https://doi.org/10.48047/AFJBS.6.14.2024.1134-1148

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Effect of Acceptability on the Improvement of a Seasoning Premix for Cabrilla Ceviche (*Paralabrax humeralis*)

Fredy Crispin, Rossmery K., Raúl Porturas Olaechea, Fabiola Olivares, Rodrigo Gamarra Navarrete

1. Sanchez: Faculty of Fisheries Engineering, Department of Aquaculture and Fisheries Industries,National Agrarian University La Molina, Lima 12, La Molina, Lima-Peru. E-mail: fcrispin@lamolina.edu.pe ORCID: https://orcid.org/0000-0002-0490-3739 Scopus Author ID: 59136729200 (AUTOR)
2. Torres Flores: Faculty of Fisheries Engineering, Department of Aquaculture and Fisheries Industries, National Agrarian University La Molina, Lima 12, La Molina, Lima-Peru. E-mail: rossmery030993@gmail.com
3. Faculty of Fisheries Engineering, Department of Aquaculture and Fisheries Industries,National Agrarian University La Molina, Lima 12, La Molina, Lima-Peru. E-mail: rporturas@lamolina.edu.peORCID: https://orcid.org/0000-0002-5136-8097 Scopus Author ID: 57192338694
4. Faculty of Fisheries Engineering, Department of Aquaculture and Fisheries Industries, National Agrarian University La Molina, Lima 12, La Molina, Lima-Peru. E-mail: folivares@lamolina.edu.peORCID: http://orcid.org/0000-0002-0722-5320 Scopus Author ID: 56116937600
5. Faculty of Fisheries Engineering, Department of Aquaculture and Fisheries Industries, National Agrarian University La Molina, Lima 12, La Molina, Lima-Peru. E-mail: 20141308@lamolina.edu.pe ORCID: https://orcid.org/0000-0003-3398-5478

Contact: fcrispin@lamolina.edu.pe

Volume 6, Issue 14,2024

Received: 10 JULY 2024

Accepted: 31 JULY 2024

Published: 02 AUG 2024

doi:10.48047/AFJBS.6.14.2024.1134-1148

ABSTRACT

The broth of ceviche is a balanced mixture of key ingredients that provides acceptable acidity. This study evaluated and improved the formulation of a commercial ceviche premix of cabrilla(*Paralabrax humeralis*), focusing on pH, acidity, and acceptability.

Initially, a consumer acceptability test was conducted comparing the premix with a traditional ceviche broth from well-rated restaurants. The traditional broth had an average pH of 3,59 ± 0,06 and an acidity of 4,03 ± 0,12 g of citric acid/100 ml. In contrast, the premix showed a pH of 2,66 ± 0,09 and an acidity of 4,36 ± 0,20 g of citric acid/100 ml, with a low acceptability of37,78% and pungency issues.

The formulation was improved by adding 0.4% silicon dioxide, evaluated through a hedonic test, with a p-value = 0,000536 < 0,05, indicating significant differences between the evaluated doses (0,3%, 0,4%, and 0,6%) with 95% confidence. The adjustment with atomized lemon (17,5g/100 ml of water) resulted in a broth with a pH of 3,6 ± 0.08 and an acidity of 4,34 ± 0,10 g of citric acid/100 ml, similar to the traditional broth, increasing acceptability to 74,57%. However, consumers perceived significant differences between the ABC2 and ABC formulas, demonstrated in an acceptability test with 40 consumers (p-value = 0,000067 < 0,05).

Keywords: ceviche, cabrilla, premix, silicon dioxide, acceptability

RESUMEN

El caldo del ceviche es una mezcla equilibrada de ingredientes clave que proporciona una acidez aceptable. Este estudio evaluó y mejoró la formulación de una premezcla comercial de ceviche de cabrilla (*Paralabrax humeralis*), centrándose en el pH, la acidez y la aceptabilidad.

Inicialmente, se realizó una prueba de aceptabilidad del consumidor comparando la premezcla con un caldo de ceviche tradicional de restaurantes bien valorados. El caldo tradicional tenía un pH promedio de 3,59 ± 0.06 y una acidez de 4,03 ± 0,12 g de ácido cítrico/100 ml. En cambio, la premezcla mostró un pH de 2,66 ± 0,09 y una acidez de 4,36 ± 0,20 g de ácido cítrico/100 ml, con una baja aceptabilidad del 37,78% y problemas de picor.

Se mejoró la formulación añadiendo 0,4% de dióxido de silicio, evaluada mediante una prueba hedónica, con un valor-p = 0,000536 < 0,05, indicando diferencias significativas entre las dosis evaluadas (0,3%, 0,4% y 0,6%) con un 95% de confianza. El ajuste con limón atomizado (17,5 g/100 ml de agua) resultó en un caldo con un pH de 3,6 ± 0,08 y una acidez de 4,34 ± 0,10 g de ácido cítrico/100 ml, similar al caldo tradicional, aumentando la aceptabilidad al 74,57%. No obstante, los consumidores percibieron diferencias significativas entre las fórmulas ABC2 y ABC, demostradas en una prueba de aceptabilidad con 40 consumidores (valor-p = 0,000067 < 0,05).

Palabras clave: ceviche, cabrilla, premezcla, dióxido de silicio, aceptabilidad.

I. INTRODUCTION

Peruvian gastronomy has grown remarkably in recent years, highlighting dishes such as ceviche, ají de gallina, lomo saltado, and arroz con mariscos, which have gained worldwide popularity (CENFOTUR, 2023).

Peruvian ceviche is one of Peru's most emblematic dishes, known for its unique combination of flavors (PROMPERU, 2020; Bradley, 2023). Its origin is attributed to the Mochica and Inca cultures, which used fermented juices and chicha to marinate the fish (PROMPERU, 2018). The pH is crucial for pathogen inactivation, but the ingredients and temperature also influence its reduction (Lopes *et al.*, 2022).

In different regions of Peru, ceviche adapts to local ingredients. For example, in Piura, it is served with zarandaja, sweet potato, and corn, while in Chiclayo it is accompanied by maize tortilla (PROMPERU, 2020).

The cabrilla, Paralabrax humeralis, is a fish with distinctive characteristics such as its gray-brown color and orange spots, in addition to being important in the demersal fishery for its high-quality meat (IMARPE, 2021).

Peruvian lime, essential in ceviche, has a pH of 2,3 and is mostly produced in Piura, Lambayeque, Tumbes, Loreto, and Ucayali (Puchoc C. & Puchoc J., 2021). Dehydrated lime juice powder, with maltodextrin, regulates moisture and increases shelf life (Alva & Elescano, 2022).

Garlic, Allium sativum, and chili peppers, especially Capsicum chinense, are fundamental ingredients that provide flavor and heat to ceviche (Jesús & Carbajal, 2019; Torres, 2018; Hernández & Radahelly, 2023). Dehydrated chili powder has a pH of 4,91 and a maximum humidity of 11% (Gonzales *et al.*, 2008; CODEX ALIMENTARIUS, 2022).

Black pepper, Piper nigrum, and ginger, known as kion, are also important components that contribute to the flavor and medicinal properties of the dish (CONITTA, 1991; García & Rayo, 2018; MINAGRI, 2020; Siedentopp, 2008).

Silicon dioxide, used as an anti-caking and anti-moisture agent, improves food texture (Requena & Vietti, 2019; Kwon *et al.*, 2023). Its use in dehydrated foods, such as atomized products, is key to maintaining quality and prolonging shelf life (Ávila *et al*., 2015; Avello *et al*., 2023; Peng *et al*., 2013).

The need to improve a commercial seasoning premix for cabrilla ceviche was identified due to its high initial pungency, which affected acceptability. This study aimed to improve the formulation to increase its acceptability and offer a practical and straightforward option for preparing ceviche (PROMPERU, 2020).

II. MATERIALS AND METHODS

2.1. Execution Location

The present work was carried out in a retail supplier company, located in the district of San Luis, in the province of Lima, dedicated to the production, development, commercialization, and distribution of products such as condiments and spices nationwide. The other part was conducted in the engineering and chemistry laboratories of the Faculty of Fisheries at the National Agrarian University La Molina (UNALM).

2.2. Materials

2.2.1. Raw Material

Cabrilla (*Paralabrax humeralis*) was acquired in its commercial size at the Ventanilla Fish Terminal, Constitutional Province of Callao, Peru. It was transported on ice and processed immediately. For the tests, 2-centimeter cubes were used.

2.2.2. Ceviche Flavor Premix

The premix called "DON CEVICHE" from the brand DOÑA YOLA will be kept as a proprietary and confidential development. The ingredients of the original formula include: powdered atomized lemon, salt, powdered garlic, powdered ginger, powdered black pepper, and powdered limo chili. The ceviche broth is prepared by dissolving a 50 g sachet of the premix in 100 ml of water, to which 500 g of fish cut into cubes is added (the instructions do not specify the type of fish or the size of the cubes). It is left to rest for 5 to 10 minutes and served with accompaniments such as sweet potato, corn, onion, and cancha (toasted corn).

2.2.3. Traditional Ceviche Broth

The traditional ceviche broth was evaluated by acquiring ceviche in three specialized seafood restaurants (cevicherías) located in the city of Lima.

2.2.4. Ingredients

The ingredients used for the formulation adjustment are atomized lemon powder from DOÑA YOLA and Food Grade silicon dioxide.

2.2.5. Materials and Equipment

Solutions: pH 4, 7, and 10 buffer solutions, NaOH: 0.1 N, phenolphthalein (1% solution in ethanol).

Materials: Spoons, strainer, stainless steel bowl, disposable plates, 50 ml graduated cylinder, 150 ml beaker, 100 ml glass beaker, 50 ml glass burette, 250 ml glass Erlenmeyer flask, 10 ml volumetric pipette, hedonic preference questionnaires, general acceptability questionnaires, plastic spoons, consumer panel (40 participants).

Equipment: Hanna pH meter, model pH 4 HI98217, Mettler Toledo digital balance, model CUB, Shengwin Speed magnetic stirrer and mixer model YG-5KG.

2.1.1. Analytical Methods of Evaluation

pH: Determined according to AOAC 981.12 (2012).

Acidity: Determined according to AOAC 942.15 (2019).

Preference Test: 5-point hedonic scale with 40 panelists (25-50 years). Each panelist evaluated 3 samples with silicon dioxide at 0.2%, 0.4%, and 0.6%. They indicated their level of liking according to the verbal-numeric scale (Tolentino, 2023; Ramírez, 2015; Witting, 2001).

General Acceptability: Linear graphic scale from 0 to 15 points, from "I like it very much" to "I dislike it very much". Two samples (ABC and BCA) were evaluated: traditional ceviche broth and broth with flavor premix (Crispin-Sanchez et al., 2024).

Chemical Evaluation: Proximal analysis in triplicate for the premix and ceviche broth. Methods: protein (AOAC 954.05, Cap. 4, p. 8, 20th ed., 2016); lipids (AOAC 920.39, Cap. 4, p. 40, 20th ed., 2016); moisture (AOAC 934.01, Cap. 4, p. 1, 20th ed., 2016); ashes (AOAC 942.05, Cap. 4, p. 8, 20th ed., 2016); and carbohydrates by difference (MS-INN, Collazos, 1993).

2.3 Experimental Methodology

2.3.1 Preparation of the Flavor Premix

Figure 2 shows the flow diagram of the processes carried out for the preparation of the flavor premix.

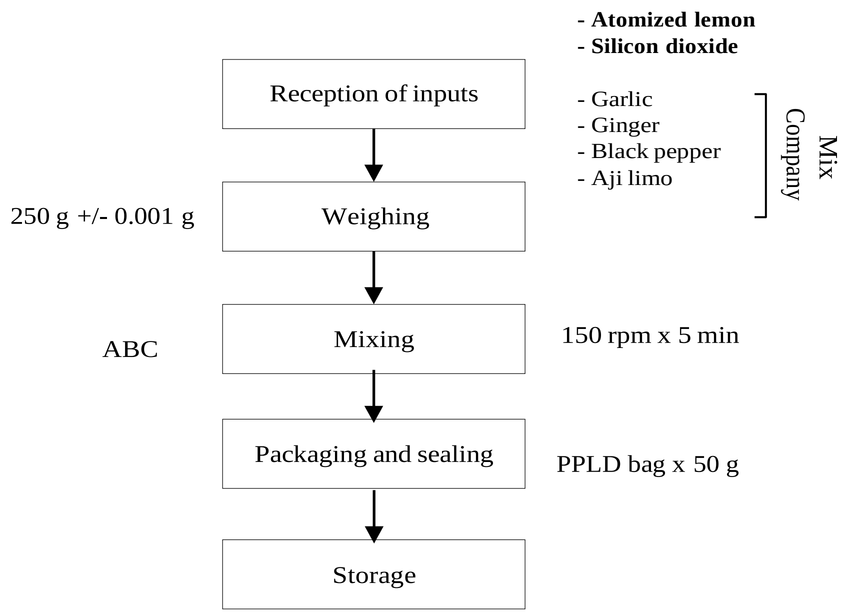

Figure 2. Flow of operations for obtaining flavor premix (ABC)

2.3.2. Experimental Design

Figure 3 shows the experimental design, which establishes all the stages and operations carried out, indicating the analyses and tests to be performed in each of them.

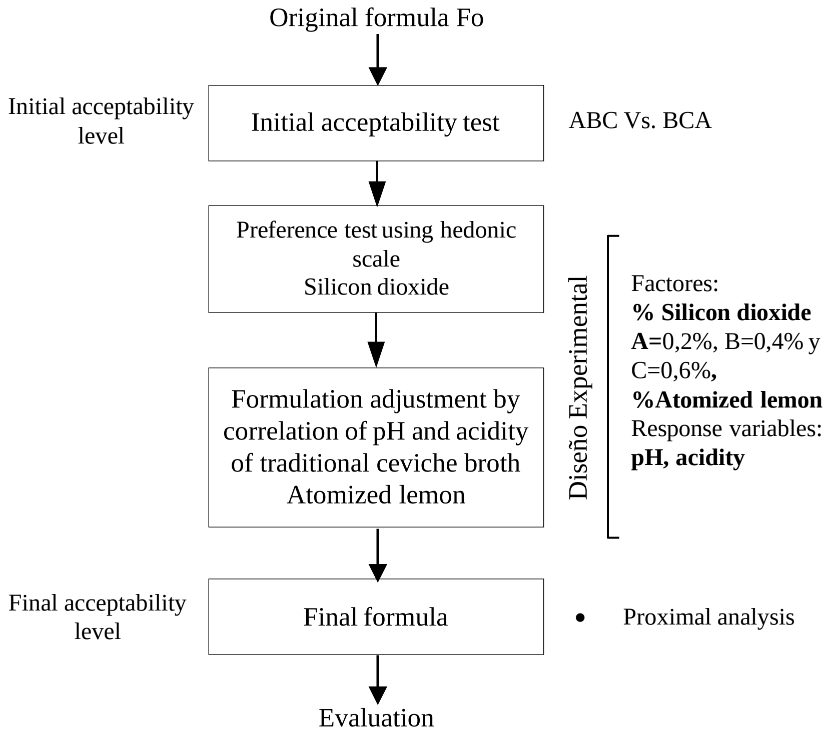

Figure 3. Experimental design for the improvement of powdered ceviche premix formulation

2.3.3. Statistical Analysis

Acceptability was evaluated with the t-test to compare the mean difference (0.0) against the alternative hypothesis that the difference is not equal to 0.0. With a P-value < 0.05, the null hypothesis is rejected, and the alternative is accepted.

The preference test was evaluated with the F-test. A P-value < 0.05 indicates a significant difference between the means of the three variables, with a confidence level of 95.0%. For the significance of the means, multiple range tests were used with Fisher's least significant difference (LSD) method.

The pH adjustment was performed using linear regression to describe the relationship between pH and atomized lemon. If the P-value < 0.05, a significant relationship is considered, with a confidence level of 95.0%.

All statistical analyses were performed using STATGRAPHICS Centurion 8.1 software.

III. RESULTS Y DISCUSSION

3.1. Base Formula Acceptability

The ceviche broth was prepared using the base flavoring formula (BCA) and an acceptability test was conducted with 40 panelists, comparing it with a traditional ceviche broth (BCA) from three restaurants in Lima. Consumers (20-60 years old) gave average scores of 12.0645 and

4.5575 to the BCA and ABC samples, respectively (Figure 4). According to the p-value (< 0.05), the null hypothesis was accepted, indicating significant differences between BCA and ABC. The flavored premix (ABC) had an acceptability of 37.78%, suggesting that it needs improvement.

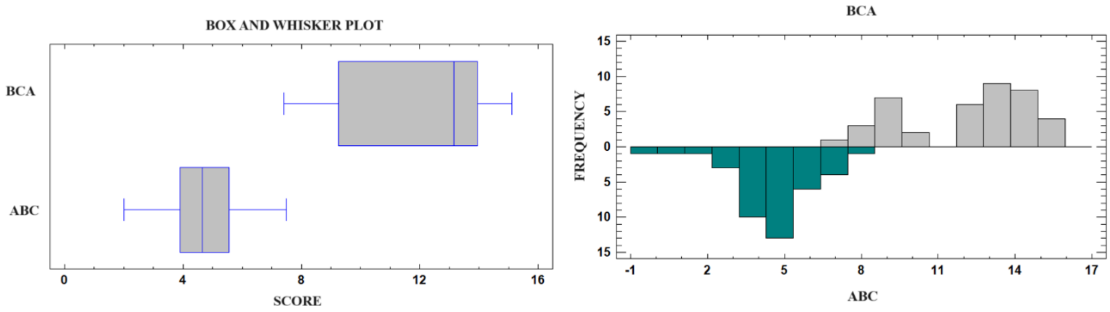

Figure 4. Box plot and mean comparison of ABC and BCA formulas

3.2. Determination of Adjusted Formula

Evaluation of Silicon Dioxide

The dose that significantly reduces the pungency of the ceviche broth premix was determined, based on an acceptance ≥ 50%. A preference test was conducted using a hedonic scale with three formulations: 0.2% (A), 0.4% (B), and 0.6% (C). The ANOVA (Table 2) showed an F-ratio of 58.3421 and a p-value < 0.05, indicating statistically significant differences between the means of the three doses with a 95% confidence level.

Table 2. Analysis of variance of the effect of silicon dioxide doses

Source	Sum of Squares	df	Mean Square	F-Ratio	p-Value
Between groups	49,2667	2	24,6333	58,34	0,0000
Within groups	49,4	117	0,422222		
Total (Corr.)	98,6667	119			

The multiple range test indicated significant differences with a 95% confidence level. Fisher's least significant difference (LSD) method identified three homogeneous groups (Figure 5).

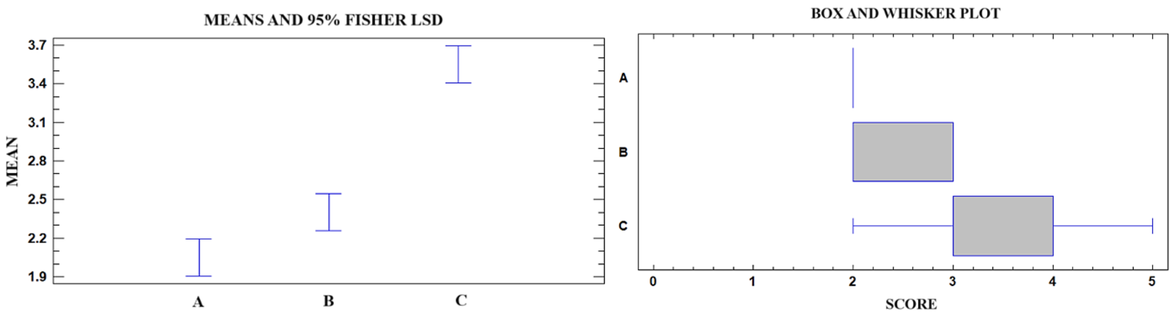

Figure 5. 95% Fisher LSD mean comparison and box plot

Preference leaned towards the 0,6% (C) dose. However, the 0,4% (B) dose showed the lowest coefficient of variation (20,67%) and a mean preference of 2,5, indicating a 50% preference. Additionally, considering the supplier's recommendation and costs, it was decided to use the 0,4% (B) dose of silicon dioxide in the flavoring premix.

pH and Acidity Adjustment

According to Zakrzewski *et al.* (2022), pH is crucial in ceviche preparation, as marinating the fish in lemon juice (pH 2,5-3,6) affects the viability of bacteria such as Salmonella spp., Escherichia coli, and Listeria monocytogenes. Ingredients in ceviche, such as chili peppers and onions, have bactericidal potential whose effectiveness depends on exposure time.

At this stage, the goal was to achieve acidity and pH similar to traditional ceviche. This was done by measuring the pH and acidity of traditional ceviche broth and adjusting it with atomized lemon. The calibration curve shows a significant relationship (ANOVA, p-value < 0,05) between pH and atomized lemon, with an R^2 of 99,88%. The adjusted equation is pH = 5,81715 – 0,126462*Atomized Lemon, indicating that 17,5 g of atomized lemon juice result in a pH of 3,6, consistent with Tyl & Sadler (2022) on the importance of titratable acidity.

This pH contributes to ceviche safety by creating a hostile environment for pathogens (Jay *et al*., 2005; Cases, 2024) and reducing microbial load, making it suitable for consumption when proper practices are followed (Keenleyside, 2023). Although a pH of 3,6 does not eliminate all microorganisms, it significantly reduces their number, making ceviche safer if consumed promptly (Adams & Moss, 2008). Other studies show that marinating fish in weak acids (pH 3,7-4,2) reduces microbial activity and denatures proteins (Logrén *et al.*, 2022). It is essential to use fresh fish and good handling practices to ensure product safety.

Table 3. Analysis of variance of the effect of atomized lemon adjustment and pH

Source	Sum of Squares	df	Mean Square	F-Ratio	p-Value
Model	0,331345	1	0,331345	4867,22	0,0000
Residual	0,000408462	6	0,0000680769		
Total (Corr.)	0,331753	7			

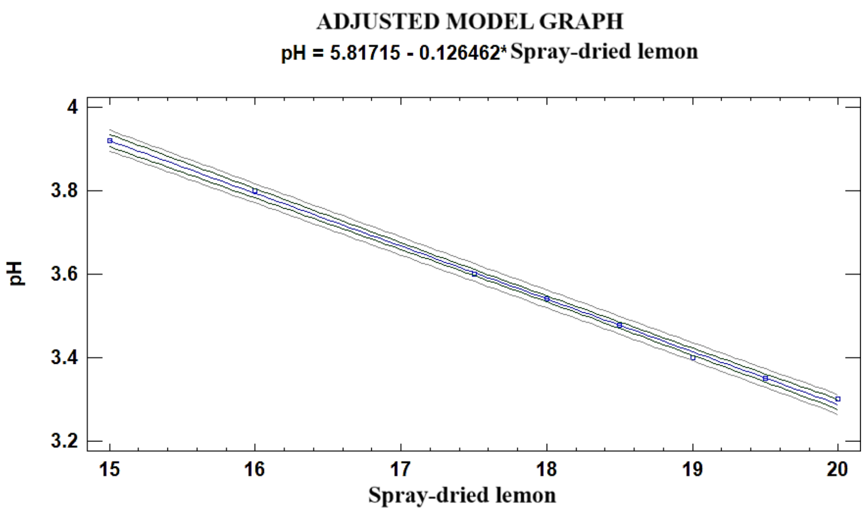

Figure 6. Calibration curve of pH vs. grams of atomized lemon juice poder

The traditional cabrilla ceviche broth (BCA) had a pH of 3,59 ± 0,06 and an acidity of 4,03 ± 0,12 g of citric acid/100 ml. The initial flavored premix broth had a pH of 2,66 ± 0,09 (ABC). The final formula projects that 17,5 g of atomized lemon juice should achieve a pH of 3,6, incorporated into the final adjusted formula (ABC2).

Final Formula

The final formulation (ABC2) was adjusted with silicon dioxide (0,4%) and atomized lemon juice (17,5 g/50 g of product). This had an average pH of 3,6 ± 0,08 and an acidity of 4,39 ± 0.10 g of citric acid/100 ml, similar to a traditional cabrilla ceviche broth. Zakrzewski *et al.* (2022) reported a pH of dolphin fish ceviche (Coryphaena hippurus) between 3,2 and 3,3 using citric acid, sufficient to inhibit pathogenic microorganisms. Logren (2022) obtained a pH of 3,7 to 4,2 by marinating Baltic herring (Clupea harengus membras) in various acids, achieving high microbiological quality.

The most significant changes were increased moisture and decreased proteins during storage (Logren, 2022). Protein denaturation by lemon juice acid affects the texture and pH of ceviche, and can release amino acids that interact with acids, modifying their acidity. Fat acts as a buffer, mitigating pH changes (Zakrzewski et al., 2022), while carbohydrates affect liquid viscosity (Nash, 2023). The high moisture content of the fish can dilute the lemon juice, affecting the acid concentration and pH of the ceviche (Tyl & Sadler, 2022).

3.3 Final Formula Acceptability

The ceviche broth was prepared with the adjusted flavoring premix (ABC2) and an acceptability test was conducted with 40 panelists, comparing it with a traditional ceviche broth (BCA) from three restaurants in Lima. Consumers, aged 20-60, gave average scores of 10,758 and 8,0225 to BCA and ABC2, respectively (Figure 6). According to the p-value = 0,0000667006 < 0,05, the null hypothesis was accepted, indicating significant differences between BCA and ABC2. Although ABC2 scored lower, its acceptability increased to 74,57%, compared to the initial 37,78%.

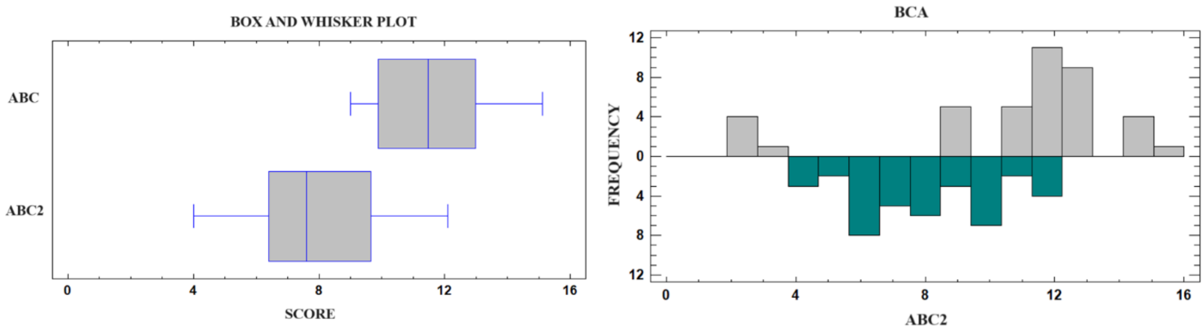

Figure 7. Box plot and mean comparison of ABC2 and BCA formulas of ceviche broths

3.4. Proximal Analysis

The final adjusted formulation (ABC2) underwent proximal analysis, yielding the following results: moisture 4.12%; protein 5.77%; fat 1.1%; carbohydrates 60.14%; fiber 3.04%; and ash 27.23%. In Peru, the Regulation on Food and Beverage Sanitary Surveillance and Control DS N° 007-98-SA (DIGESA, 1998) indicates that these values are within considerations for powdered products. Regarding minerals, no maximum sodium limit is specified for flavored premixes, but it follows WHO (2023) and other international regulations.

The CODEX ALIMENTARIUS (1991) does not establish a specific maximum sodium limit for premixes but requires that the sodium content be clearly declared on the label and that the product does not contribute to excessive sodium consumption. Regulation (EC) No 1169/2011 (EC, 2021) states that the recommended daily intake of sodium should not exceed 2,300 mg per person. Likewise, WHO recommends that daily sodium intake should not exceed 2,000 mg for adults to reduce the risk of hypertension and cardiovascular diseases.

IV. CONCLUSIONS

- The traditional cabrilla ceviche broth has a pH of 3.59 ± 0.06 and an acidity of 4.03 ± 0.12 g of citric acid/100 ml.
- The initial flavored ceviche premix presented a pH of 2.6 and an acceptability of 37.78%.
- The dose of 0.4% silicon dioxide affects the pungency of the flavored ceviche premix.
- A calibration curve was obtained with the relation pH = 5.81715 – 0.126462 * atomized lemon.
- The curve allowed the adjustment of 17.5 g of powdered atomized lemon juice/100 ml of water, achieving a pH of 3.6 and an acidity of 4.34 g of citric acid/100 ml of water, with characteristics similar to traditional ceviche broth, which increased the acceptability of the improved product (ABC2) to 74.57%.

Acknowledgements

The researchers thank the retail supplier company that owns the "DOÑA YOLA" brand for its collaboration in the study, providing logistical support and information for the development of this research.

Conflicts of Interest

The authors of this research work declare that they have no personal or economic conflict of interest with individuals or organizations that could unduly influence this manuscript.

Author Contributions

Preparation and execution: RTF. FCS Development of the methodology: RTF. FCS. RPO and FO; Conception and design: RTF. FCS; Proximal analysis: RPO.FO; Article editing: FCS. RGN; Study supervision: FCS. RPO and FO.

V. REFERENCES

Adams, M. R., & Moss, M. O. (2000). *Food microbiology*. Royal society of chemistry. Available at: https://books.google.com/books?hl=es&lr=&id=cr_rh9NB1tsC&oi=fnd&pg=PA1&dq=%22Food+Microbiology.%22+Royal+Society+of+Chemistry.&ots=F1Uvh5IOd7&sig=HQFg0Ft6xYAN6b5lRDYhq_Iz21w#v=onepage&q=%22Food%20Microbiology.%22%20Royal%20Society%20of%20Chemistry.&f=false

Alva D., D. A. & Elescano A., K. S. (2022). Feasibility study for the implementation of a dehydrated lime juice (Citrus aurantifolia) production plant. [Industrial Engineering Thesis, University of Lima]. https://repositorio.ulima.edu.pe/handle/20.500.12724/16457

AOAC, A. O. (2016). *Official Methods of Analysis*. 2(20). US.

Avello, M., Fernández, M., Fernández, P., Torres, E. & Pastene, E. (2023). Initial development of a phytopharmaceutical derived from Citrus limón juice for the treatment of hypertensive crises. *Revista Chilena de Cardiología, 42*(2): 82-89. http://dx.doi.org/10.4067/S0718-85602023000200082

Bradley, R. C. (2023). *Eating Peru: A Gastronomic Journey*. University of Oklahoma Press. Available at: https://books.google.es/books?hl=es&lr=&id=U2S2EAAAQBAJ&oi=fnd&pg=PR9&dq=The+Secret+Ingredient+for+Classic+Ceviche&ots=D5COGx751B&sig=z24hVy2EoatsGXH0hauFPvXQ71M#v=onepage&q&f=false

Cases, M. (2024). *The Introduction To Microbiology*. Microbiology for Manchester Community College. Open Education Resource (OER) Libre Texts Project. Available at: https://bio.libretexts.org/Courses/Manchester_Community_College_(MCC)/Remix_of_Openstax%3AMicrobiology_by_Parker_Schneegurt_et_al/08%3A_Microbial_Growth/8.03%3A_The_Effects_of_pH_on_Microbial_Growth

CENFOTUR (Centro de Formación en Turismo). 2023. Peruvian gastronomy in the world. Consulted on February 28, 2023. Available at: https://www.cenfotur.edu.pe/2023/boletin-1-2023/la-gastronomia-peruana-en-el-mundo/

CODEX ALIMENTARIUS. (1991). General Codex Standard for the Labeling of Prepackaged Foods. CODEX STAN 1-1985, Rev. 1-1991. Adopted by the Codex Alimentarius Commission at its 14th session (1981) and later revised at its 16th and 19th sessions (1985 and 1991), and amended at its 23rd and 24th sessions (1999 and 2001). Available at: https://www.fao.org/4/y2770s/y2770s02.htm#fn1

CODEX ALIMENTARIUS. (2022). Standard for Dried or Dehydrated Chili and Paprika CXS 353-2022. FAO/WHO. Available at: https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FStandards%252FCXS%2B353-2022%252FCXS_353s.pdf

CONITTA. Pepper Piper nigrum Ed.: National Commission for Agricultural Technology Research and Transfer ITTA Series No. 12 - Ministry of Agriculture and Livestock. State University San José - Costa Rica 1991 14p. Available at: https://bdigital.zamorano.edu/server/api/core/bitstreams/de48c6bb-3979-4d87-8cc6-f23dee9cebcd/content

Crispin-Sanchez, F., Medina, W., Crisóstomo G., O., Crispin S., I., Huamán C., N. L., Chire-Fajardo, G., & Ureña P., M. (2024). Effect of formulation on the fluffiness and volume of a commercial cake premix in relation to its acceptability. *Migration Letters, 21*(S5): 2101-2118. DOI: https://doi.org/10.59670/ml.v20iS5.8586

DIGESA (1998). Regulation on the Sanitary Surveillance and Control of Food and Beverages. SUPREME DECREE No. 007-98-SA. Available at: http://www.digesa.minsa.gob.pe/Codex/D.S.007_98_SA.pdf

EP. (1995). Directive No 95/2/EC of 20 February 1995 on food additives other than colours and sweeteners. EUROPEAN PARLIAMENT AND COUNCIL. Official Journal of the European Union, L061, 1-40. Available at: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31995L0002

EP. (2011). Regulation No 1169/2011 of October 25, 2011, on the provision of food information to consumers. EUROPEAN PARLIAMENT AND COUNCIL. Official Journal of the European Union, L304, 1-9. Available at: https://www.boe.es/doue/2011/304/L00018-00063.pdf

García, M., & Rayo J., N. (2018). Production of a complete seasoning based on spices such as cilantro, oregano, garlic, onion, black pepper, and cumin, produced in the Mauricio Díaz Müller pilot plant in the period September-December 2017. [Food Engineering Thesis, National Autonomous University of Nicaragua]. Institutional Repository. http://riul.unanleon.edu.ni:8080/jspui/bitstream/123456789/6998/1/241464.pdf

Goicochea, C.; Moquillaza, P. & Mostacero, J. (2012). Age and growth of Paralabrax humeralis (Valenciennes) in the sea of Callao, 1996. *IMARPE Report*, *39*(1-2): 23-25. https://repositorio.imarpe.gob.pe/handle/20.500.12958/2199

González, A., Espinoza E., A., Cañizares C., A. & Mendez N., J. R. (2008). Obtaining a sweet pepper powder (Capsicum chinense) produced by forced air dehydration. *UDO Agricultural Scientific Journal*, *8*(1): 118-126. https://www.bioline.org.br/pdf?cg08015

Hernández, G. & Radahelly, C. (2023). Study of limo pepper (Capsicum chinense Jacq.) in ripe state to determine its quality components expressed in carotenoid index using hyperspectral images. [Thesis in Food Industries Engineering, National Pedro Ruiz Gallo University]. Institutional Repository. https://repositorio.unprg.edu.pe/handle/20.500.12893/11418

IMARPE. (2021). Report: Analysis of the biology, fishery, and population status of cabrilla Paralabrax humeralis on the Peruvian coast. https://cdn.www.gob.pe/uploads/document/file/3306191/An%C3%A1lisis%20de%20la%20biolog%C3%ADa,%20pesquer%C3%ADa%20y%20estado%20poblacional%20de%20la%20cabrilla%20Paralabrax%20humeralis%20en%20el%20litoral%20peruano.pdf

Jay, J. M., Loessner, M. J. & Golden, D. A. (2008). *Modern Food Microbiology*. Springer Science & Business Media. Available at: https://scholar.google.es/scholar?hl=es&as_sdt=0%2C31&q=Jay%2C+J.+M.%2C+Loessner%2C+M.+J.%2C+%26+Golden%2C+D.+A.+%282005%29.+%22Modern+Food+Microbiology.%22+Springer+Science+%26+Business+Media.&btnG=

Jesús R., J. L. & Carbajal G., W. N. (2019). Obtaining and characterization of inulin from Allium sativum "GARLIC" bulb, "MAPUR" variety obtained in Ahuac-Chupaca April to December 2018. [Pharmaceutical Chemistry Thesis, Peruvian University of the Andes]. Institutional Repository. https://repositorio.upla.edu.pe/handle/20.500.12848/1104

Keenleyside, W. (2023). Cap.9,5: The Effects of pH on Microbial Growth. *Microbiology: Canadian Edition*. Ecampus Ontario. Available at: https://ecampusontario.pressbooks.pub/microbio/chapter/the-effects-of-ph-on-microbial-growth/

Kwon, R.-Y., Kim, S.-B., Youn, S.-M. & Choi, S.-J. (2023). Fate determination and characterization of food additive silicon dioxide and titanium dioxide in commercial foods. *Front Biosci*, *28*(2): 36. https://doi.org/10.31083/j.fbl2802036

Largo A., E., Cortes R., M., & Ciro V., H. J. (2015). Influence of Maltodextrin and Spray Drying Process Conditions on the Quality of Panela Cane Juice Powder. *National Faculty of Agronomy Journal Medellin*, *68*(1), 7509-7520. https://doi.org/10.15446/rfnam.v68n1.47839

Logrén, N. et. al. (2022). Effects of weak acids on the microbiological, nutritional and sensory quality of baltic herring (Clupea harengus membras). *Foods*, *11*(12), 1717. https://doi.org/10.3390/foods11121717

Lopes, S. M., da Silva, D. C., & Tondo, E. C. (2022). Bactericidal effect of marinades on meats against different pathogens: A review. *Critical Reviews in Food Science and Nutrition, 62*(27), 7650-7658. https://doi.org/10.1080/10408398.2021.1916734

Marin, E., Lemus, R., Flores, V. & Vega, A. (2006). The rehydration of dehydrated foods. *Chilean Journal of Nutrition, Santiago Dec. 2006, 33*(3): 527-538. http://dx.doi.org/10.4067/S0717-75182006000500009

MINAGRI (2020). Peruvian ginger or kión, a returning star (Zingiber officinale). Technical Note No. 09. December. Available at: https://cdn.www.gob.pe/uploads/document/file/1476844/El%20jenjibre%20o%20ki%C3%B3n%20peruano,%20una%20estrella%20que%20vuelve.pdf

Nash, E. (2023). The science behind how ceviche is cooked. *The Daily Meal*. Available at: https://www.thedailymeal.com/1276282/science-behind-ceviche-cooked/#:~=Ceviche%20is%20'cooked'%20with%20acid%20rather%20than%20heat&text=This%20happens%20because%20high%20temperatures,form%20new%20bonds%20and%20thicken

OMS (2023). Sodium intake reduction. Available at: https://www.who.int/es/news-room/fact-sheets/detail/salt-reduction

Paterson, A., & Brockel, U. (2015). Caking development in lemon juice powder. *Journal Procedia Engineering*, *102*: 142-149. https://doi.org/10.1016/j.proeng.2015.01.117

Peng, Z., Li, J., Guan, &., & Zhao, G. (2013). Effect of carriers on physicochemical properties, antioxidant activities and biological components of spray-dried purple sweet potato flours. *LWT-Food Science and Technology, 51*(1), 348-355. https://doi.org/10.1016/j.lwt.2012.09.022

PROMPERÚ. (2018). Cebiche: Peru's flagship dish. *Peru Blog – Gastronomy*. Consulted on February 25, 2023. Available at: https://peru.info/es-pe/gastronomia/noticias/2/13/cebiche--plato-bandera-del-peru

PROMPERÚ. (2020). Discover the origin of ceviche, one of the most trendy and acclaimed dishes. Consulted on February 25, 2023. Available at: https://www.peru.travel/es/masperu/descubre-el-origen-del-cebiche-uno-de-los-potajes-mas-trendys-y-aclamados

PROMPERÚ. (2020). Peruvian triumph: Cebiche is the most popular dish in South America. *Peru Blog – Gastronomy*. Consulted on February 25, 2023. Available at: https://peru.info/es-pe/gastronomia/noticias/2/14/triunfo-peruano--el-cebiche-es-el-plato-mas-popular-de-sudamerica

Puchoc S., C. N. & Puchoc S., J. A. (2021). Effects of consumption of Peruvian lemon (Citrus aurantifolia and Citrus latifolia) on dental structures, 2019. [Dentistry Thesis, Peruvian University of the Andes]. Institutional Repository. https://repositorio.upla.edu.pe/handle/20.500.12848/2468

Ramírez Miranda, E. J. (2015). Preparation of dehydrated soup from quinoa germ and leaves (Chenopodium quinoa, Willd) and pea (Pisum Sativum). [Food Industries Engineering Thesis, National Agrarian University La Molina]. Institutional Repository. https://repositorio.lamolina.edu.pe/handle/20.500.12996/2178

Requena, F., & Vietti, F. (2019). Evaluation of the stability of total carotenoids in snacks made from lúcuma (Pouteria lucuma) dehydrated by convective drying. [Food Engineering Thesis, National University of Callao]. Institutional Repository. https://repositorio.unac.edu.pe/handle/20.500.12952/5798

Siedentopp, U. (2008). Ginger, an effective medicinal plant as a medicine, spice or infusion. *Acupuncture Journal, 2*(3): 188-192. https://www.elsevier.es/es-revista-revista-internacional-acupuntura-279-articulo-el-jengibre-una-planta-medicinal-13125914

Tolentino A., M. (2023). Formulation of sweet cookies made from cassava and quinoa to promote their consumption and diversification in the food industry. [Food Industries Engineering Thesis, National Agrarian University La Molina]. Institutional Repository. https://hdl.handle.net/20.500.12996/5630

Torres T., H. M. (2018). Determination of the consumptive use of garlic var. Napurí (Allium sativum L.) with drip irrigation in the Majes irrigation – Arequipa. [Agronomy Thesis, National University of San Agustín]. Institutional Repository. https://repositorio.unsa.edu.pe/items/4c3f834f-6572-4578-9cbb-b79f921ab85a

Tyl, C. & Sadler, G. (2022). 22. pH and Titratable Acidity. Book: *Food Analysis*. Springer International Publishing. Available at: https://www.springerprofessional.de/en/ph-and-titratable-acidity/12340714

Wittig R., E. (2001). Sensory evaluation: a current methodology for food technology. [Online]. https://repositorio.uchile.cl/handle/2250/121431

Zakrzewski, A. J., Chajęcka-Wierzchowska, W., & Zadernowska, A. (2022). Ceviche-Natural Preservative: Possibility of Microbiota Survival and Effect on L. monocytogenes. *Foods*, *11*(6), 860. https://doi.org/10.3390/foods11060860