Low-sodium fish burgers: Sensory profile and drivers of liking

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ABSTRACT

The aims of this study were to determine the descriptive sensory profile and drivers of liking of eight samples of low-sodium Serra Spanish Mackerel (*Scomberomorus brasiliensis*) fish burgers. The sensory profile was determined by 12 trained assessors, and acceptance testing was performed using 243 consumers. Partial least-squares regression analysis was used to identify the drivers of liking and rejection of fish burgers (i.e., "Mackerel burger"). The results of the sensory descriptive profile indicated that the attributes appearance, aroma, and flavor were stronger for the samples prepared from whole minced fish. Acceptance was also higher for formulations containing whole minced fish. The descriptive terms that drove consumer preference and determined the acceptance were fish shape, salty taste, umami taste, fish flavor, herb flavor, and residual artificial flavor, and the term fish shape positively affected the results. Thus, despite the preparation of a fish-based product with low sodium and high acceptance is feasible, the drivers of liking should be considered.

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1. Introduction

Fish and its derivatives are a nutritious alternative (Clerfeuille et al., 2013) to promote a healthy diet with low levels of salt, sugar, saturated fat and trans fatty acids (Brasil, 2010a).

Efforts to promote healthy eating in Brazil include the encouragement of fish consumption (Brasil, 2010b), promotion of healthy food options at schools (Chaves, Mendes, Brito, & Botelho, 2009), use of low sodium levels in processed foods (Nilson, Jaime, & Resende, 2012), and the creation of the National System for Food and Nutrition Safety (Sistema Nacional de Segurança Alimentar e Nutricional — SISAN) to guarantee the human right to food (Recine & Vasconcellos, 2011).

Serra Spanish Mackerel — *Scomberomorus brasiliensis* (Collette, Russo, & Zavala-Camin, 1978) is an important resource for the artisanal fishing fleet in Brazil (Nóbrega & Lessa, 2009). *S. brasiliensis* is available year round, particularly from April to August, and can be used in various dishes and products because it contains few bones (Ramires, Rotundo, & Begossi, 2012).

However, the sensory properties and factors that affect product attributes, and consumers' acceptance should be investigated (Melo, Bolini, & Efraim, 2009). Thus, the descriptive analysis test is a broad, flexible and useful sensory method that provides detailed information on all of the sensory properties of the product (Murray, Delahunty, & Baxter, 2001).

Therefore, this study aimed to determine the descriptive sensory profile and the drivers of liking of eight samples of low-sodium Serra Spanish Mackerel (*S. brasiliensis*) fish burger.

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2. Materials and methods

2.1. Fish raw material

Serra Spanish Mackerel (*S. brasiliensis*, average weight 1469.8-g), was obtained from artisanal fishermen at Z-4 Fisherman Colony in Matinhos, Paraná (PR), Brazil, in August, 2013.

Fish were acquired fresh and immediately placed in styrofoam boxes with ice, and transported to the Food Education Laboratory (Laboratório de Educação Alimentar - LEAL) of the Coastal Sector at the Federal University of Paraná (Universidade Federal do Paraná - UFPR). In the laboratory, fish were washed in chlorinated water (5 mg·L^{-1}), gutted, decapitated, and manually filleted. The filets were washed in chlorinated water (5 mg·L^{-1}), and ground in a meat grinder (Liemita, G.Paniz, Brazil) with an 8-mm disk to obtain minced whole mackerel.

Half of the minced fish (6 kg) was stored in polypropylene containers in 600-g portions, and maintained at −18 °C for a week until the manufacturing process. The other half was subjected to three washing cycles (Kuhn, Soares, Prentice-Hernández, & Vendruscolo, 2003), using chlorinated water (5 mg·L^{-1}) from the city water supply network at a temperature < 10 °C in the ratio 3:1 (water/minced fish, w/w).The first cycle was performed with alkaline salt solution (0.15 g/100 g NaCl and 0.2 g/100 g NaHCO3) for 15—20 min under slow manual shaking. In the second cycle, only chlorinated cold water was used, and a solution of 0.2 g/100 g NaCl was used in the third cycle to extract soluble proteins and water (Martín-Sánchez, Navarro, Pérez-Álvarez, & Kuri, 2009). Next, draining by compression was performed to remove excess water. The minced fish was then packed in polyethylene containers in 600-g portions and stored at −18 °C for a week for further preparation of fish burgers.

2.2. Formulations and preparation of fish burgers

Eight formulations were prepared (Table 1) in a 2 × 2 × 2 factorial design using the following variables: minced fish (whole and washed, 75.44 g/100 g, and 86.24 g/100 g moisture, respectively), cooking salt (NaCl; 1.5 g/100 g and 0.75 g/100 g), and monosodium glutamate (MSG; 0 g/100 g and 0.3 g/100 g).

Fine textured soy protein (VITAO®, provided by Nutrihouse Alimentos Ltda., Curitiba, PR, Brazil), cornstarch (QUERO®, Jundiaí, State of São Paulo, Brazil, purchased from a local supermarket), powdered onion and garlic, parsley and chive flakes (provided by Nutrimental S/A Indústria e Comércio de Alimentos, Curitiba, PR, Brazil) and cold water (5 °C). MSG (AJI—NO—MOTO®) was provided by Ajinomoto do Brasil Indústria e Comércio de Alimentos Ltda. (city of São Paulo, State of São Paulo, Brazil), and cooking salt (CISNE®, Refinaria Nacional de Sal S.A., Cabo Frio, State of Rio de Janeiro, Brazil) was purchased from a local market.

First, the soy protein was mixed to cold water. Then, the minced fish was homogenized with NaCl (and MSG, when in the formulation), seasonings, prehydrated soy protein, and cornstarch using a mixer (WALITA® Philips Brazil). The mixture was refrigerated to 3 °C, and 100 g was molded in a 110-mm-diameter burger mold. The burger samples were molded into fish shape using a manual cutter (25 × 50 mm), hereafter referred to as "Mackerel burgers", placed in polyethylene bags and frozen (−18 °C) until analysis. The average weight of a "Mackerel burger" was 6.84 g ± 0.24 g.

2.3. Cooking process

A conventional electric oven (Layer, J. Ryal, Brazil) was pre-heated for 30 min 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, Bratchell, Greenhoff, & Vallis, 1989). Mackerel burgers were baked for 10 min and turned after 5 min. After baking, the samples were maintained at 63 °C in a conventional electric oven and immediately served to the assessors 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.

2.4. Determination of sensory descriptive profile

The sensory descriptive profile was determined according to Stone and Sidel (2004). The test was performed in the Sensory Analysis Laboratory of the UFPR Nutrition Department in individual booths (22 °C) under white light. The assessors were instructed to wash their mouth with water between samples to avoid carryover effects (Wakeling & MacFie, 1995). The samples were presented monadically in balanced complete blocks (Macfie et al., 1989) and coded with three digit numbers (Stone & Sidel, 2004).

The study was approved by the Research Ethics Committee of the School of Medical Sciences of University of Campinas (Universidade Estadual de Campinas − UNICAMP) under number CAAE 06047212.0.3001.0096, and all volunteers were provided with a written inform consent.

2.4.1. Pre-selection of assessors

To build the team of assessors, a pre selection was performed with 30 candidates using Wald's sequential analysis (Meilgaard, Civille, & Carr, 2007) and triangle tests (Morais, Cruz, Faria, & Bolini, 2014) with two fish burger formulations, at 1% significant level, as follows: one formulation containing 0.75 g/100 g NaCl and 0.00 g/100 g MSG, and the other with 0.00 g/100 g NaCl and 0.30 g/100 g MSG. After the tests, 20 assessors were selected.

2.4.2. Development of descriptive terminology

The network method (Moskowitz, 1983) was used to determine the descriptive terms for the eight Mackerel burger treatments. The samples were presented in pairs, and the assessors were asked to describe the differences and similarities between the samples

Table 1
Design used to prepare the formulations and sodium levels in Mackerel burgers.

Ingredient	Formulations							
	F1	F2	F3	F4	F5	F6	F7	F8
Minced fish	Whole	Whole	Washed	Washed	Whole	Whole	Washed	Washed
salt concentration (g/100 g)	1.5	1.5	1.5	1.5	0.75	0.75	0.75	0.75
Monosodium glutamate (g/100 g)	0	0.3	0	0.3	0	0.3	0	0.3
Sodium content (mg/100 g)*	461.78[b] ± 17.16	517.76[a] ± 19.33	398.30[c] ± 9.66	462.43[b] ± 11.46	243.22[d] ± 19.22	264.77[d] ± 5.11	199.26[e] ± 3.04	205.48[e] ± 2.50

* Identical letters in the same row are not significantly different at a 5% confidence level (p ≤ 0.05).