed cuts (fillets and belly flap areas) of the hybrid sorubim. The results showed that all products were within the parameters required by current Brazilian legislation.

For raw fish, cooled or frozen, that will not be consumed raw, the established parameters are the absence of *Salmonella* sp. in 25 g and a maximum count of 5x10³ CFU/g for *Staphylococcus aureus*. For precooked fish, cooled or frozen, the established parameters are: absence of *Salmonella* sp. in 25 g, and maximum counts of 5x10² CFU/g for *S. aureus*, and of 1x10² CFU/g for coliforms at 45°C (ANVISA, 2001). Thus, the procedures performed during the handling and preparation of the products were adequate from the hygienic-sanitary stand-point for the safety of the sensory panellists. Therefore, sensory evaluations were conducted.

Table 3 presents the results for the acceptance test of the colour, taste, texture and odour sensory attributes of the ready-to-cook dishes prepared with fillets and belly flap areas of hybrid sorubim. The averages of attribute scores ranged from the equivalent of “I did not like” to “I liked moderately” for treatments that did not contain sauce, both for fillets (T2) and belly flap areas (T4). For the treatments with sauce (T1 and

Table 3. Sensory analysis of ready-made dishes prepared from the fillet and belly flap area cuts of hybrid sorubim

Attribute	Treatment			
	T1	T2	T3	T4
Door	8.08 ^a ± 0.71 (89.77)	6.69 ^b ± 1.69 (74.33)	8.08 ^a ± 0.79 (89.77)	6.13 ^b ± 1.70 (68.11)
Colour	8.10 ^a ± 0.90 (90.00)	6.67 ^b ± 1.60 (74.11)	8.08 ^a ± 0.71 (89.77)	6.50 ^b ± 1.50 (72.22)
Taste	8.46 ^a ± 0.65 (94.00)	7.15 ^b ± 1.64 (79.44)	8.21 ^a ± 0.99 (91.22)	6.94 ^b ± 1.56 (77.11)
Texture	8.42 ^a ± 0.71 (93.55)	7.42 ^b ± 1.47 (82.44)	8.31 ^a ± 0.72 (92.33)	7.06 ^b ± 1.34 (78.44)

T3), these averages were higher and varied from the equivalent of “I liked” to “I liked it very much”.

Means with the same letter in the same column do not differ statistically at 5% ($P>0.05$). Values in parenthesis are the acceptability index (%). Treatments (T1, T2, T3, and T4) are according to Table 1.

The average scores for each of the sensorial attributes evaluated did not significantly differ ($p>0.05$) between T1 and T3, or between T2 and T4. However, there were significant differences between T1 and T2, as well as between T3 and T4 ($p<0.05$) (Table 3). Thus, despite them utilising different cuts, neither the treatments with sauce (fillet and belly flap area) nor the treatments without sauce (fillet and belly flap area) had detectably different sensory attributes. Considering that the belly flap area is a cut of lesser interest and commercial value, it may be an option for commercial ready-to-cook moqueca (T1 and T3) dishes.

Table 3 also shows (in parenthesis) the AIs for the odour, colour, flavour and texture sensory attributes of the ready-to-cook dishes prepared with fillets and belly flap areas of hybrid sorubim. Products with AI above 70% were considered acceptable (Stone & Sidel, 2004). All the sensorial attributes of the evaluated treatments were acceptable, except for the odour attribute of T4, which scored an AI of 68.11%. The other AIs ranged from 89.77 to 94.00% for ready-to-cook moqueca dishes prepared with fillets and belly flap areas, and from 72.22 to 82.44% for dishes prepared with belly flap areas without

sauce. In this sense, the best AIs were obtained for the treatments with added sauce (Table 3).

Figure 2 shows the percentage of the purchase intention frequencies of the ready-to-cook dishes prepared with fillets and belly flap areas of hybrid sorubim. The sums of the purchase intentions, “certainly would buy” and “probably would buy”, were 93.75, 50.00, 95.85 and 35.40% for T1, T2, T3, and T4, respectively, showing that the ready-to-cook moqueca dishes (T3 and T1) both received higher percentages of positive purchase intention than did the fish without sauce (Figure 2). Comparing the results of Table 3 with those of Figure 2, it was clear that the panellists’ purchase intentions did not reflect the acceptance rate of the ready-to-cook dishes without sauce. However, despite the lower purchase intention, the AIs (Table 3) demonstrated that it is possible to prepare ready-to-cook moqueca dishes from fillets and belly flap areas without the addition of sauce.

Figure 3A presents percentages of fish consumption frequency, while Figure 3B presents the percentages of fish moqueca consumption frequency as reported by our panellists. The highest percentage of fish consumption frequency and fish moqueca consumption frequency was 2 to 3 times a month. If compared to the other animal proteins, the frequency is very low. This may be due to both the price of the fish and the preparation time of this dish. On the other hand, these data indicate that there is a large market for this type of dish in Brazil.

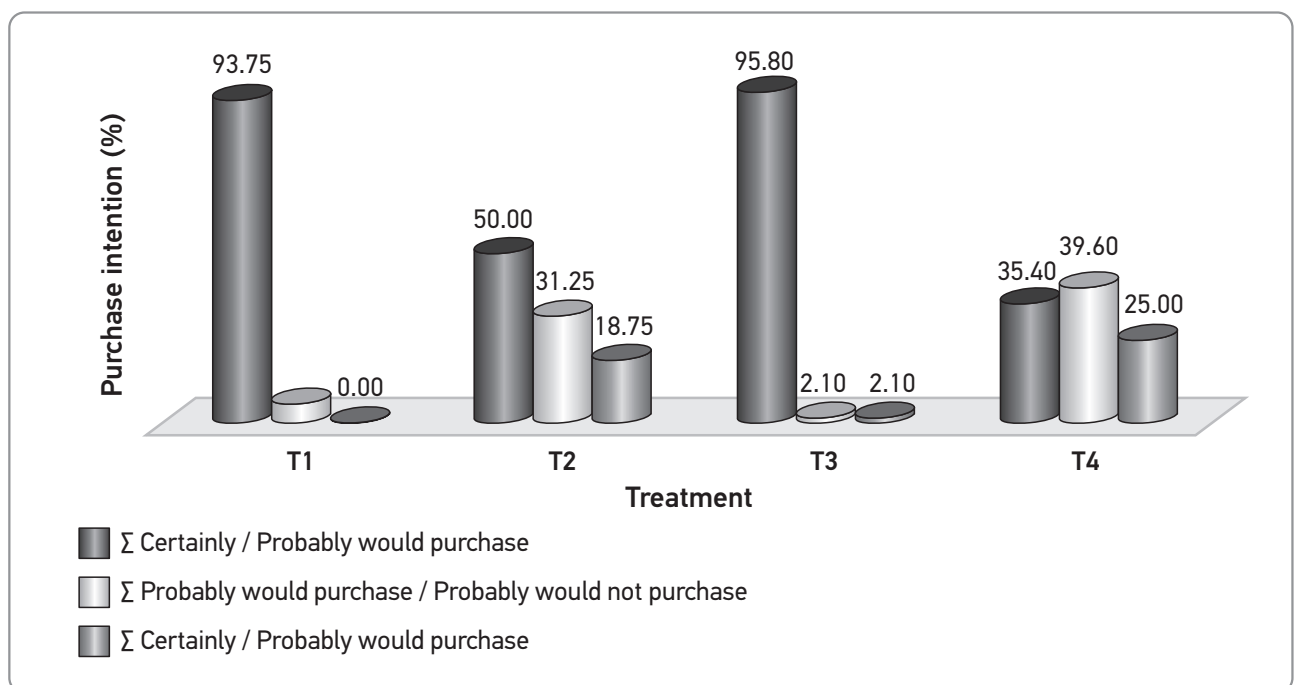


Figure 2. Purchase intention (%) of ready-made dishes prepared from the fillet and belly flap area cuts of hybrid sorubim. Treatments (T1, T2, T3, and T4) according to Table 1.

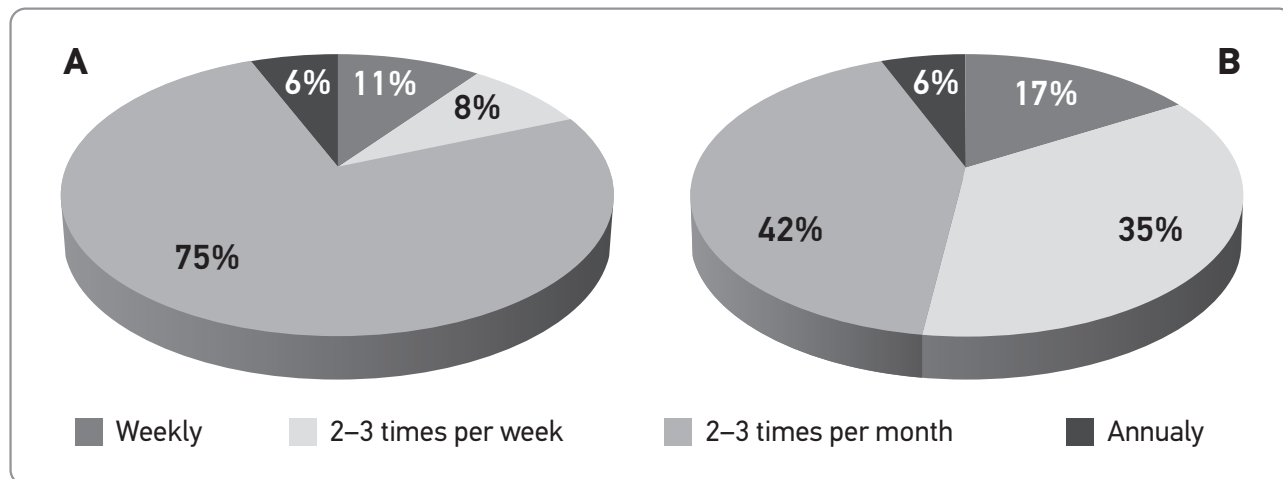


Figure 3. Frequency of consumption (%) of fish (A) and fish moqueca (B).

Conclusions

All treatments complied with the legislation for chemical and microbiological parameters, as well as the definition of ready-to-cook products of animal origin. The dishes prepared with fillet and belly flap area cuts added with tomato sauce and vegeta-

bles were more acceptable to the panellists according to their sensory evaluation and purchase intentions, with no difference between the types of cut. Therefore, the use of a less commercially desirable meat cut (belly flap area) is feasible in the elaboration of ready-to-cook moqueca dishes.

Kvalitet i prihvatljivost gotovih jela pripremljenih od fileta i područja trbušnog operkuluma/režnja hibridnog sorubima

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Aps t r a k t: Gotova jela za kuvanje su pripremljena korišćenjem fileta i područja trbušnog operkuluma/režnja hibridnog sorubima. U ovoj studiji, ocenjene su hemijske, mikrobiološke i senzorne karakteristike dobijenih proizvoda. Četiri različita tretmana su postavljena: (T1) file, paradajz sos i povrće; (T2) file bez paradajz sosa; (T3) područje trbušnog operkuluma/režnja sa paradajzom i povrćem i (T4) područje trbušnog operkuluma/režnja bez paradajz sosa. Nakon mariniranja potapanjem u salamuri, stavljeni su u vakum pakete i kuvani. Mikrobiološka i približna analiza dala je rezultate u okviru standarda koji zahtevaju važeći zakoni. Senzorna analiza je pokazala stope prihvatljivosti iznad 70%. Prema senzornoj proceni i nameri kupovine, najprihvaćenija su jela pripremljena od fileta i komada isečenih iz područja trbušnog operkuluma/režnja, sa dodatkom paradajz sosa i povrća, bez razlike između delova korišćenih u pripremi jela. Zbog toga je u izradi gotovih „moqueca“ jela izvodljiva upotreba manje vrednog mesa (područje trbušnog opekuluma/režnja).

Ključne reči: „moqueca“, riblji proizvod, gotova hrana, bezbednost hrane, *Pseudoplatistoma reticulatum*, *Pseudoplatistoma corruscans*.

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