Development and Characterization of Rainbow Trout Pâté Added with Serrano Chili Microcapsules [†]

César Antonio Ortiz Sánchez [1,*], Marina Guevara Valencia [1], Arturo Erick Figueiras Carrillo [2], Katherine Bravo Ariza [3], Areli Brenis Dzul [3] and Eduardo Hernández Aguilar [1]

[1] Facultad de Ciencias Químicas, Universidad Veracruzana, Orizaba, Veracruz, Mexico; email1@email.com (M.G.V.); email2@email.com (E.H.A.)

[2] Depto. De Ingeniería Química, TECNM/Instituto Tecnológico de Orizaba; email1@email.com

[3] Depto. De Ingeniería Industrial, TECNM/Instituto Tecnológico de Orizaba; email1@email.com (K.B.A.); email2@email.com (A.B.D.)

[*] Correspondence: ceortiz@uv.mx

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Abstract: Rainbow trout (*O. mykiss*) is rich in proteins and its production is high. Serrano chili peppers (*C. annuum* L.) have capsaicinoids which participate in the prevention of different illnesses. The aim of this work was to evaluate the effect of Serrano chili microcapsules addition on the physicochemical properties and sensory acceptance of a rainbow trout pâté. Pâté with microcapsules had 23.16, 5.94, and 73.07% of protein, fat, and moisture content, respectively. Color measurement showed a redness tendency (a* = 7.5 and b* = 22.3) with a luminosity of 78%. During sensory analysis pâté was rated positively meaning a feasible acceptance.

Keywords: Pâté; chili microcapsules; physicochemical characterization; sensory analysis

1. Introduction

Rainbow trout (*Oncorhynchus mykiss*) is a commonly aquacultured fish, its global production was around 911 800 tons in 2019 [1]. Protein content in *O. mykiss* is around 25% of the fresh weight, suggesting that the raw material could be a good source for protein extraction [2]. Fish proteins possess many functional properties such as emulsification, oil binding capacity, solubility, and viscosity, all of which depend on both the type of raw material and the process parameters (enzyme employment, pH, temperature, and hydrolysis time) [3].

Pâté is as a cooked product that is ready to be consumed and it is popular in the gastronomy of different countries. Traditional pâté formulation consists of minced liver, fat and meat from pork mixed with water and different additives with a subsequent thermal process, it could be considered as an emulsion turned into a paste [4].

On the other hand, Serrano chili pepper (*Capsicum annuum* L.) is one of the most preferred cultivars in México, and a widely used ingredient in Mexican gastronomy as well. They have an important content of vitamin C and E, several minerals, and phenolic compounds that confer high antioxidant potential. Capsaicinoids present in *C. annuum* L. are the main ones responsible for its color, pungency, and antioxidant activity [5], however, such biomolecules are easily degraded by high temperatures, oxygen, light, acidity, and pro-oxidant agents; one way to overcome that is through microencapsulation, in that process bioactive compounds are protected or surrounded by a wall material, so their shelf life can be extended, other benefits of microencapsulation are improvement of water

solubility for lipophilic molecules, permeability, odor masking, control release either slowly or at the target site, and bioavailability improvement of the bioactive compounds [6].

One problem when adding Serrano chili peppers into a food product is its high pungency, attributed to capsaicinoids, so through microencapsulation that could be improved due to controlled flavor release.

Nowadays consumers demand high quality food products with health benefits, therefore, different processes and formulations have been modified for the production of healthier food; one good strategy is the addition of biomolecules with biological activity without putting on side quality factors such as nutritional value and final sensory acceptability.

Taking advantage of the different functional properties exhibited by fish proteins, capsaicinoids present in Serrano chili peppers, and microencapsulation, this work aimed to develop, characterize and measure the acceptance of a rainbow trout pâté with chili microcapsules.

2. Materials and Methods

2.1. Materials

Fillets of rainbow trout, dry Serrano pepper (*Capsicum annuum* L.), canola oil, salt, cornstarch, and sorbitol were purchased in a local supermarket in Orizaba, Veracruz, Mexico. Arabic gum (GA) was acquired from Droguería Cosmopólita, Mexico. All the other reagents employed were analytical grade.

2.2. Preparation of Oleoresin

Dry Serrano peppers were grounded and mixed with canola oil in a 1:3 (*w/w*) ratio, placed in a glass container and kept in the darkness for 48 h; the resulting oleoresin was separated by centrifugation 3000 rpm for 10 min and stored at 4 °C in an amber glass bottle for its further employment [7].

2.3. Preparation of Emulsion with Microcapsules

Serrano pepper oleoresin emulsion was prepared at a concentration of 30% solids (*w/w*) with a 1:4 (*w/w*) ratio oleoresin:GA; first, GA was dissolved in distilled water and oleoresin was added drop-wise till reaching the concentration stated above. The resulting emulsion was homogenized at 5000 rpm for 10 min and employed immediately for pâtés preparation [8].

2.4. Pâté Formulation

Pâtés with and without Serrano oleoresin microcapsules (PWSO and PNSO respectively) were formulated as described in Table 1. For their preparation rainbow trout fillets were sliced in 3 cm cubes and manually washed with ice in a 7:1 (*w/w*) ratio, excess of water was removed with hand pressure. That process was repeated three times for obtaining a homogenous dough. All pâtés elaborated were emulsified in a food processor and immediately placed in glass containers for high heat treatment (90 °C, 45 min) with a subsequent chilling until 1 °C. The resulting pâtés were stored at 4 °C for their further use.

Table 1. Formulation of rainbow trout pâtés.

Ingredients	PNSO	PWSO
	Quantity (%)	
Rainbow trout dough	67.95	87.95
Ice	5	5
Salt	2	2
Sorbitol	0.05	0.05

Cornstarch	5	5
Serrano oleoresin microcapsules	0	20

PNSO stands for pâté without Serrano oleoresin microcapsules and PWSO is pâté with Serrano oleoresin microcapsules.

2.5. Physicochemical Characterization of Pâtés

Physicochemical characterization of PNSO, PWSO, and a commercial sample was done on the Association of Official Analytical Collaboration (AOAC) International methods. Moisture was determined by drying samples at 104.5 °C to a constant weight (AOAC 23.003:2003). For protein content the Kjeldahl method was employed, first protein and organic nitrogen was converted into ammonia during digestion of the pâté with sulfuric acid in the presence of a mercury catalyst mixture, then the acid digestion was turned alkaline, and the ammonia was distilled and titrated with standard acid. The percentage of nitrogen was quantified and converted into protein using a factor of 6.25 (AOAC 2001.11). Fat content was determined gravimetrically by extracting lipids from pâté samples using hexane (AOAC 920.39C) [9]. The color of the three pâtés was evaluated using a Konica Minolta CR-400 portable colorimeter. Luminosity (L), a*, and b* parameters were read at room temperature.

2.6. Sensory Analysis of Pâtés

A sensory analysis measuring consumers' acceptance of the PNSO and PWSO samples was performed with 120 untrained tasters who are pâté consumers, no age, gender or other criteria were applied for choosing the judges except allergies to the ingredients. Judges were seated in a sensory analysis laboratory with individual cabins provided with neutral colors, white light, controlled ventilation, and away from distractions noise, odours and the preparation room. First, a glass of water was provided for cleaning the papillae, after that, 30 g of each sample was served with a toast. Panelists were instructed to cleanse their palate in between samples. All the samples were randomly numbered and served at room temperature. Judges evaluated each pâté in terms of acceptance using a hedonic scale of nine points, with the extremes "I dislike very much" or "I like very much" [10–12].

2.7. Statistical Analysis

Results are presented as the mean of three replicates ± standard deviation. A one-way analysis of variance (ANOVA) was performed, followed by a post-hoc Tukey test to identify differences between treatments at a p-value < 0.05 using Minitab (V.21.1.0).

3. Results and Discussion

3.1. Physicochemical Characterization of Pâtés

Table 2 shows the composition of the two different pâtés elaborated and a regular commercial sample found in the local supermarket. Moisture content for PNSO and PWSO was around 70% which is higher than the commercial sample. According to Vargas Ramella et al. [10] a high moisture content might be due to the addition of microcapsules since the wall material, arabic gum, may retain water. Xing et al. [13] reported that capsaicin microcapsules produced by complex coacervation displayed potential antimicrobial applications in food preservation, therefore the addition of Serrano oleoresin microcapsules could help to extend the shelf life of both pâtés even if they have a high moisture content.

Due to the addition of Serrano oleoresin microcapsules, the fat content in PWSO pâté was higher than PNSO and commercial sample; it is worth mentioning that even if the amount of fat seems to be elevated it is composed mainly of capsaicinoids which possess antioxidant, antiinflammatory, anticarcinogenic, antifungal activities among other properties [14].

Protein content in PNSO and PWSO was higher than the commercial sample, which could be related to the lack of pure fish protein in the commercial pâté and its substitution by other non-nutritive ingredients such as synthetic preservatives. Also, PWSO had a high protein content due to the addition of arabic gum which has 5% of protein in its composition.

During the washing cycles involved in the pâté elaboration process, protein content may change followed by a rise in moisture. According to Galvao et al. [15] washing process is important because it inhibits protein denaturalization, caused by some enzymes, and it also removes blood that can affect the color of the product.

Vargas Ramella et al. [10] elaborated a deer pâté added with chia oil microcapsules, they reported 53.26, 15.18, and 18.22% for moisture, fat, and protein content respectively; lately Matiucci et al. [11] reported a moisture content of 63%, proteins 15.3%, and fat 11.59% in Tilapia pâté.

Color parameters of a final product are related to the acceptance by the consumers, it depends on the raw materials and the processing techniques employed. In the CIELab scale, L represents the percentage of brightness (0 black and 100 white), a* red to green and b* yellow to blue.

It can be observed in Table 2 that all samples are equal in terms of luminosity (L), however there is a significant difference in the other coordinates. PWSO has a tendency to redness, related to high a* and b* values, due to the addition of Serrano oleoresin microcapsules rich in capsaicinoids. In a pâté elaborated with Tilapia Matiucci et al. [11] reported 62.17, 5.24, and 14.06 for L, a* and b* respectively; Vargas Ramella et al. [10] obtained L 51.27, a* 13.48 y b* 16.86 in deer pâté added with chia oil microcapsules.

Table 2. Physicochemical characterization of different pâtés.

	PWSO	**PNSO**	**Commercial**
Moisture (%)	73.076 ± 0.541 a	70.623 ± 0.713 b	64.600 ± 1.612 c
Fat (%)	5.948 ± 0.688 a	3.125 ± 0.395 b	3.290 ± 0.136 b
Protein (%)	23.160 ± 2.675 a	19.008 ± 0.953 b	9.379 ± 0.025 c
Luminosity (%)	78.060 ± 2.151 a	79.213 ± 0.463 a	78.355 ± 1.652 a
a*	7.587 ± 0.219 a	4.375 ± 0.200 b	1.037 ± 0.086 c
b*	22.310 ± 0.342 a	11.778 ± 0.139 b	6.737 ± 0.263 c

PNSO stands for pâté without Serrano oleoresin microcapsules and PWSO is pâté with Serrano oleoresin microcapsules. Values in the same row followed by different letters are different (Tukey's test $p < 0.05$).

3.2. Sensory Analysis of the Pâtés

New food product development must include sensory analysis as it reflects how much consumers like or dislike a product, it also helps during process optimization, cost analysis, shelf life determination and market research. The hedonic scale is a test used during the evaluation of products and is easily understood by those judged, several companies also employ it because it brings reliable results [4,16].

In this work overall liking response for both samples was positively evaluated on the 9-point hedonic scale with mean values of 7.098 ± 1.398 and 7.366 ± 1.540 for PNSO and PWSO, respectively. Matiucci et al. [11] evaluated the acceptance of a pâté elaborated with Tilapia and obtained a score of 8; Munhoz et al. [17] reported the same value for a fish burger made with *Pterodoras granulosus*. Vargas Ramella et al. [10] reported low acceptance scores in a deer pâté added with chia oil microcapsules, they argue that the high content of polyunsaturated fatty acids, more susceptible to degradation, changed the final flavor of the product.

In surimi fish balls elaborated with *Perilla frutescens* extracts Zhao et al. [18] reported an overall acceptability of 4.6 over a 5-point hedonic scale; similar results were published by Ünlüsayın et al. [19] in a pâté elaborated with smoked rainbow trout.

In a pâté elaborated with jaraqui fish fillets Decaris Rolim et al. [4] reported an acceptance of 4.58 over 5-point hedonic scale, according to them a product needs an acceptance rate over 70% to be fit for trade. In the present study, the judge's answers were close to that value indicating that the rainbow trout pâté with Serrano chili microcapsules would be suitable for marketing.

4. Conclusions

Rainbow trout pâté elaborated with Serrano chili microcapsules showed a high protein content and an important amount of capsaicinoid rich fat, its color has a tendency to redness and it has good sensory acceptability. Rainbow trout pâté could be an excellent alternative for increasing the demand of fish products with health benefits. It's possible to develop new food products with the incorporation of bioactive molecules into traditional formulation, as a result, a functional food cloud be developed and new consumer's needs can be satisfied.

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