SENSORY ACCEPTANCE OF "MACKEREL BURGER" WITH REDUCED SALT CONTENT AS AN ALTERNATIVE FOR SCHOOL FEEDING

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This study aimed to evaluate consumers' acceptance of Serra Spanish Mackerel burgers (*Scomberomorus brasiliensis*) with reduced sodium content for school feeding programs. The variables studied were fish pulp (full and washed) and concentration of table salt (1.5% and 0.75%) and monosodium glutamate (0% and 0.3%). The samples were subjected to the determination of sodium content and consumers' acceptance test with both adults and children. The tests with adult consumers were performed in two Brazilian cities: Campinas, São Paulo State, and Matinhos, Paraná State, while the tests with children were carried out only in Matinhos city. The results were evaluated through an analysis of variance, Tukey's test ($p \leq 0.05$) and a frequency distribution bar graph. The tests with adults from both cities were compared by Student's t-test ($p < 0.05$). Significant differences were observed in the sodium content of all formulations, which ranged from 199.26 mg/100 g (F7) to 517.76 mg/100 g (F2). Significant differences ($p < 0.05$) were observed in the acceptance tests with adult consumers for the attributes' appearance, flavor, and overall impression between the two cities by t-test. For the consumer test with children, no significant difference was observed, with scores ranging from 6.67 to 6.75. The data suggest that the fish burgers can be part of school meals.

KEY-WORDS: ACCEPTABILITY; FISH BURGER; SALT; SCOMBEROMORUS BRASILIENSIS; BRAZILIAN SCHOOL NUTRITION PROGRAM.

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INTRODUCTION

The growing global demand for healthy foods with low contents of sodium, sugar, and saturated and *trans* fat levels (WORLD HEALTH ORGANIZATION; UNAIDS, 2007) has increased the consumption of fish and its derivatives (CLERFEUILLE et al., 2013).

The inclusion of fish burgers with reduced sodium content (WELLARD; GLASSON; CHAPMAN, 2012) in school feeding programs (ROGERS et al., 2007) has proven to be an alternative to increase fish consumption (MITTERER-DALTOÉ et al., 2013).

According to the Ministry of Fisheries and Aquaculture, only 34% of schools have offered fish on school menus in 2011 (BRASIL, 2012b), which is not often used in school feeding programs even in Brazilian regions with a high consumption of fish (CHAVES et al., 2009).

As reported by Bernardon et al. (2009) and Caporale et al. (2009), the school environment enables interactions and changes in behavior and provides for the adoption of new lifestyles, since children's preferences can be driven primarily by the sensory quality of food (MUSTONEN; RANTANEN; TUORILA, 2009).

A large amount of salt (sodium chloride) has been used by food industries in the manufacture of meat and fish products due to its preservative effects on reducing water activity and inhibiting microbial growth; in addition, salt improves flavor of meat products and plays a key role in obtaining the desired texture (NASCIMENTO et al., 2007; RHEE; ZIPRIN, 2001; WEISS et al., 2010).

Despite these important functions, several public health agencies have recommended to reduce both salt and sodium content in processed foods (JAWOROWSKA et al., 2012; NILSON; JAIME; RESENDE, 2012; STRINGHETA et al., 2007).

Therefore, there is a need for product acceptance by consumers, integrating the sensory characteristics of a product and its suitability for the intended use (GIMÉNEZ; ARES; ARES, 2012).

Sensory properties are key attributes responsible for the acceptance or rejection of fish-based product. For children and young consumers, the attributes' taste, texture, and appearance of fish based product must be considered when developing these products (DOPICO; TUDORAN; OLSEN, 2010).

Considering that sensory analysis is an important tool for the development of food products (CADENA et al., 2013), this study aimed to evaluate the consumers' acceptance of Serra Spanish Mackerel burgers in two Brazilian cities.

MATERIAL AND METHODS

2.1 Fish raw material

The Serra Spanish Mackerel (*Scomberomorus brasiliensis*) is a marine fish of commercial value from some Brazilian coastal waters (LIMA; CHELLAPPA; THATCHER, 2005; SOARES, 2018; XIMENES, 1981). *S. brasiliensis* is a migratory species, living in the open ocean (ALMEIDA et al., 2007) and a coastal pelagic species distributed in the western Atlantic Ocean and the Caribbean Sea from the Yucatan Peninsula and Belize to south of the Tramandaí Lagoon, Rio Grande do Sul State, Brazil (BATISTA; FAVRÉ, 2001; COLLETTE; NAUEN, 1983; COLLETTE; RUSSO; ZAVALA-CAMIN, 1978; GOLD et al., 2010; LIMA et al., 2009; ZAVALA-CAMIN, 1983).

This species was chosen for the study because of its versatility of preparation, which can be fried, baked, cooked or used in fish recipes since it has few bones (RAMIRES; ROTUNDO; BEGOSSI, 2012). In addition, it is an important resource for the artisanal fishing fleet in Brazil

(FONTELES-FILHO, 1988; NÓBREGA; LESSA, 2009), especially in the municipality of Matinhos, Paraná State, Brazil (QUADROS; BOLINI, 2015).

Samples were obtained from artisanal fishermen at Z-4 Fishermen Colony in Matinhos, Brazil, in September 2013. The gender, age and maturation stage of the species was not determined to reflect the actual marketing and supply of the product.

Fish were acquired fresh and immediately placed between layers of ice in Styrofoam boxes and transported to the Laboratory of Food Education of the Coast Sector/Federal University of Paraná (UFPR). In the laboratory, fish were washed in chlorinated water (5 mg.L^{-1}), gutted, decapitated and manually filleted. Fillets were washed in chlorinated water (5 mg.L^{-1}), and then ground in a meat grinder (model LIEMITA®, G. PANIZ Indústria de Equipamentos para Alimentação Ltda., Caxias do Sul, Rio Grande do Sul State, Brazil) with an 8-mm disc to obtain the Serra Spanish Mackerel pulp.

Then, half of the pulp was placed in polypropylene containers in 600 g portions and stored at -18 °C until fish burgers manufacture, and the other half was subjected to three washing cycles (KUHN et al., 2003).

2.2 Pulp washing

The pulp was subjected to three washing cycles using chlorinated water (5 mg.L^{-1}) from the city water supply system at a temperature < 10 °C in the ratio 3:1 (water/pulp, w/w). After each wash, the sample was manually pressed using a sieve and a spoon.

The first washing cycle was performed with alkaline salt solution (0.15% NaCl and 0.2% NaHCO$_3$) for 15-20 minutes under slow manual shaking. In the second cycle, only chlorinated cold water was used, and a solution of 0.2% NaCl was used in the third cycle to extract soluble proteins and water (MARTÍN-SÁNCHEZ et al., 2009).

Next, draining by compression was performed to remove excess water. The pulp was then packed in polyethylene containers in 600 g portions and stored at -18 °C until fish burger manufacture.

2.3 Formulation and preparation of the fish burguer

Eight formulations were prepared in a 2 X 2 X 2 factorial design as shown in Table 1 using the following variables: fish pulp (full and washed), table salt – NaCl (1.5% and 0.75%) and monosodium glutamate – MSG (0% and 0.3%).

TABLE 1 - DESIGN USED FOR THE PREPARATION OF THE SERRA SPANISH MACKEREL BURGER FORMULATIONS

Ingredient	Formulations*							
	F1	F2	F3	F4	F5	F6	F7	F8
Pulp	full	full	Washed	Washed	full	full	Washed	Washed
Table salt	1.5%	1.5%	1.5%	1.5%	0.75%	0.75%	0.75%	0.75%
Monosodium glutamate	0%	0.3%	0%	0.3%	0%	0.3%	0%	0.3%

* Formulations: F1 (Formulation 1); F2 (Formulation 2); F3 (Formulation 3); F4 (Formulation 4); F5 (Formulation 5); F6 (Formulation 6); F7 (Formulation 7); F8 (Formulation 8).

The ingredients used in all formulations were: fine-textured soybean protein (VITAO®, provided by Nutrihouse Alimentos Ltda., Curitiba, PR, Brazil), maize starch (QUERO® by Coniexpress S.A. Indústrias Alimentícias, Jundiai, São Paulo State, Brazil, acquired in a local market), powdered onion and garlic, parsley and chive flakes (provided by Nutrimental S/A Indústria e Comércio de Alimentos, Curitiba, PR, Brazil) and cold water. Monosodium glutamate (AJI-NO-MOTO®) was provided by Ajinomoto do Brasil Indústria e Comércio de Alimentos Ltda. (city of São Paulo, São Paulo State, Brazil), and table salt (CISNE® Refinaria Nacional de Sal S.A., Cabo Frio, Rio de Janeiro State, Brazil) was purchased from a local market.

First, the soy protein was mixed to cold water. Then, the pulps were homogenized with NaCl (and MSG, when formulation required), spices, pre-hydrated soybean protein and maize starch for three minutes at medium speed in WALITA® mixer (Philips Brazil, Barueri, São Paulo State, Brazil). The mixture was cooled to 3°C, and 100 g was molded in a 110 mm diameter burger mold. The samples were molded into the fish shape using a manual cutter (25 x 50 mm), referred to as "Mackerel burger" ("Sororoca burguer"), Figure 1. Fish burgers were then placed in polyethylene bags and frozen (-18°C) until the time of analysis. The average weight of the "Mackerel burger" was 6.84 g ± 0.24 g.
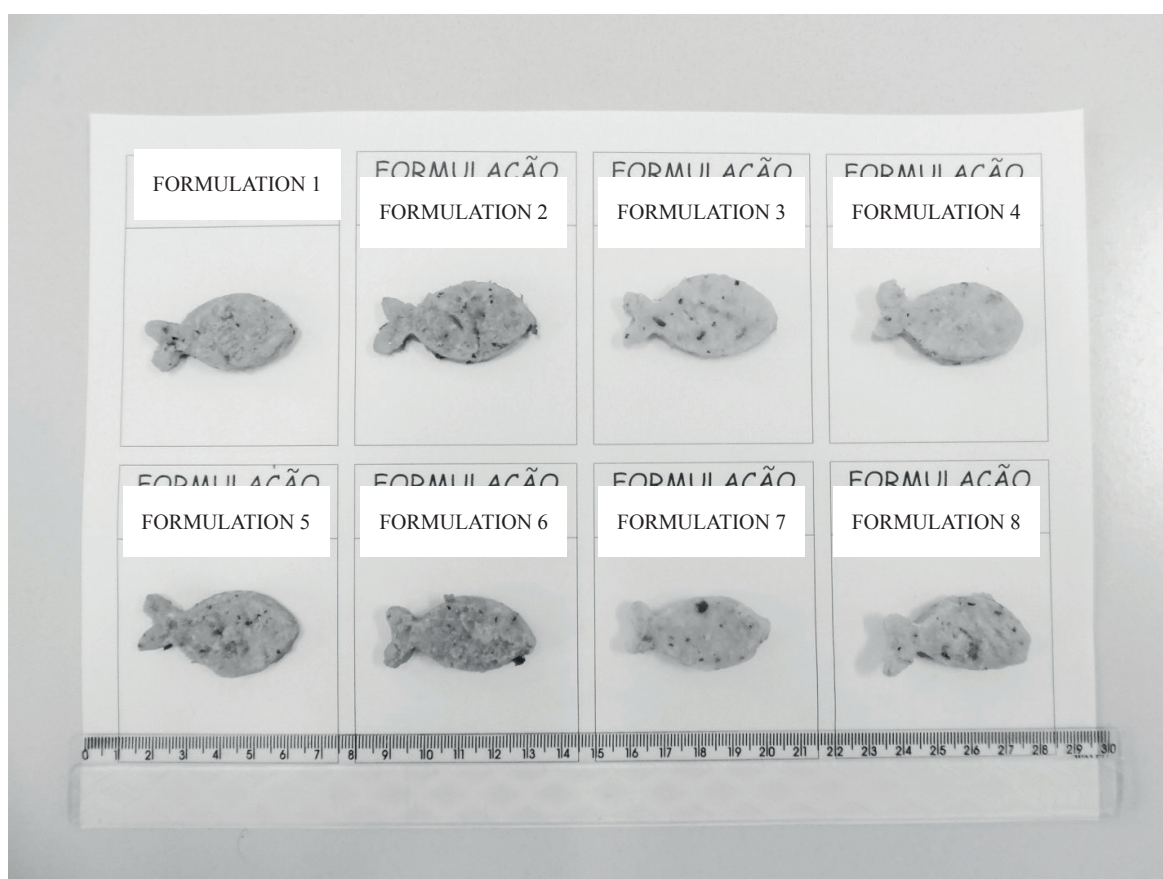

FIGURE 1 - FORMULATIONS OF ROASTED "MACKEREL BURGER" READY FOR ANALYSIS

The sodium content was determined and consumers' preference test was performed, including acceptance tests, consumers' attitude, just-about-right scale, facial hedonic scale, and consumption intention.

The study was approved by the Research Ethics Committee of the School of Medical Sciences, University of Campinas (UNICAMP) under No. CAAE 06047212.0.0000.5404.

2.4 HEAT TREATMENT

A conventional electric oven (Layer, J. Ryal and CIA, Ltda, Jundiaí, São Paulo, Brazil) was preheated for 30 minutes using the broil function, and the temperature was maintained between 220 and 240 °C.

The samples were placed on an parchment lined baking sheet according to the balanced complete block design (MACFIE et al., 1989).

The "Mackerel burger" was baked for ten minutes, and turned after five minutes. Then, the samples were maintained at 63 °C in a conventional electric oven and immediately offered to the consumers to avoid changes in the sensory characteristics (ASTM INTERNATIONAL, 2010). A cup of water was placed in the oven to prevent drying of the samples.

2.5 SODIUM CONTENT

The sodium content was determined using a 910 flame photometer analyser (Analyser Com. and Ind. Ltda., São Paulo, São Paulo State, Brazil), as described by Martins and Reissmann (2007). The analyses were performed in triplicate.

2.6 SENSORY ANALYSIS

2.6.1 Consumer Analysis - Adult

The acceptance tests, just-about-right scale and consumer attitude were performed in two Brazilian cities, with 243 consumers, of which 120 were recruited in University of Campinas (UNICAMP), Campinas, State of São Paulo (SP) and 123 in Federal University of Paraná (UFPR) and Public Schools of the city of Matinhos, PR. Consumers from Campinas were between 18 and 59 years old (40.0% male and 60.0% female), and consumers from Matinhos were between 19 and 71 years old (42.3% male and 57.7% female). All consumers signed an informed consent form.

The consumer acceptance was assessed using an unstructured 9-cm linear hedonic scale (STONE; BLEIBAUM; THOMAS, 2012) rated from "extremely disliked" to "liked very much." Consumers evaluated the appearance, aroma, flavor, texture, and overall impression of the samples.

The just-about-right scale was used to evaluate how ideal the samples were for the attribute salty taste. The ideal of salty taste was assessed using an unstructured 9-cm scale anchored with "extremely less salty than ideal" on the left, "just-about-right" in the center, and "extremely saltier than ideal" on the right of the scale (MEILGAARD; CIVILLE; CARR, 2007).

The purchase intention was evaluated similarly to the acceptance test with a five-points scale ranging from "1 - certainly would not buy the product" to "5 - certainly would buy the product" (MEILGAARD; CIVILLE; CARR, 2007).

Each consumer evaluated eight "Mackerel burger" formulations in a single session in individual cabins at 22 °C. Distilled water at room temperature was offered to consumers for cleansing the palate between samples.

To avoid bias, no further information was provided to the consumers (GOMES et al., 2014), and all samples were evaluated in a monadic way and according to a balanced block design, and served in a plastic dish coded with three digits (MACFIE et al., 1989).

2.6.2 Consumer Analysis - Children

The tests of facial hedonic scale and consumption intention were conducted in two public schools in the city of Matinhos, PR with 3rd, 4th and 5th grade children (Table 2). One hundred twenty-three consumers aged between 7 and 14 years were recruited, of whom 64 (52.0%) were boys and 59 (48.0%) were girls who liked fish and wanted to participate in the test. The children's participation was authorized by parents or a guardian through a signed informed consent form (ASTM INTERNATIONAL, 2011).
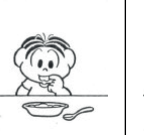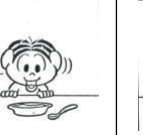
The tests were performed in individual booths with fluorescent light in a classroom free of odors. All samples were evaluated in a monadic way and according to a balanced block design, and served in a plastic dish coded with three digits (MACFIE et al., 1989).

Consumers were advised to drink a small amount of water to cleanse the palate between samples. Each child performed the evaluation of the eight "Mackerel burger" formulations in two sessions on consecutive days (four samples per day). To avoid bias, no additional information about the samples was provided to consumers (GOMES et al., 2014).

For the facial hedonic scale test, a structured seven-point scale (Turma da Mônica® [Monica's Gang®] scale) proposed by Vieira (VIEIRA, 1981) was used (Figure 2). The girls answered by marking the assessment form that contained the character Mônica®, and the boys marked the form that contained Cebolinha®.

Name:_____ Grade:_____ Date:_____
Mark an X on the face that best represents what you think about "Mackerel burger" <u>359.</u>

Girls

Boys
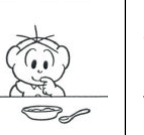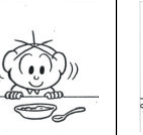
FIGURE 2 - MODEL OF THE ASSESSMENT FORM OF THE FACIAL HEDONIC SCALE (VIEIRA, 1981)

A space was left for children to write what they liked or did not like in each sample.

The consumption intention was determined using the a three-point structured scale (1 – would eat the product; 2 - maybe would eat/maybe would not eat; 3 - certainly would not eat the product), adapted from Meilgaard, Civille and Carr (2007). The term *consumption* was used instead of *purchase* (OLSEN et al., 2008), once the objective is to offer "Mackerel burger" in the school feeding program, thus the students can choose to eat the product or not.

2.7 STATISTICAL ANALYSIS

The results from the sodium content analysis and consumer tests were evaluated by analysis of variance (ANOVA) and Tukey's test (p ≤ 0.05). For the acceptance tests, ANOVA was used with two factors (consumer and sample). Internal Preference Map was constructed with the acceptance generated from the overall impression. The data obtained by the consumer test in each city were evaluated separately.

A comparison of the means of the acceptance test, just-about-right scale, and purchase intention between two groups (Campinas and Matinhos city) were performed using Student's t-test (p ≤ 0.05) (VOORPOSTEL; DUTRA; BOLINI, 2014).

The results of the consumption and purchase intention tests were analyzed through a bar graph of the frequency distribution for each sample (ANDRADE, 2012).

Statistical tests were performed using SAS software version 9.4 (SAS INSTITUTE, 2013) and Microsoft Office Excel 2007.

3 RESULTS AND DISCUSSION

3.1 Sodium content

The sodium content of the samples ranged from 199.26 mg/100 g (F7) to 517.76 mg/100 g (F2) (Table 2), which was significantly higher (p < 0.05) in the formulations with higher salt content (F1, F2, F3 and F4). Among the samples prepared with full pulp (F1, F2, F5 and F6), the formulations without MSG addition (F1 and F3) had a significantly lower sodium content (p < 0.05) when compared to the formulations containing MSG (F2 and F4). With respect to the formulations with full pulp and lower salt (F5 and F6), no significant differences (p < 0.05) were observed for the salt content when compared to the formulations with full pulp and washed pulp (F7 and F8).

Reductions in sodium content greater than 48% were observed for all formulations, once a reduction of 48.3% was found from F1 to F5; 48.9% from F2 to F6; 50.0% from F3 to F7; and 55.6% from F4 to F8. Among the Brazilian strategies to reduce sodium intake is the monitoring of sodium content in processed foods (NILSON; JAIME; RESENDE, 2012). The sodium content of the samples of this study was lower than that found by the National Health Surveillance Agency (ANVISA) for commercial beef, poultry and mixed burgers, which had 709 mg/100 g (363 mg/100 g – 1031 mg/100 g), 656 mg/100 g (365 mg/100 g – 981 mg/100 g) and 690 mg/100 g (563 mg/100 g – 876 mg/100 g), respectively (BRASIL, 2010). In the subsequent report, sodium was only determined in beef burgers, with mean values of 701 mg/100 g (134 mg/100 g – 1120 mg/100 g) (BRASIL, 2012a). Lee, Chung and Moon (2010) investigated the sodium content of 89 children's favorite foods in Korea, and found a sodium content of 793.5 mg/100 g (663.6 – 923.3 mg/100 g). Dunford et al. (2010) evaluated the sodium content of burgers from Australian fast-food chains and found 520 mg/100 g (321 mg/100 g – 774 mg/100 g).

TABLE 2 - SODIUM CONTENT IN THE "MACKEREL BURGER"

Formulation	Sodium content (mg/100 g)[*]
F1	461.78 ± 17.16b
F2	517.76 ± 19.33a
F3	398.30 ± 9.66c
F4	462.43 ± 11.46b
F5	243.22 ± 19.22d
F6	264.77 ± 5.11d
F7	199.26 ± 3.04e
F8	205.48 ± 2.50e
LSD[**]	33.08

[*] Means with the same letters in the same row are not significantly different at 5% level ($p < 0.05$) according to Tukey's test;
[**] LSD: least significant difference by Tukey's test at 5% significance level.

The F3, F5, F6, F7 and F8 can be considered moderate-sodium formulations, while F1, F2 and F4 were high-sodium formulations (BRASIL, 2010; FELICIO et al., 2013).

The sodium intake recommended for children aged 4-8 years and 9-13 years is 1.2 g/day and 1.5 g/day respectively (PADOVANI et al., 2006). In school feeding, salt intake should be limited to not more than 30% of the daily needs (UK DEPARTMENT FOR EDUCATION AND SKILLS, 2006), which is equivalent to 360 mg/day and 450 mg/day for children aged 4-8 years and 9-13 years, respectively. The Food Standards Agency (FSA) in the UK has also proposed 300 mg of sodium per 100 g burger (DESMOND, 2006). Thus, the formulations with reduced salt (F5, F6, F7 and F8) were consistent with the standards established by the FSA and can be part of the children's meals.

3.2 Consumer analysis - Adult

According to Giménez, Ares and Ares (2012), first the product must first be accepted by the consumers and should be considered as part of an integrated trial of the perceived sensory characteristics of a product and its suitability for the intended use, which was observed in the present study.

Table 3 shows the results of the acceptance test and just-about-right scale test of the "Mackerel burger". For the attribute appearance, the formulations with full pulp (F1, F2, F5 and F6) had greater acceptance and differed statistically ($p < 0.05$) from those prepared with the washed pulp (F3, F4, F7 and F8).

TABLE 3 - MEANS OF THE ACCEPTANCE TEST AND JUST-ABOUT-RIGHT SCALE TEST OF THE "MACKEREL BURGER" IN TWO BRAZILIAN CITIES (N = 243)

City	Formulation	Appearance	Aroma	Flavor	Texture	Overall Impression	JAR[*]
Campinas[***]	F1	6.19 a	6.30 a	6.52 a	5.88 ba	6.45 ba	0.18 a
	F2	6.31 a	6.12 bac	6.73 a	5.95 ba	6.58 a	0.22 a
	F3	5.30 cb	5.62 c	5.20 d	5.63 ba	5.41 c	-0.00 ba
	F4	5.61 b	6.05 bac	5.81 c	5.92 ba	6.01 b	0.08 ba
	F5	6.51 a	6.23 a	5.91 bc	5.89 ba	6.14 ba	-0.34 dc
	F6	6.64 a	6.15 ba	6.42 ba	6.16 a	6.51 a	-0.14 bc
	F7	4.99 c	5.71 bc	4.82 d	5.56 b	4.97 c	-1.02 e
	F8	5.40 cb	5.87 bac	5.81 c	6.23 a	6.02 b	-0.51 d
	LSD[**]	0.54	0.50	0.59	0.60	0.49	0.30
Matinhos[****]	F1	7.56 BA	7.09 A	6.92 A	6.39 B	6.89 BA	0.23 BA
	F2	7.62 A	6.88 A	6.94 A	6.40 B	7.05 BA	0.30 A
	F3	6.82 DC	6.78 BA	6.46 A	6.75 BA	6.52 B	-0.04 BDC
	F4	6.86 BDC	6.77 BA	6.80 A	7.20 A	6.97 BA	0.03 BAC
	F5	7.57 BA	6.80 BA	6.58 A	6.64 BA	6.76 BA	-0.31 ED
	F6	7.49 BAC	6.87 A	6.86 A	7.18 A	7.16 A	-0.18 EDC
	F7	6.61 D	6.26 B	5.52 B	6.19 B	5.72 C	-0.99 F
	F8	6.38 D	6.57 BA	6.51 A	6.70 BA	6.51 B	-0.42 E
	LSD[**]	0.71	0.59	0.67	0.66	0.57	0.33
t-test[*****]	p value	**<u>< 0.0001</u>**	**<u>0.0012</u>**	0.9664	0.0671	**<u>0.0470</u>**	0.5950

[*] JAR: just-about-right scale;

[**] LSD: least significant difference by Tukey's test at 5% significance level;

[***] Means with the same lowercase letters in the same column do not differ significantly at 5% (p < 0.05) according to Tukey's test for the city of Campinas (N = 120);

[****] Means with the same uppercase letters in the same column do not differ significantly at 5% level (p < 0.05) according to Tukey's test for the city of Matinhos (N = 123);

[*****] Bold and underlined text indicates significant differences at 5% level (p < 0.05) between the two cities.

Regarding the aroma, F3 was the least accepted by the consumers of Campinas city, with no significant difference from the formulations F2, F4, F7, and F8. The lowest acceptance scores were observed for formulation F7 by the consumers of Matinhos city, which was significantly different from F1, F2, and F6. The attribute taste of the formulations containing MSG (F2, F4, F6, and F8) had a higher acceptance scores than the equivalent sample without the addition of this ingredient (F1, F3, F5, and F7). The consumers of Campinas city found that samples with washed pulp (F3, F4, F7 and F8) were significantly different from the samples produced with the whole pulp. Among them, the samples F3-F7 and F4-F8 were statistically equal. Regarding the consumers of Matinhos city, only the flavor of the formulation F7 differed statistically from the others (p < 0.05), with the lowest acceptance scores.

Similar behavior was observed for the attributes texture and overall impression when compared to the attribute flavor, and the samples with glutamate (F2, F4, F6, and F8) showed higher acceptance scores than the equivalent without this ingredient. Regarding the overall impression, the consumers of Campinas city preferred the formulation F2, which did not differ from F1, F2, and F5, whereas the consumers of Matinhos city preferred the formulation F6, which did not differ from F1, F2, F4, and F5. The formulation F7 had the lowest acceptance score in both cities, which was statistically (p < 0.05) equivalent to F3 in Campinas city, and different (p < 0.05) from the others in Matinhos city.

The formulation F3 showed a mean intensity on the JAR scale in both cities and was closest to just-about-right. The formulations with higher salt content (F1, F2, F3, F4) had a higher intensity of the attribute salty taste than the low-salt formulations (F5, F6, F7, F8), and the formulations with MSG were more intense than the corresponding samples that did not contain the ingredient (F2 > F1 > F4 > F3 > 8F6 > F5 > F8 > F7).

Significant differences ($p < 0.05$) for the attributes' appearance, flavor, and overall impression were observed in the t-test for the consumers from each city.

The results of the acceptance test are consistent with literature data (DI MONACO et al., 2009; MARENGONI et al., 2009; PEREIRA et al., 2003; SARY et al., 2009; SEBBEN et al., 2000; SILVA; FERNANDES, 2010), once higher acceptance scores were obtained for burgers made with different fish species. Higher acceptance scores were observed for all attributes in the findings of Tokur et al. (2006), who assessed the sensory quality of fish strips produced with full and washed carp (*Cyprinus carpio*) pulp; Tokur et al. (2004), who assessed tilapia (*Oreochromis niloticus*) burgers; and Ozogul and Uçar (2013), who analyzed chub mackerel (*Scomber japonicus*) burgers.

In contrast, Marengoni et al. (2009) and Sary et al. (2009) found no differences in the acceptance of tilapia burgers prepared with full and washed pulp.

The addition of MSG contributed to a higher acceptance of the "Mackerel burger", evidencing that the MSG can contribute to sodium reduction without affecting palatability, thus improving flavor quality and providing lower salt intake (GYU-HEE, 2011; JINAP; HAJEB, 2010; MALULY; PAGANI; CAPARELLO, 2011).

Figure 3 shows the internal preference map of "Mackerel burger", which considered the individual consumers' preferences in each city. The principal components I and II explained 47.94% and 43.19% of the variability among individuals, respectively, regarding the acceptance of the different samples by consumers from Campinas and Matinhos. The samples with full fish pulp (F1, F2, F5 and F6) were located on the right side of the map for both cities. In addition, a good acceptance score was observed for the formulation F4, which was prepared with washed pulp, lower salt content, and addition of MSG.
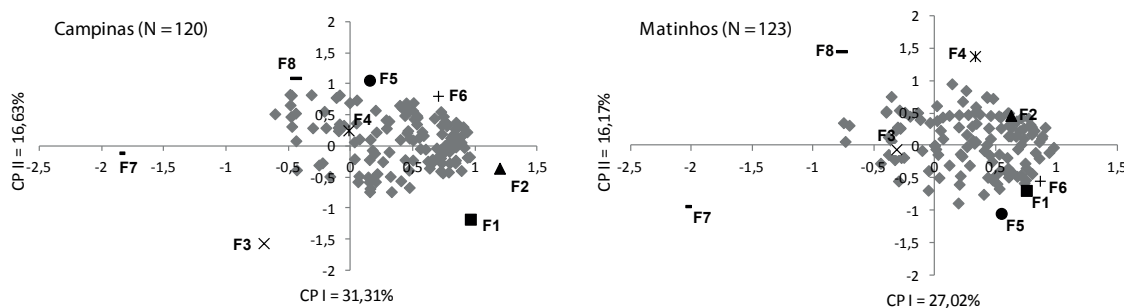

FIGURE 3 - INTERNAL PREFERENCE MAP OF THE "MACKEREL BURGER"[a] IN TWO BRAZILIAN CITIES (N = 243)

In these maps, the area near the five samples was confirmed by the results of Tukey's test, in which the "Mackerel burger" formulations with full fish pulp were the most accepted, followed by the samples prepared with washed pulp, containing a higher salt content and MSG (F4).

Intermediate scores were obtained for the acceptance of the formulations F3 and F8, due to the lower number of assessors or the distance from the other samples. The formulation F7 was the least accepted by the consumers, as evidenced by the greater distance from the other samples.

The locality where the tests were performed is of great importance due to the cultural differences and food habits of the consumers (OLSEN et al., 2008; SHAVIKLO et al., 2011;

TRONDSEN et al., 2004; VERBEKE; VACKIER, 2005), which may have contributed to the differences in appearance, aroma, and overall impression of the "Mackerel burger". The consumers in the present study lived in different regions of Brazil; Campinas is located in the southeast approximately 200 km from the sea, whereas Matinhos is a coastal city in the south region.

Figure 4 shows the frequency of purchase intention of Sororoca burger for the cities of Campinas and Matinhos. Significant ($p < 0.05$) differences were observed for the formulations F3, F4, F5, F7, and F8 when the cities were compared by the t-test. In Campinas, only the samples with full fish pulp (F1, F2, F5, and F6) had a positive acceptance (would definitely buy the product and possibly would buy the product), as opposing to Matinhos, where a positive purchase intention above 64% was observed for all samples. The formulations F7 and F8 received the highest negative scores for the purchase intention in Campinas and Matinhos, respectively.
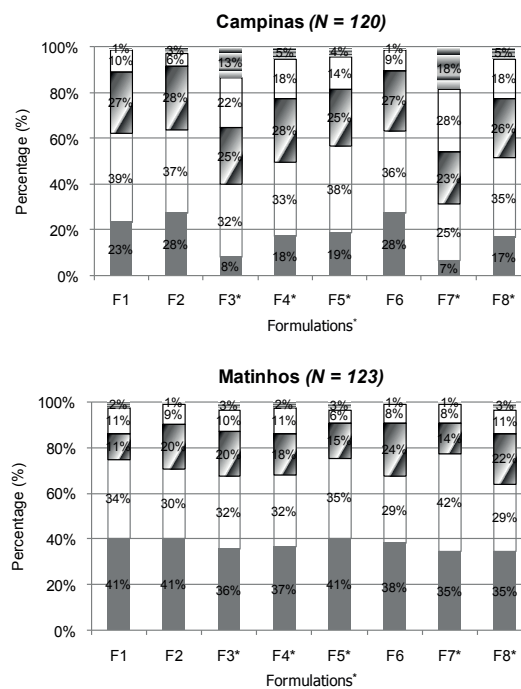

FIGURE 4 - FREQUENCY DISTRIBUTION OF THE PURCHASE INTENTION OF "MACKEREL BURGER" IN TWO BRAZILIAN CITIES BY ADULT CONSUMERS *(N = 243)*

certainly would buy the product; possibly would buy the product; maybe would buy/ maybe would not buy; possibly would not buy the product; certainly would not buy the product.
* The samples exhibit significant difference at 5% level ($p < 0.05$) between the cities according to the t test.

Despite the differences in the attributes appearance, aroma, and overall impression, the purchase intention did not vary between the cities, thus the positive results of this attribute may be good indicators for the purchase of fish-based products (HONKANEN; OLSEN; VERPLANKEN, 2005; TUU et al., 2008). The results of the purchase intention are consistent with the findings of Marengoni et al. (2009), who found that consumers were more likely to purchase tilapia burger than to reject it.

3.3 Consumer analysis - Children

The results of the facial hedonic scale test of the "Mackerel burger" are shown in Table 4 and indicate an excellent acceptance of all formulations, with no significant differences ($p < 0.05$) between them. The percentage of consumption intention of "Mackerel burger" by children was equal to or greater than 89% for all formulations (Figure 5).

TABLE 4 - MEANS OF THE FACIAL HEDONIC SCALE TEST OF THE "MACKEREL BURGER"
(N = 123)

Variable	Formulations								
	F1	F2	F3	F4	F5	F6	F7	F8	LSD*
Facial Hedonic Scale**	6.75a	6.69a	6.67a	6.76a	6.67a	6.75a	6.68a	6.72a	0.25

* LSD: least significant difference by Tukey's test at 5% significance level.
** Means with the same letters in the same row do not differ significantly at 5% level ($p < 0.05$) according to Tukey's test.
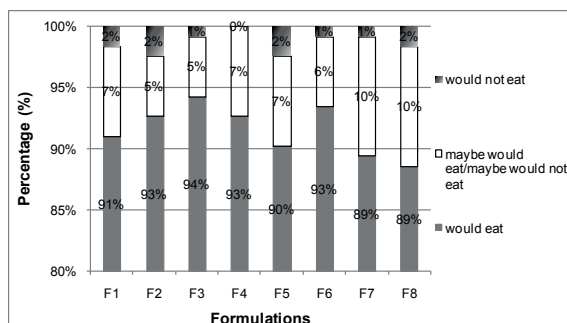

FIGURE 5 - FREQUENCY DISTRIBUTION OF THE CONSUMPTION INTENTION OF "MACKEREL BURGER" BY CHILD CONSUMERS *(N = 123)*

Flavor is the main attribute for the purchase or consumption of fish-based products. For many younger consumers (children), this is the only criterion for choosing a product (DOPICO; TUDORAN; OLSEN, 2010). The results of this study are consistent with the findings of Pagliarini et al. (PAGLIARINI; GABBIADINI; RATTI, 2005), who assessed the consumers' preference of breaded fish in meals provided in the primary schools in the city of Milan, and Mitterer-Daltoé et al. (2013), who analyzed the acceptance of breaded anchovy (*Engraulis anchoita*) in two public schools of Brazil's southern region.

CONCLUSION

Different acceptance results were observed for the attributes appearance, flavor, and overall impression in both cities, and the formulations produced with the whole pulp and addition of MSG were the most accepted by adult consumers. The formulations F3 and F4 presented ideal intensity for salty taste.

The good acceptance and positive purchase behavior of adults, together with the high acceptance of children suggested that the "Mackerel burger" with reduced salt content (formulations

5 and 6) can be part of school feeding programs, once it is a fish-based product prepared with regional fish that is free of bones and available year-round.

These results show that Serra Spanish Mackerel can be used as raw material for the preparation of fish-based products with good acceptance by children and adults. Therefore, it is a valid and promising product for school feeding programs, besides contributing to Brazilian artisanal fisheries.

ACEITAÇÃO SENSORIAL DE HAMBÚRGUER DE SOROROCA COM TEOR REDUZIDO DE SAL COMO ALTERNATIVA PARA A ALIMENTAÇÃO ESCOLAR

O trabalho teve como objetivo avaliar a aceitação do consumidor em relação a amostras de hambúrguer de Sororoca (*Scomberomorus brasiliensis*) com teor reduzido de sódio, para a alimentação escolar. As variáveis estudadas foram: polpa de pescado (integral e lavada), concentração de sal - NaCl (1,5% e 0,75%) e glutamato monossódico (0% e 0,3%). As amostras foram submetidas a determinação de teor de sódio e análise do consumidor – adultos e crianças. A análise do consumidor adulto foi realizada em duas cidades brasileiras: Campinas, Estado de São Paulo, e em Matinhos, Estado do Paraná; e o teste com crianças foi realizado apenas em Matinhos. Os resultados foram avaliados por análise de variância, teste de média de Tukey ($p \leq 0,05$) e por meio da distribuição de frequência em gráfico de barras. A análise do consumidor – adultos – realizada em duas cidades brasileiras foi comparada pelo teste t de Student ($p \leq 0,05$). As amostras diferiram estatisticamente no teor de sódio ($p < 0,05$), que variou de 199,26mg/100 g (F7) a 517,76 mg/100 g (F2). Diferenças significativas ($p < 0,05$) foram observadas no teste de aceitação para os consumidores adultos em relação à aparência, aroma e impressão global e mostraram-se diferentes estatisticamente pelo teste t entre as duas cidades ($p < 0,05$). Para o teste de consumidor com as crianças, não foi observado diferença. Os dados sugerem que os hambúrgueres de Sororoca podem fazer parte da alimentação escolar.

PALAVRAS-CHAVE: ALIMENTAÇÃO ESCOLAR; HAMBÚRGUER DE PEIXE; SCOMBEROMORUS BRASILIENSIS; TEOR REDUZIDO DE SAL; TESTE DE ACEITAÇÃO.

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