Development and Characterization of Rainbow Trout Pâté Supplemented 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, Prolongación Oriente 6, Orizaba C.P. 94340, Veracruz, Mexico; mguevara@uv.mx (M.G.-V.); eduhernandez@uv.mx (E.H.-A.)
2 Departamento De Ingeniería Química, Tecnológico Nacional de México, Instituto Tecnológico de Orizaba, Oriente 9, Orizaba C.P. 94320, Veracruz, Mexico; arturo.fc@orizaba.tecnm.mx
3 Departamento De Ingeniería Industrial, Tecnológico Nacional de México, Instituto Tecnológico de Orizaba, Oriente 9, Orizaba C.P. 94320, Veracruz, Mexico; katherine.ba@orizaba.tecnm.mx (K.B.-A.); areli.bd@orizaba.tecnm.mx (A.B.-D.)
* Correspondence: ceortiz@uv.mx
† Presented at the 4th International Electronic Conference on Foods, 15–30 Oct 2023; Available online: https://foods2023.sciforum.net/

Abstract: Rainbow trout (O. mykiss) is rich in proteins and its production is high. Serrano chili peppers (Capsicum annuum L.) contain capsaicinoids that participate in the prevention of different illnesses. The aim of this work was to evaluate the effect of the addition of Serrano chili microcapsules on the physicochemical properties and sensory acceptance of rainbow trout pâté. Pâté with microcapsules had 23.16, 5.94, and 73.07% 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, the pâté was rated positively, indicating a feasible acceptance.

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

1. Introduction

Rainbow trout (Oncorhynchus mykiss) is a commonly aquacultured fish, and its global production rate was around 911,800 tons in 2019 [1]. The 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 a cooked product that is ready to be consumed and is popular in the gastronomy of different countries. The traditional pâté formulation consists of minced liver, fat, and meat from pork mixed with water and different additives using a subsequent thermal process; it could be considered as an emulsion turned into a paste [4].

On the other hand, Serrano chili peppers (Capsicum annuum L.) are one of the most preferred cultivars in Mexico and a widely used ingredient in Mexican gastronomy. They have an important content of vitamins C and E, several minerals, and phenolic compounds that confer high antioxidant potential. Capsaicinoids present in C. annuum L. are the main elements 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 this is through microencapsulation, a process in which bioactive compounds are protected or surrounded by a wall material, thereby extending their shelf life. Other benefits of microencapsulation are the 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 to a food product is their high pungency, which is attributed to capsaicinoids. Through microencapsulation, this 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 to produce healthier food. One effective strategy is the addition of biomolecules with biological activity without setting aside 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 study 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 from a local supermarket in Orizaba, Veracruz, Mexico. Gum arabic (GA) was acquired from Droguería Cosmopolita, Mexico. All other reagents employed were of analytical grade.

2.2. Preparation of Oleoresin

Dry Serrano peppers were ground and mixed with canola oil in a 1:3 (w/w) ratio, placed in a glass container, and kept in the dark for 48 h. The resulting oleoresin was separated using centrifugation at 3000 rpm for 10 min and stored at 4 °C in an amber glass bottle for further use [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 of oleoresin:GA. First, GA was dissolved in distilled water and oleoresin was added dropwise until reaching the concentration stated above. The resulting emulsion was homogenized at 5000 rpm for 10 min and employed immediately for pâté 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 into 3 cm cubes and manually washed with ice in a 7:1 (w/w) ratio, and excess water was removed with hand pressure. This process was repeated three times to obtain a homogenous dough. All pâtés were emulsified in a food processor and immediately placed in glass containers for high-heat treatment (90 °C, 45 min) with subsequent chilling until they reached 1 °C. The resulting pâtés were stored at 4 °C for further use.

Table 1. Formulation of rainbow trout pâtés.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>PNSO</th>
<th>PWSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainbow trout dough</td>
<td>67.95</td>
<td>87.95</td>
</tr>
<tr>
<td>Ice</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Salt</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sorbitol</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Cornstarch</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Serrano oleoresin microcapsules</td>
<td>0</td>
<td>20</td>
</tr>
</tbody>
</table>

PNSO stands for pâté without Serrano oleoresin microcapsules, and PWSO is pâté with Serrano oleoresin microcapsules.
2.5. Physicochemical Characterization of Pâtés

The physicochemical characterization of PNSO, PWSO, and a commercial sample was performed using the Association of Official Analytical Collaboration (AOAC) International methods. Moisture content was determined by the AOAC 934.06 method using a vacuum oven (70 °C; ≤100 mmHg). For protein content, the AOAC 2001.11 method was employed. First, protein and organic nitrogen were converted into ammonia during digestion of the pâté with sulfuric acid in the presence of a mercury catalyst mixture. The acid digestion then 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. Fat content was determined gravimetrically by extracting lipids from the pâté samples using hexane (AOAC 920.39C) [9]. The colors of the three pâtés were evaluated using a Konica Minolta CR-400 portable colorimeter (Ramsey, New Jersey, USA). 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 using 120 untrained tasters who were 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 featuring neutral colors, white light, controlled ventilation, and a location away from distractions such as noise, odors, and the preparation room. First, a glass of water was provided for cleaning the papillae, after which 30 g of each sample was served with toast. The panelists were instructed to cleanse their palate between samples. All 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 being “I dislike very much” and “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 prepared pâtés and a regular commercial sample found in the local supermarket. The moisture content of PNSO and PWSO was around 70%, which is higher than that of the commercial sample. According to Vargas Ramella et al. [10], the high moisture content might be due to the addition of microcapsules because the wall material, gum arabic, may retain water. Xing et al. [13] reported that capsaicin microcapsules produced using complex coacervation displayed potential antimicrobial applications in food preservation; therefore, the addition of Serrano oleoresin microcapsules could help extend the shelf life of both pâtés, even if they have a high moisture content.

Table 2. Physicochemical characterization of different pâtés.

<table>
<thead>
<tr>
<th></th>
<th>PWSO</th>
<th>PNSO</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (%)</td>
<td>73.076 ± 0.541 a</td>
<td>70.623 ± 0.713 b</td>
<td>64.600 ± 1.612 c</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>5.948 ± 0.688 a</td>
<td>3.125 ± 0.395 b</td>
<td>3.290 ± 0.136 b</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>23.160 ± 2.675 a</td>
<td>19.008 ± 0.953 b</td>
<td>9.379 ± 0.025 c</td>
</tr>
<tr>
<td>Luminosity (%)</td>
<td>78.080 ± 2.151 a</td>
<td>79.213 ± 0.463 a</td>
<td>78.355 ± 1.652 a</td>
</tr>
<tr>
<td>a*</td>
<td>7.587 ± 0.219 a</td>
<td>4.375 ± 0.200 b</td>
<td>1.037 ± 0.086 c</td>
</tr>
<tr>
<td>b*</td>
<td>22.310 ± 0.342 a</td>
<td>11.778 ± 0.139 b</td>
<td>6.737 ± 0.263 c</td>
</tr>
</tbody>
</table>

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

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

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

Vargas Ramella et al. [10] prepared deer pâté with chia oil microcapsules and reported moisture, fat, and protein contents of 53.26, 15.18, and 18.22%, respectively. Recently, Matiucci et al. [11] reported a moisture content of 63%, a protein content of 15.3%, and a fat content of 11.59% in tilapia pâté.

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

Table 2 shows that all samples are equal in terms of luminosity (L); however, there is a significant difference in the other coordinates. PWSO tends to be redder, which is related to high a* and b* values, due to the addition of Serrano oleoresin microcapsules rich in capsaicinoids. In a pâté prepared using tilapia, Matiucci et al. [11] reported values of 62.17, 5.24, and 14.06 for L, a*, and b*, respectively; whereas Vargas Ramella et al. [10] obtained 51.27, 13.48, and 16.86 for the same parameters in a deer pâté made with chia oil microcapsules.

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 provides reliable results [4,16].

In this study, the overall enjoyment response for both samples was positively evaluated on the nine-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 prepared with tilapia and obtained a score of eight; 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 for deer pâté supplemented with chia oil microcapsules. They argued that the high content of polyunsaturated fatty acids, which are more susceptible to degradation, changed the final flavor of the product.

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

In a pâté prepared with jaraqui fish fillets, Decaris Rolim et al. [4] reported an acceptance value of 4.58 on a 5-point hedonic scale. According to them, a product needs an acceptance rate over 70% to be suitable for trade. In this study, the judges’ answers were close to that value, indicating that rainbow trout pâté with Serrano chili microcapsules would be suitable for marketing.
4. Conclusions

Rainbow trout pâté prepared with Serrano chili microcapsules showed a high protein content and a significant amount of capsaicinoid-rich fat. Its color tends to be redder, and it has good sensory acceptability. Rainbow trout pâté could be an excellent alternative for increasing the demand for fish products with health benefits. It is possible to develop new food products by incorporating bioactive molecules into traditional formulations. As a result, a functional food cloud can be developed, and new consumer needs can be satisfied.

Author Contributions: Conceptualization, A.B.-D. and C.A.O.-S.; methodology, A.E.F.-C.; validation, E.H.-A.; formal analysis, M.G.-V.; investigation, K.B.-A.; resources, E.H.-A.; data curation, A.E.F.-C. and M.G.-V.; writing—original draft preparation, C.A.O.-S.; writing—review and editing, C.A.O.-S. and A.B.-D.; visualization, K.B.-A.; supervision, M.G.-V. and E.H.-A.; project administration, A.B.-D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data sharing is not applicable to this article.

Conflicts of Interest: The authors declare no conflict of interest.

References


Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.