



Original Article

Analysis of the impact of comprehensive management on the development of Guayaquil's "huecas"

Poveda-Anchundia, T., Sarmiento-Victor, S., Alvarez-Cacedo, E., León-Anchundia, K. and Molina-Bravo, G. (p. 05)

Original Article

Partial substitution of wheat flour (*Triticum durum*) by sweet potato flour (*Ipomoea batata*) and maca (*Lepidium meyenii*) in a pastry product: alfajores

Haro-Quiñones, A., Ayala-Arias, S., Dextre-Flores, Y., Velásquez-Dávila, G. Julca-Herrera, J. and Avalos-Ramírez, Y. (p. 25)

Original Article

Relationship between the pattern of consumption of nutritional supplements and the degree of Bigorexia in bodybuilders of Metropolitan Lima

Fajardo, L., Guerra, Á., and Abad, G. (p. 71)



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Editorial

Agri-food science: knowledge that nourishes

The present edition of the Scientific Journal of Universidad Le Cordon Bleu brings together research that explores food from multiple perspectives, among them: the use of native supplies, the preparation of jams made from endemic Amazonian fruits, fruit preservation, nutrition in urban contexts related to knowledge and practices in healthy eating among mothers, the use of nutritional supplements in bodybuilders, and the analysis of environmental factors that influence the gastronomic experience. In addition, a critical analysis of the origin of the term cebiche, an emblematic dish of Peruvian gastronomy, is presented. These works reflect the dynamism of the sciences oriented toward food, and their capacity to generate applied and transformative knowledge.

As part of the editorial team's commitment to continuous improvement, since the previous issue the XML JATS format has begun to be implemented in each article, strengthening interoperability, digital preservation, and the international visibility of the contents. This initiative is framed within adherence to the principles of open science, which promotes open access, transparency, and academic collaboration.

Currently, the journal is in the process of evaluation for its inclusion in SciELO, which represents a significant step toward the consolidation of quality editorial standards.

We thank the authors, reviewers, and collaborators who make this outcome possible, and an invitation is extended to new researchers to share their contributions with the scientific community through publications on topics related to the journal's editorial lines.

Reading science is also a way of building it. May this edition inspire new questions, practices, and alliances in the agri-food field.

THE EDITOR

Analysis of the impact of comprehensive management on the development of Guayaquil's "huecas"

Análisis del impacto de la gestión integral en el desarrollo de las "huecas" guayaquileñas

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ABSTRACT

This research project analyzes the impact of integral management on the development of gastronomic establishments known as *huecas* in Guayaquil, based on McGregor's Theories X and Y. A non-experimental approach was adopted, allowing for the management of the fundamentals based on pre-existing theoretical categories, concepts, variables, and proposals. This methodological approach was key to collecting valuable information from the selected sample, thus facilitating the design of an integral process reengineering focused on continuous improvement and organizational transformation for sustainable growth and institutional development. For data collection, techniques such as direct observation and the application of structured surveys were used, directed to the managers and employees of the *huecas* studied. These methods allowed obtaining a detailed view of the current management and operational practices, as well as the perceptions and attitudes of the staff regarding their work and work environment, including motivation, commitment levels, and leadership perceptions. As a result of the research, the creation of a specific process reengineering model for the analyzed holes was achieved. This model includes the implementation of standardized processes that seek to optimize operational efficiency, improve service quality, and increase customer satisfaction, while also fostering innovation and strategic decision-making capacities.

Keywords: Gastronomic establishment, comprehensive management, huecas, reengineering.

RESUMEN

El presente proyecto de investigación tiene como objetivo general analizar el impacto de la gestión integral en el desarrollo de los "huecos" en Guayaquil, basado en las Teorías X y Y de McGregor. La investigación se llevó a cabo utilizando un enfoque no experimental, lo cual permitió gestionar los fundamentos con base en categorías, conceptos, varia-



bles o propuestas preexistentes. Este enfoque metodológico fue clave para recolectar información valiosa de la muestra seleccionada, facilitando así el diseño de una reingeniería de procesos integral enfocada en la mejora continua y la transformación organizacional para el crecimiento sostenible y el desarrollo institucional. Para la recolección de datos, se utilizaron técnicas como la observación directa y la aplicación de encuestas estructuradas, dirigidas a los gerentes y empleados de los "huecos" estudiados. Estos métodos permitieron obtener una visión detallada de las prácticas actuales de gestión y operación, así como de las percepciones y actitudes del personal respecto a su trabajo y entorno laboral, incluyendo los niveles de motivación, compromiso y percepciones sobre el liderazgo. Como resultado de la investigación, se logró la creación de un modelo específico de reingeniería de procesos para los huecos analizados. Este modelo incluye la implementación de procesos estandarizados que buscan optimizar la eficiencia operativa, mejorar la calidad del servicio e incrementar la satisfacción del cliente, fomentando además la innovación y las capacidades de toma de decisiones estratégicas.

Palabras clave: Establecimiento gastronómico, gestión integral, huecas, reingeniería.

INTRODUCTION

The present research proposes an analysis of the impact of comprehensive management on the development of the *huecas* of Guayaquil, gastronomic establishments that represent not only a traditional culinary option but also an important cultural and economic axis for many families in Guayaquil, Ecuador. Despite popularity, these *huecas*, their, face structural challenges and difficulties in adapting to new market trends, which has limited their growth and consolidation as formal businesses (Susana and Brunett, 2021).

The Ecuadorian gastronomic context shows that the culinary richness of the country is not always reflected in a business strengthening of its actors. *Huecas* offer typical dishes, native flavors, and a close experience with the consumer; however, many of them continue to operate with traditional methods and with significant administrative limitations (Castro and Zaldumbide, 2022).

In this sense, a key opportunity can be identified in the implementation of

comprehensive management strategies that allow these ventures to transform, professionalize their operation, and consolidate as references of gastronomic tourism. Comprehensive management contemplates the planning, control, organization, and direction of resources focused on continuous improvement in terms of service, administration, customer service, and culinary offering (González, 2022).

One of the most influential elements in this process is the incorporation of digital marketing. At present, social networks have gone from being an optional tool to becoming a fundamental channel to make ventures visible, generate sales, and build relationships with the target audience. However, inadequate or unplanned use may negatively affect the image of the business (Polo *et al.*, 2019).

According to Duarte-Casar y Rojas Le-Fort (2024), many *huecas* still manage their advertisement in a traditional way, losing opportunities for positioning in an increasingly digitalized market. In addition, they lack content strategies that create

emotional connections with users, which is particularly relevant in a sector where the cultural and sensory component is decisive for customer loyalty.

The challenge lies in breaking the structural barriers that prevent *huecas* from evolving as businesses. These barriers include the lack of management training, the absence of standardized processes, and limited access to technological tools.

Huecas, as spaces that combine gastronomy, history, and tradition, require a comprehensive approach that considers their cultural particularities. Process management, the implementation of best practices, and a focus on service quality are pillars to ensure their sustainability and competitiveness (Buenaño *et al.*, 2019).

To achieve this goal, a multidimensional approach is necessary, considering the efficient management of resources, innovation in product offerings, personalized customer service, and a clear digital communication strategy (Quimí, 2019).

The justification for this research lies in the need to promote the growth of these businesses from an academic and technical perspective, strengthening the local economic fabric and positioning *huecas* as key players in gastronomic tourism in Guayaquil (Mejía *et al.*, 2017).

Digital marketing emerges as a key tool that, if properly used, can significantly enhance the reach and image of these businesses. However, its implementation must be accompanied by proper content management, consumer knowledge, and a constant evaluation of the results (Bravo, 2021).

Consequently, the present study proposes a mixed approach, with quantitative and qualitative methodologies, that

allows for a diagnosis of the current situation of *huecas* and the design of proposals for an applicable improvement. Integral management is not only conceived as a set of administrative techniques but as a model of cultural and organizational transformation.

The objective is clear: to turn *huecas* into sustainable businesses, with their own identity, capable of competing in a dynamic environment without losing their traditional essence. This transformation requires a strategic perspective that integrates knowledge from the gastronomic, digital, and business domains.

MATERIALS AND METHODS

This research is framed within a mixed methodological approach, non-experimental in nature, with an exploratory and descriptive design. A joint discussion is incorporated to draw inferences based on all the information collected, with the aim of achieving a better understanding of the problem analyzed: the impact of comprehensive management on the development of *huecas* in Guayaquil (Sampieri and Baptista, 2014).

The approach is both quantitative and qualitative. The first was addressed through structured surveys applied to customers of selected *huecas*, with the objective of understanding their level of satisfaction, perception of service quality, loyalty, and other key aspects used to evaluate business performance.

This research is delimited to a practical analysis within the reality of Guayaquil-based enterprises, considering the operational capacities of the *huecas*. The non-experimental design responds to the need to observe phenomena as they occur, without manipulating variables.

The study population corresponds to the entrepreneurs participating in the "Raíces 2024" fair held in the city of Guayaquil. This event brings together *huecas* representative of the local culinary tradition. The sample was intentional, non-probabilistic, and consisted of three enterprises selected based on their track record, level of participation in training processes, and willingness to collaborate in the study.

RESULTS AND DISCUSSION

The analysis of the results obtained in this study about the *huecas* reveals significant patterns regarding customer experience, the perception of service quality, and the elements that promote consumer loyalty.

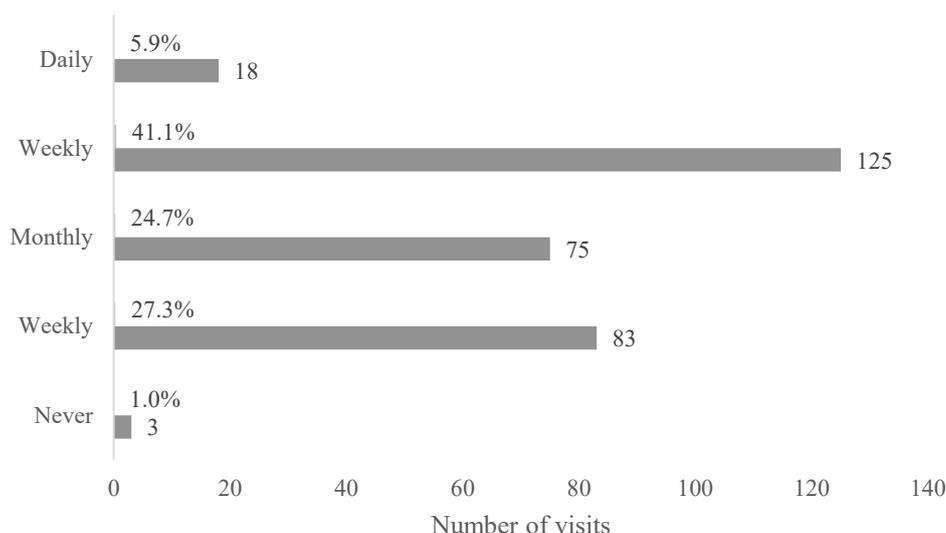


Figure 1. Frequency of visits to the *huecas*

In regards to the frequency of visits, it was observed that 41.1% of respondents visit the *huecas* weekly, highlighting the importance of consistency in the experience offered by these establishments. This figure also reflects the loyalty of an important segment of customers, who value the local culinary offerings and are attracted by affordable prices. The frequency of weekly visits, followed by occasional visits (27.3%) and monthly visits (24.7%), indicate that the *huecas* have a high recurrence rate among their clients, but also point to an opportunity to improve loyalty among

more sporadic consumers by encouraging higher frequency through digital marketing strategies or promotions.

The evaluation of the overall experience of diners about the *huecas* showed a tendency in which the majority of respondents (56.3%) rated their experience as a 3, indicating moderate satisfaction. This finding reflects that, while the *huecas* are meeting their customers' expectations, there is a clear opportunity to improve the overall experience, either through process optimization, continuous improvement of service quality, or innovation in the dishes offered.

Table 1.
How would you rate your overall experience at the huecas?

Items	Quantity	%
1	4	1.3
2	26	8.6
3	171	56.3
4	45	14.8
5	58	19.1
Total	304	100

The classification of the overall experience with a low to medium score, compared to a rating of 4 or 5, highlights that there is room to improve comprehensive management practices, particularly in aspects such as hygiene, staff training, and dish presentation.

On the other hand, when diners were asked about the importance of a "Huaca" implementing comprehensive management practices, the results showed that 50.3% of

respondents consider it very important for *huecas* to implement hygiene, customer service, and food quality practices. This finding emphasizes the relevance of operational and management aspects, which are essential for customer loyalty and the successful positioning of these businesses within the competitive gastronomic sector. However, the lack of standardization in the implementation of these processes could be contributing to many diners not perceiving a consistently satisfactory level of quality.

Table 2.
How important is it for you that a "Hueca" implements comprehensive management practices (hygiene, customer service, food quality)?

Items	Quantity	%
1	2	0.7
2	27	8.9
3	153	50.3
4	32	10.5
5	90	29.6
Total	304	100

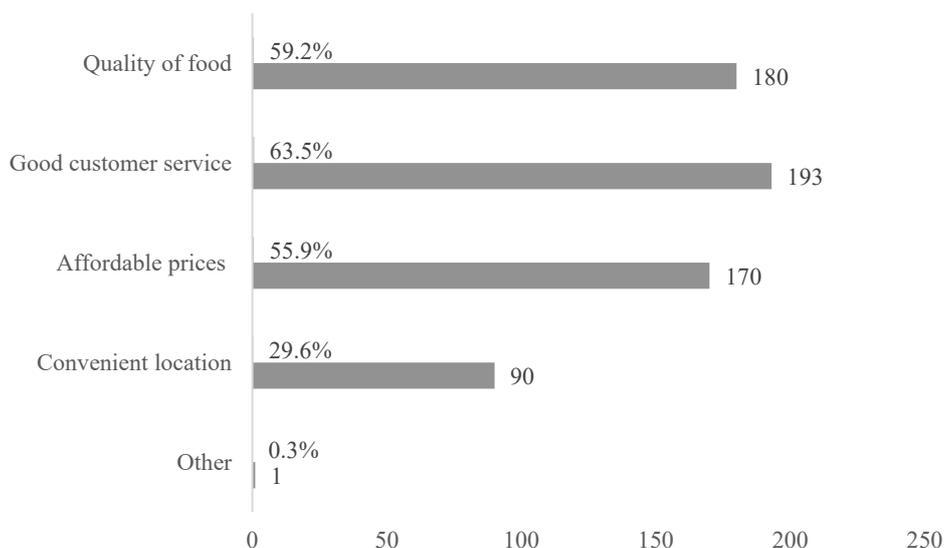


Figure 2. How important is it to you that a “Hueca” implements comprehensive management practices (hygiene, customer service, and food quality)?

In regards to the factors that motivate consumers to return to the *huecas*, the survey results highlight that good customer service (63.5%) is the main driver of loyalty. This finding emphasizes the importance of personalized attention and staff friendliness, key elements in creating a memorable experience for customers. Food quality (59.2%) and affordable prices (55.9%) are also considered determining factors, which

underscores that consumers value both culinary excellence and the quality-price ratio in their decision to return. These results suggest that, although the *huecas* have an attractive offering, it is crucial to continue strengthening service quality and the gastronomic proposition, as well as maintaining affordable prices to ensure that consumers return frequently.

Table 3.

Would you recommend a “Hueca” that implements good comprehensive management practices to your friends or family?

Items	Quantity	%
Definitely yes	166	54.6
Probably yes	132	43.4
Not sure	6	2.0
Probably not	0	0.0
Definitely not	0	0.0
Total	304	100.0

According to the data collected from the survey, diners would definitely recommend one of their favorites *huecas* or one where they had a pleasant experience, with 54.6%, while 43.4% would probably recommend it. One aspect highlighted in the interviews and respondents' comments was dissatisfaction arising from the lack of hygiene, particularly when diners observed that in some *huecas* the same hand was used to handle payments and serve food. These types of practices highlight the urgent need to professionalize the operation of these establishments by implementing better Good Manufacturing Practices (GMP). Staff training in key areas such as food handling, personal hygiene, and customer service should be a priority to guarantee customer safety and satisfaction.

In that sense, Boada's work *et al.* (2023) about the perceptions by consumers and how they impact their shopping preferences and their satisfaction is particularly relevant to understand the factors that influence customer loyalty on *huecas*. According to these authors, perceptions of service quality and product authenticity are factors that directly affect consumer satisfaction and loyalty, a concept that is also reflected in this study. Also, Alcívar *et al.* (2024) provide a useful perspective on how local gastronomy can attract both consumers and tourists, highlighting the importance of the gastronomic experience for customer satisfaction. This is especially applicable to those *huecas* where the autochthonous gastronomic proposal plays a key role in customer's experience.

Lastly, the study by Solano-Solano *et al.* (2023), focused on customer satisfaction in the food and beverage sector in Ecuador, reinforces the importance of service quality and efficient management in

consumer loyalty. These authors emphasize the relevance of service quality as a crucial determinant for consumer loyalty, a finding that is also observed in the results obtained regarding the "Huacas Guauaquileñas".

CONCLUSIONS

The study conducted on *huecas* in Guayaquil highlights the urgent need to establish a comprehensive management model aimed at optimizing their operational and customer service processes. Through this research, fundamental elements were identified, such as the lack of formalization of administrative procedures and the importance of continuous staff training to enhance service quality and ensure customer satisfaction. Survey findings indicate that consumers place a high value on customer service and product quality. This underscores the importance of implementing Good Manufacturing Practices (GMP) in the *huecas* as an essential measure to ensure customer loyalty and safety.

The purpose of the process reengineering suggested in the present research is to increase operational efficiency, improve the customer experience, and strengthen the sustainable development of *huecas*. In this way, a solid foundation is established for these enterprises to continue their expansion, thus ensuring their position as benchmarks for local gastronomic tourism.

It is imperative that entrepreneurs maintain a continuous adaptation to the new demands of the market, especially regarding the implementation of digital technologies, which plays a crucial role in the visibility and promotion of businesses. The incorporation of standardized management practices and a perspective of continuous improvement will contribute significantly to their consolidation as formal and

competitive gastronomic establishments. Consequently, the establishment of comprehensive management, complemented by innovation in internal processes and high-quality customer service, is essential to ensure their long-term success and sustainability.

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- Tatiana Poveda–Anchundia: Project administration, conceptualization, research, supervision.
- Scarlett Sarmiento–Victor: Conceptualization, writing, research.
- Eneyda Alvarez–Caicedo: Methodology, validation, data curation.
- Karen León-Anchundia: Formal analysis, validation.
- Grace Molina–Bravo: Software.

Preparation of a jam made from endemic Amazonian fruits and its sensory evaluation

Elaboración de una mermelada de frutos endémicos amazónicos y su evaluación sensorial

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ABSTRACT

The aim of this study was to produce jam from Amazonian endemic fruits and evaluate its sensory attributes. The study was experimental, applying a completely randomized block design (CRBD) with seven treatments. The fruit trees were unguurahui (*Oenocarpus bataua* var. *Bataua*), tumbo (*Passiflora mollissima*) and guava (*Psidium guajava* L.). Sensory evaluation was carried out using a nine-point hedonic scale. Proximate chemical analysis and dietary fiber, physicochemical and microbiological tests of the selected formulation were carried out. ANOVA and Fisher's test were applied to verify a significant difference between the formulations and the Friedman test to determine preference with a statistical significance level $p < 0.05$. The formulations F1 (100% unguurahui), F2 (100% tumbo), F3 (100% guava), F4 (50% unguurahui and 50% tumbo), F5 (50% unguurahui and 50% guava), F6 (50% tumbo and 50% guava), and F7 (25% unguurahui, 50% tumbo, and 25% guava) were evaluated. There was a significant difference in the attributes of odor, texture, and appearance. F7 (sample 978) was the most accepted, which presented soluble solids (66.8°Brix) and pH 3.2; the number of yeasts and molds was < 10 CFU/g estimated. F7 complies with national and international regulations, as it is a safe product with adequate nutritional quality.

Keywords: Jam, unguurahui, tumbo, guava, sensory evaluation.

RESUMEN

El objetivo de este estudio fue elaborar una mermelada de frutos endémicos amazónicos y evaluar sus atributos sensoriales. La investigación fue experimental, aplicándose un diseño de bloque completamente al azar (DBCA) con siete tratamientos. Los frutos fueron unguurahui, (*Oenocarpus bataua* var. *Bataua*), tumbo (*Passiflora mollissima*) y guayaba



(*Psidium guajava* L.). La evaluación sensorial se realizó mediante escala hedónica de nueve puntos. Se realizó análisis químico-proximal y fibra dietaria, fisicoquímico y ensayos microbiológicos de la formulación seleccionada. Se aplicó ANOVA y Fisher para verificar diferencia significativa entre las formulaciones y prueba de Friedman, para determinar preferencia con un nivel de significancia estadístico $p < 0,05$. La F1 (100 % unguahui), F2 (100 % tumbo); F3 (100 % guayaba), F4 (50 % unguahui y 50 % tumbo), F5 (50 % unguahui y 50 % guayaba), F6 (50 % tumbo y 50 % guayaba) y F7 (25 % unguahui, 50 % tumbo y 25 % guayaba). Hubo diferencia significativa en los atributos olor, textura y apariencia. La F7 (muestra 978) fue la de mayor aceptación, la cual presentó sólidos solubles (66,8 °Brix) y pH 3,2; el número de levaduras y mohos fue < 10 estimado. La F7 cumple con la normativa nacional e internacional, por ser un producto inocuo y de calidad nutricional.

Palabras clave: Mermelada, unguahui, tumbo, guayaba, evaluación sensorial.

INTRODUCTION

The unique fruit species of the Amazon region are characterized by notable physicochemical qualities and nutritional and pharmacological benefits, being rich sources of essential nutrients, antioxidants, and a variety of bioactive compounds such as phenols, flavonoids, anthocyanins, and carotenoids (Pereira *et al.*, 2023).

Within Amazonian biodiversity, the unguahui (*Oenocarpus bataua* var. *Bataua*) stands out as a palm native to the tropical American zone with possible roots in the Amazon; its fruits, highly nutritious and abundant in oil and protein components, are used in the preparation of foods and non-alcoholic beverages, including “chapo” in Peru and “vino” in Brazil, as well as ice creams and sweets (Instituto Nacional de Defensa de la Competencia y de la Protección de la Propiedad Intelectual [Indecopi], 2019). This palm is also valued as a non-timber forest resource, providing key foods for socially disadvantaged communities (Córdoba *et al.*, 2019).

Another Amazonian fruit of interest is tumbo (*Passiflora mollissima*), recognized for its antioxidant properties and a chemical composition that varies depending on factors such as soil quality, geography, and sun exposure. In this regard, Lopa *et al.* (2021) found that tumbo from the Cusco region is particularly rich in antioxidants due to its high content of phenols and flavonoids. Additionally, Fernández-Condori and Ramos-Escudero (2021) observed that several native fruits, including soursop and highland tumbo, have low glycemic indexes, enhancing their nutritional profile.

Regarding guava (*Psidium guajava* L.), this small tree species of the Myrtaceae family is notable for its fruit, used in the production of jams, beverages, and a wide range of food products. Its fruits are especially rich in vitamin C, significantly surpassing oranges in this regard, and also provide carbohydrates, proteins, fiber, and a diversity of carotenoids and polyphenols (Habtemariam, 2019).

Based on the above, the purpose of this study was to develop a jam using endemic fruits from the Amazon and to evaluate its sensory attributes.

METHODS AND MATERIALS

Study Location

The preparation of jam formulations based on endemic Amazonian fruits was carried out in the laboratories of Universidad Le Cordon Bleu, while the phy-

sicochemical, microbiological, and proximate analyses were conducted by the Total Quality Laboratory of the Universidad Nacional Agraria la Molina.

Research Design

This research was experimental, applying a completely randomized block design (CRBD) with seven treatments.

Table 1 shows the formulation of jams based on endemic Amazonian fruits.

Table 1.
Formulation of jams based on endemic Amazonian fruits.

Formulations	Ungurahui	Tumbo	Guayaba
F1 (998)	100	0	0
F2 (232)	0	100	0
F3 (356)	0	0	100
F4 (999)	50	50	0
F5 (063)	50	0	50
F6 (159)	0	50	50
F7 (987)	25	50	25

Note: values expressed as percentage (%)

F1 (100% unguurahui), F2 (100% tumbo), F3 (100% guava), F4 (50% unguurahui and 50% tumbo), F5 (50% unguurahui and 50% guava), F6 (50% tumbo and 50% guava), and F7 (25% unguurahui, 50% tumbo, and 25% guava).

Figure 1 shows the flow diagram for the preparation of jams with endemic Amazonian fruits.

Table 2 shows the ingredient content in each formulation of the native fruits used, according to the mixture design for the different formulations and their respective codifications, detailed below.

The raw materials (ungurahui, tumbo, and guava) were selected; then, they were washed with potable water and disinfected with sodium hypochlorite (0.05% ppm). Subsequently, the peels and seeds were removed (peeling/pulping); next, cooking and pectin extraction (concentration 1) were carried out at 60 °C for 20 min. Then, concentration 2 was obtained using 50% sugar and citric acid at a temperature between 65–70 °C for 20 min. Pectin (0.05–0.80%) was added, and concentration 3 was obtained with 50% sugar at 105 °C for 20 min. Finally, the jams were packaged at <85 °C and cooled to 25 °C.

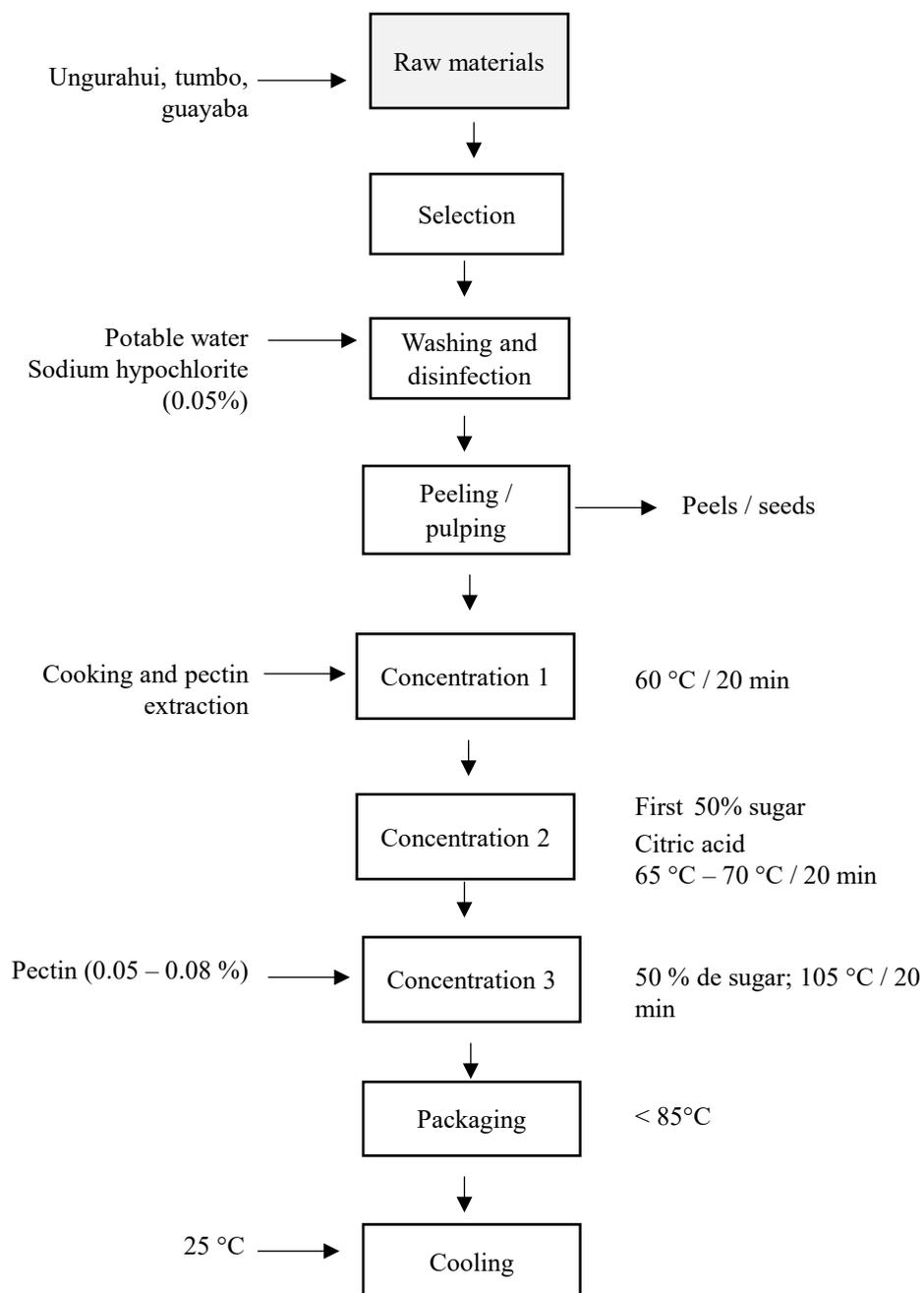


Figure 1. Flow diagram for the preparation of jams with endemic fruits

Table 2.
Ingredient content in each formulation

Ingredients	F1 (998)	F2 (232)	F3 (356)	F4 (999)	F5 (063)	F6 (159)	F7 (987)
Fruit	60	60	60	100	100	100	100
Sugar	36	36	36	60	60	60	60
Pectin	3.1	3.1	2.9	5	5	5	5
Citric acid	0.31	0.177	0.186	0.1	0.5	0.1	0.1

Note: values expressed in grams (g)

Sensory Evaluation of the Formulations

The sensory evaluation was conducted with 70 panelists: 10 professionals (chefs and faculty from Universidad Le Cordon Bleu) and 60 semi-trained panelists (students of the Gastronomy and Business Management program at the same university), using an acceptability test to assess the degree of liking or disliking of the product for the different attributes evaluated. Panelists were asked to select a score on a five-point hedonic scale from 1 to 5: dislike very much (1); dislike (2); neither like nor dislike (3); like (4); and like very much (5), for each of the attributes: color, odor, sweetness, texture, acidity, and appearance.

Each panelist had the opportunity to taste all jam formulations, and each was provided a glass of water to rinse the mouth between sensory tests, thereby cleaning the palate between each tasting.

Chemical Analysis – Proximate and Dietary Fiber of the Selected Formulation

The following methods were used: protein (AOAC 920.152); carbohydrates (by difference Peruvian Ministry of Health

– National Institute of Nutrition - MS-INN Collazos 1993); total fat (AOAC 960.39); ash (AOAC 920.108); moisture (AOAC 930.04); crude fiber (AOAC 930.10).

Additionally, the percentage (%) of Kcal from carbohydrates, fat, protein, and total energy was calculated; soluble solids (°Brix) were determined (Peruvian Technical Standard-NTP 203.072; 1977, revised in 2017 and AOAC 981.12).

Microbiological Assays

The number of yeasts and molds was determined (ICMSF – International Commission on Microbiological Specifications for Foods). Reference values: coliforms <10 CFU/g; yeasts <10 CFU/g; molds <10 CFU/g.

Statistical analysis

The Friedman test was used to determine the preference of the formulations; to identify significant differences between the attributes of each jam formulation, a statistical analysis of variance (ANOVA) and Fisher's test were performed at a statistical significance level of $p < 0.05$.

RESULTS AND DISCUSSION

Various fruits have been used to produce value-added foods, particularly jams, which are preserved using packaging or sealing techniques to extend their consumption period. The production of these jams generally involves the use of pectin, either obtained from commercial or natural sources, to facilitate the gelling process of the product. Depending on the selected ingredients and preparation method, different types of preserves can be obtained, such as preserves, jellies, and jams, all valued for their economy, year-round availability, and organoleptic characteristics (Naeem *et al.*, 2017).

Jams and jellies, characterized as products of intermediate moisture and semi-solid consistency, are prepared by cooking fruits with sugar (pectin and acid could be added) until the total soluble solids content exceeds 65% (Codex Stan-79, 1981). Cooking releases the natural acidity and pectin from the fruits, which are essential for developing the final texture of the product (Shinwari & Rao, 2018).

The sensory evaluation showed that sample F7 (sample 987) was preferred by

the panelists, standing out in terms of color, sweetness, texture, and general appearance. Significant differences were found in the attributes of odor, texture, and appearance using analysis of variance (ANOVA) (Figs. 2, 3, 4, and 5), and comparative studies indicated variations in sensory perception depending on the composition of the jam, especially in the presence of sweeteners (Loyola & Acuña, 2021; Palacios *et al.*, 2024).

Figure 2 shows panelists' acceptability according to the color attribute, highlighting preference in most formulations; however, sample 998 received the lowest score. No significant difference was observed between the formulations for this attribute.

Regarding the odor attribute, samples 063 and 987 showed higher acceptance, while sample 356 had lower acceptance. Significant differences were observed between F1 and F3 and F4; likewise, between F1 and F5, and between F5 and F6 (Fig. 3).

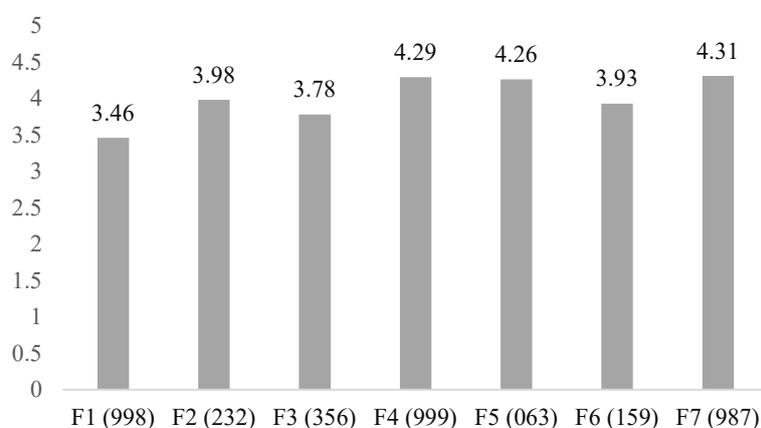


Figure 2. Color attribute score according to the hedonic scale.

ANOVA; p: >0.05

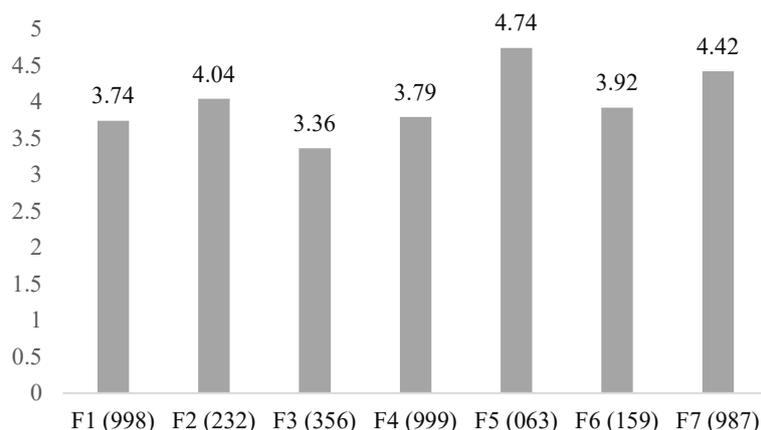


Figure 3. Odor attribute score according to the hedonic scale

ANOVA: p: <0.05 F5 vs F1, F3 and F4; F1 vs F5; F5 vs F6

It was observed that samples F7 (987), F5 (063), and F2 (232) showed the highest acceptance for sweetness, while F1, F4, and F6 received the lowest scores; however, no significant differences were found between the formulations for this attribute. Sample 987 showed the highest acceptance for texture, whereas sample 998 had the lowest score. Significant differences were observed between F1 and F5 and F7; likewise, F7 showed significant differences with F2 and F6 (Fig. 4).

Regarding the acidity attribute, samples 999, 987, and 232 showed the highest acceptance, while the remaining samples had lower acceptance. No significant differences were observed between the different formulations for this attribute.

For the appearance attribute, samples 987, 999, 063, and 232 received higher acceptance, whereas 998, 356, and 159 showed lower acceptance among the panelists. Significant differences were observed between F1 and F4, F5, and F7; li-

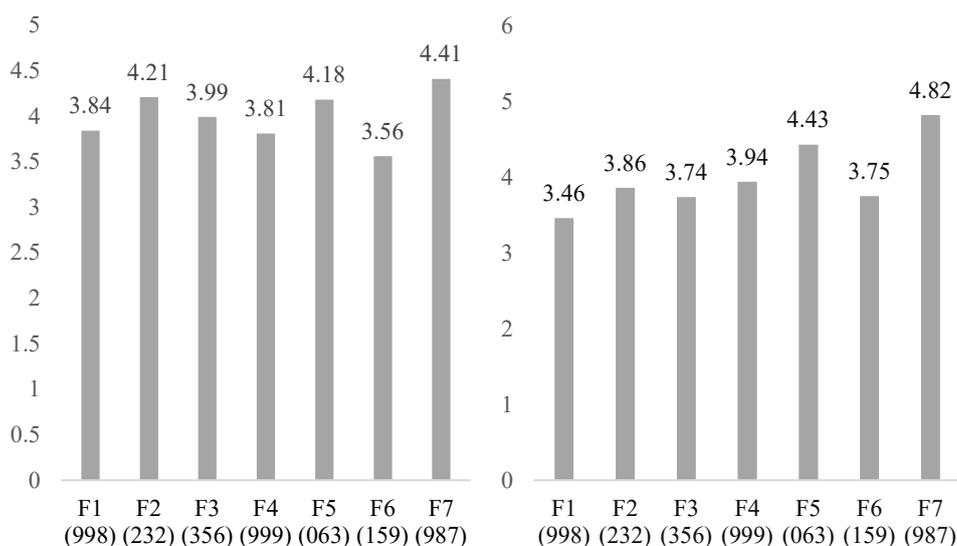


Figure 4. Sweetness and texture attribute scores according to the hedonic scale

ANOVA: p: >0.05

ANOVA: p: <0.05 F1 vs F5 y F7; F7 vs F2 and F6

kewise, significant differences were found between F3 and F4, F5, and F7 (Fig. 5).

Based on the Friedman test, sample F7 (987) was the one that showed the highest acceptance score (4.43), while F1 (998) had the lowest acceptance (3.49).

The physicochemical analysis of the selected formulation reported an acidic pH and 66.8 °Brix; meanwhile, the microbiological analysis showed that the number of yeasts and molds was <10 CFU/g (Table 3). From a physicochemical standpoint, the Brix and pH values for the chosen sample were consistent with previous research, such as jam with dietary fiber from mango peel (Luit González *et al.*, 2019), indicating that these parameters are suitable for this type of product. Variations in composition

and the use of different sweeteners may explain the differences in soluble solids and pH results observed in other studies (Neyra & Sosa, 2021; Loyola & Acuña, 2021).

Regarding its nutritional profile, sample 987 provides an adequate balance of proteins, fats, carbohydrates, fiber, and an energy content per 100 g of product, demonstrating that it is nutritionally valuable (Table 4).

Microbiological analyses confirmed that this sample complies with food quality and safety standards, similar to those reported by Ríos Duarte *et al.* (2023); these results meet international health regulations, ensuring the absence of harmful microorganisms and guaranteeing its safety for human consumption (Sanitary Standard NTP 203.047:1991 revised in 2017).

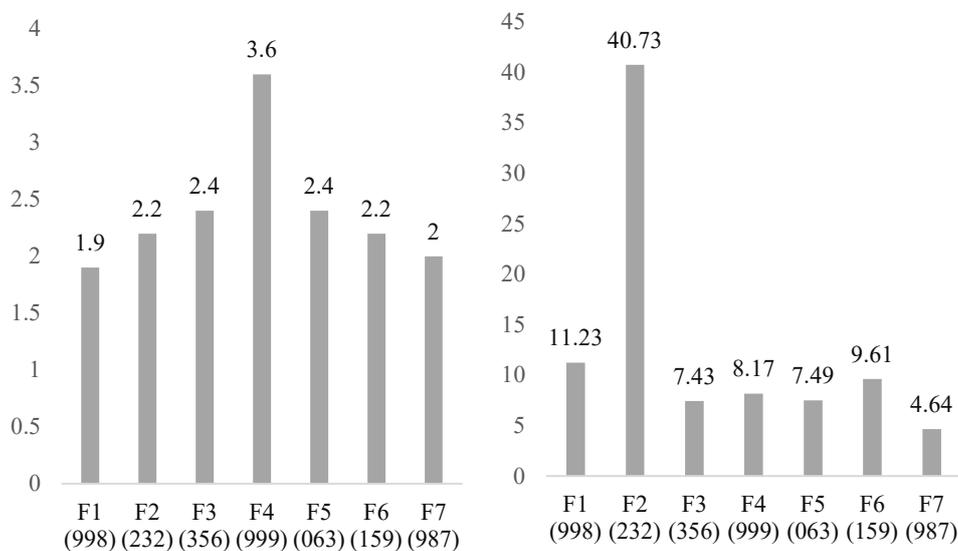


Figure 5. Acidity and appearance attribute scores based on the hedonic scale

ANOVA; p: >0.05

ANOVA; p: <0.05 F1 vs F4, F5 and F7; F3 vs F4, F5 y F7

Table 3.
Physicochemical and Microbiological Test of the Selected Formulation

Physicochemical	Value
Soluble solids (°Brix)	66.8
pH	3.2
Microbiological*	
Number of yeasts (UFC/g)	< 10 estimated
Number of molds (UFC/g)	< 10 estimated

*Norm NTS N° 071-MINSA/DIGESA

Table 4.
Proximate Chemical Analysis and Dietary Fiber of the Selected Formulation

Component	Value
Protein (N x 6.25) g	0.5
Carbohydrates (g)	69.4
Total fat (g)	1.2
Ash (g)	0.6
Moisture (g)	28.3
Total energy (Kcal)	290.4
Crude fiber (g)	0.7

Note: values expressed per 100g

CONCLUSIONS

The selected formulation was F7 (sample 987), containing 25% each of un-gurahui and guava, and 50% of tumbo.

The selected formulation complies with national and international regulations, being a safe product with nutritional quality.

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Author Contribution Statement

- Luis Alberto Taramona-Ruiz: Conceptualization; methodology; and project administration.
- Madeley Díaz-Martínez: Conceptualization; methodology.
- Ja Ram Jung-Hong: Conceptualization; methodology.
- Maribel Margot Huatuco-Lozano: Statistics; review and editing.
- Diego Javier Moya-Rojas: Data analysis; original draft.

Partial substitution of wheat flour (*Triticum durum*) by sweet potato flour (*Ipomoea batata*) and maca (*Lepidium meyenii*) in a pastry product: alfajores

*Sustitución parcial de harina de trigo (*Triticum durum*) por harina de camote (*Ipomoea batata*) y maca (*Lepidium meyenii*) en producto de pastelería: alfajores*

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ABSTRACT

With the aim of improving the quality and nutritional value of baking products, the idea of designing alfajores was proposed by partially replacing wheat flour with sweet potato and maca flour. This approach aims to offer products with high levels of nutrients present in sweet potato and maca flours. The main objective of this study was to evaluate the acceptance of alfajores made with these flours, using raw materials grown and produced in Peru. The research was carried out in the Ancash region, specifically at the facilities of the Universidad Nacional de Santa. To obtain sweet potato and maca flours, the same procedure was applied: 15 kg of raw material were used, which was subjected to a disinfection process and then dried at 55 °C for 48 hours. As a result, 2.7 kg of sweet potato flour and 3.5 kg of maca flour were obtained. The formulations used in the preparation of the alfajores consisted of 75 % wheat flour, 22.5 % sweet potato flour and 2.5 % maca flour. The estimated yield was 240 units of alfajores, based on 6 kg of total flour. The sensory analysis was evaluated regarding color, flavor, texture and purchase intensity, and it was observed that in all evaluations a high acceptability of the developed alfajores.

Keywords: Sweet potato, maca, flour substitution, formulation, alfajores.

RESUMEN

Con el propósito de mejorar la calidad y el valor nutricional de los productos de panificación, se plantea la idea de diseñar alfajores sustituyendo parcialmente la harina de trigo por harina de camote y maca. Este enfoque está dirigido a ofrecer productos con altos índices de nutrientes presentes en el camote y la maca. El objetivo principal de este estudio consistió en evaluar la



aceptación de los alfajores elaborados con estas harinas, utilizando materias primas cultivadas y producidas en Perú. La investigación se desarrolló en la región Ancash, en las instalaciones de la Universidad Nacional del Santa. Para obtener la harina de camote y maca, se siguió un mismo procedimiento: se utilizó 15 kg de materia prima, la cual fue sometida a un proceso de desinfección y luego se secó durante 48 horas a 55 °C. Como resultado, se obtuvieron 2,7 kg de harina de camote y 3,5 kg de harina de maca. Las formulaciones empleadas en la elaboración de los alfajores fueron de 75 % de harina de trigo, un 22,5 % harina de camote y 2,5 % de harina de maca. El rendimiento estimado fue de 240 unidades de alfajores en base a 6 kg de harina total. Se evaluó el análisis sensorial respecto al color, sabor, textura e intensidad de compra, donde se obtuvo una alta aceptabilidad de los alfajores.

Palabras clave: Camote, maca, sustitución de harina, formulación, alfajores.

INTRODUCTION

Poor nutrition has become a major public health problem, affecting communities globally, including Peru. Over the years, there has been a significant increase in the preference for consuming foods that prioritize taste pleasure over nutritional value, as is the case for fast foods, which contain many additives and harmful components such as saturated fats, refined flours, and harmful preservatives (Gamarra, 2021). Current food trends pose a significant challenge in promoting healthy eating habits, which has long-term repercussions on consumers' health. According to data from the World Health Organization (WHO, 2020), an alarming 32% of deaths in Peru are caused by non-communicable chronic diseases, such as obesity, diabetes, and cardiovascular disorders, conditions that can be directly caused by or strongly influenced by an inadequate diet.

Poor nutrition is a persistent problem in our society and often finds its root in the excessive consumption of processed and ultra-processed foods; products that usually contain added or refined sugars, providing low-nutrition "empty" calories, as well as salt and saturated fats (Flores, 2020). These foods not only contribute to weight gain and obesity but are also as-

sociated with the development of chronic pathologies (Maldonado, 2020). This category also includes sweets, whose consumption has shown a considerable increase in recent decades. An example is the alfajor, whose consumption has grown significantly, driven both by its appealing taste and by its increasing presence on digital media and social networks (Trivi, 2020). It is crucial to reflect on our food choices and consider how these products impact our long-term health.

Healthy foods are fundamental for human well-being, as they represent an invaluable source of essential nutrients that strengthen and nourish the body (WHO, 2018). Adequate consumption not only provides the energy necessary for daily activities but also supplies the indispensable components for the proper functioning of organs and systems. In this regard, a balanced diet, rich in proteins, carbohydrates, healthy fats, vitamins, minerals, and fiber, plays a key role in disease prevention and in the promotion of overall health.

Within this group of foods, maca stands out as an Andean superfood with high nutritional and functional value. It contains proteins, fiber, minerals, unsaturated fatty acids, glucosinolates, phenolic

compounds, phytosterols, alkaloids, and macamides, among other bioactive compounds (Yábar & Reyes, 2019; Bahukhandi *et al.*, 2021; Biasi *et al.*, 2023). These components provide not only high nutritional value but also multiple benefits, such as improved reproductive health, antioxidant, anticancer, hepatoprotective, and immunomodulatory effects (Bahukhandi *et al.*, 2021; Leitao *et al.*, 2020; Baquerizo *et al.*, 2021). Another example of a healthy food is sweet potato (*Ipomoea batatas* L.), a tuber with an outstanding nutritional profile, characterized by its high carbohydrate content that provides energy, as well as its richness in carotenoids, provitamin A, and vitamins C and B complex (Instituto Nacional de Investigación Agropecuaria, 2020). In addition, it provides dietary fiber, niacin, and proteins that promote proper digestion and strengthen the body, also being a source of minerals such as zinc, iron, phosphorus, potassium, and calcium, which are essential for bone, muscle, and immune system health (Vidal *et al.*, 2018). Due to this combination of vitamins, minerals, and bioactive compounds, sweet potato is considered a complete food that contributes to vitality and overall well-being (Vidal *et al.*, 2018; Bai *et al.*, 2021; Silva *et al.*, 2022; Cartabiano-Leite *et al.*, 2020). Among its varieties, purple sweet potato stands out for its anthocyanin content, compounds with potent antioxidant activity that help eliminate free radicals and, in synergy with hydroxycinnamic acids, provide protection against processes related to degenerative diseases (Bai *et al.*, 2021; Philpott *et al.*, 2004).

There is a growing interest in discovering healthier and more nutritious food alternatives. An innovative trend that not only promotes health but also highlights cultural and nutritional richness is the use

of native Peruvian foods for the replacement in certain conventional flours or commercial foods (Pascual & Zapata, 2010; Sandoval, 2022), opening a promising outlook for conscious and sustainable eating.

The raw materials selected for the flours are sweet potato and maca, traditional Peruvian crops with high nutritional value in vitamins, minerals, and fiber; additionally, they have the capacity to regulate blood sugar and lipid levels (Rosell *et al.*, 2024; Ludvik *et al.*, 2004). In contrast, maca is chosen as a valuable source of proteins and essential nutrients, having been shown to increase endurance and vitality (Ulloa *et al.*, 2024).

The incorporation of sweet potato and maca flour in bakery products and pastry emerges as an essential pillar to increase the nutritional value of these products, offering a variety of health benefits. Sweet potato, rich in starch, becomes an ally in providing a spongy and delicate texture in both bread and cakes (Vázquez-Chavéz & Hernández-López, 2023). This combination, in addition to giving a pleasant flavor and a pinkish hue to the dough, not only captivates the children but also opens the door to healthier and more balanced pastry options, contributing to the overall well-being of children and the general public.

In this line of research, the focus on the partial substitution of wheat flour with sweet potato and maca flour in alfajores becomes highly relevant. These Peruvian foods could play a fundamental role in reformulating eating habits and promoting healthier alternatives in pastry (Mendoza & Navarrete, 2022).

This innovation is not only aimed at providing healthier alternatives but also seeks to promote the use of local resources,

thus boosting the agricultural economy and safeguarding Peru's rich biodiversity in the process.

MATERIALS AND METHODS

Sweet Potato Flour

The sweet potato flour (*Ipomoea batatas*) was obtained from the purple variety, which was purchased at a local market in the city of Chimbote. The flour production process was adapted from that described by Sing & Villalobos (2015) and Cruz (2019). The raw material was subjected to an initial washing, removing dust, soil, or impurities, followed by disinfection with chlorine at a concentration of 60 ppm. Subsequently, a second washing was performed to remove chlorine residues. Then, the sweet potatoes were cut into pieces or slices small enough to optimize the drying process. They were later placed in a tray dryer, model SBT-10x10, for 24 hours at 55 °C. After the drying period, the dehydrated sweet potato was ground and sieved using a grain mill and a vibratory sieve, model MDMT-60XL, obtaining 2.7 kg of sweet potato flour. The approximate yield was 25%.

Maca Flour

Fresh yellow maca roots were purchased from a local market in Chimbote. They underwent an initial washing to remove dust, soil, or impurities, followed by disinfection with chlorine at a concentration of 60 ppm. Afterward, a second washing was carried out to remove chlorine residues. The roots were then cut into pieces or slices small enough to optimize the drying process and subsequently placed in a tray dryer, model SBT-10x10, for 24 hours at 55 °C.

The dried maca roots were ground and sieved using a grain mill and a vibra-

tory sieve, MDMT-60XL, through a 0.2 mm mesh to obtain fine maca flour. The yield obtained was approximately 30%; this value serves as a reference to determine the amount of raw material needed according to the desired amount of flour.

Formulations

The proposed formulation for the preparation of alfajores involves a partial substitution of wheat flour with sweet potato flour (22.5%) and maca flour (2.5%), to improve the nutritional profile of the product without compromising its characteristic texture and flavor. This choice is based on a review of the functional and sensory properties of both ingredients, as well as preliminary tests aimed at maintaining the acceptability of the alfajor.

Sweet potato flour (*Ipomoea batatas*) stands out for its high starch content, which provides superior water absorption capacity. This starch acts as a binding agent, allowing for softer, more cohesive, and spongy doughs, ideal for bakery products. According to Ayol (2022), these characteristics make it suitable as a partial substitute for wheat flour in cookie formulations.

Maca flour (*Lepidium meyenii*) contributes valuable nutritional compounds, although its strong flavor can become bitter if used in large proportions. For this reason, it was used at only 2.5%, allowing its properties to be leveraged without negatively affecting the sensory profile of the product.

The final proportion, composed of 75% wheat flour, maintains the traditional structure of alfajores, while the inclusion of alternative flours adds functional and nutritional value without drastically altering consumer acceptance. Table 1 presents the corresponding substitution percentages

for the flours, considering a total value of 100% for the flours.

Table 1 shows the contrasting proportions between sweet potato flour and maca flour. This analysis is not only based on differences in flavor but also on the binding property of the starch present in

sweet potato, which allows its use in higher quantities when combined with wheat flour in the preparation of bakery products. The influence of color is also considered, resulting from the pigments present in purple sweet potato. These pigments provide a distinctive pinkish hue to the dough and the final product.

Table 1.
Formulation of the substitution of sweet potato and maca flours in alfajores

FLOURS	PERCENTAGE
Wheat flour	75%
Sweet potato flour	22.5 %
Maca flour	2.5 %

Bakery products

For the development of this research, a formulation adapted from the original alfajores recipe was used, in which wheat flour was partially substituted with sweet potato and maca flours. The composition of the ingredients used is presented in Table 2.

In the formulation presented, the value of 100% corresponds exclusively to the sum of the flours considered (wheat flour, maca flour, and sweet potato flour). The other ingredients used in the preparation (such as cornstarch, powdered sugar, margarine, manjar blanco, and chia) were

calculated proportionally based on the total amount of flours used. In this way, the percentages assigned to these ingredients are not part of the sum equivalent to 100%, but rather represent specific ratios with respect to the flour base established for the preparation of the alfajores.

For the alfajores production process, the procedure described by Sing and Villalobos (2015) was adapted, together with prior knowledge in the preparation of bakery products with partial flour substitution.

Table 2.
Formulation for the Preparation of Alfajores

	INGREDIENTS	PERCENTAGE	FOR 1 Kg OF FLOUR
	Wheat flour	75%	0.75
Sum of flours equivalent to 100%	Maca flour	2.5 %	0.025
	Sweet potato flour	22.5 %	0.225
	Cornstarch	25%	0.25
Percentage considered based on the total amount of flour	Powdered sugar	30%	0.3
	Margarine	65%	0.65
	<i>Manjar Blanco</i>	75%	0.75
	Chía	10%	0.1

The alfajores preparation process, as indicated in Figure 1, begins with weighing the dry ingredients: wheat flour (75%), sweet potato flour (22.5%), and maca flour (2.5%) on an analytical balance. Subsequently, the flour mixture was sifted through a 0.5 mm mesh to remove lumps and impurities, obtaining a homogeneous mixture. Next, a three-stage kneading process was carried out. The first kneading incorporated margarine (65%) and powdered sugar (30%) in a mixer, performed at medium speed for 5 minutes. In the second kneading, sifted cornstarch (0.5 mm mesh) was added, kneading at medium speed for an additional 3 minutes. Finally, in the third kneading, the flour mixture was added and kneading continued for 4 minutes at medium speed, ensuring the complete integration of all components. Once the dough was obtained, molding and baking were carried out. The dough was rolled out with a rolling pin until reaching a thickness of 8–10 mm and shaped using a round cutter with a diameter of 5 cm. The dough discs obtained were placed on a baking tray.

The oven was preheated to 150 °C for approximately 10 minutes, and once the temperature was reached, the trays with the dough were placed in the oven. Baking was carried out at the same temperature for 25 minutes. During baking, a tray with chia seeds was also placed in the oven, in order to toast them and use them as a coating for the alfajores. The baked dough pieces were allowed to cool at room temperature (23–25 °C) for approximately 20 minutes, as were the chia seeds.

For the final process, the filling was applied using manjar blanco with a No. 10 round piping tip, ensuring uniform distribution. The coating of the alfajores was carried out manually by immersing the edges in toasted chia seeds. Finally, the alfajores were individually packaged and sealed in high-density polypropylene (HDPE) bags by thermal sealing. The product was stored at a temperature of 20 °C to 25 °C and at a relative humidity of 40–60%, protected from direct light.

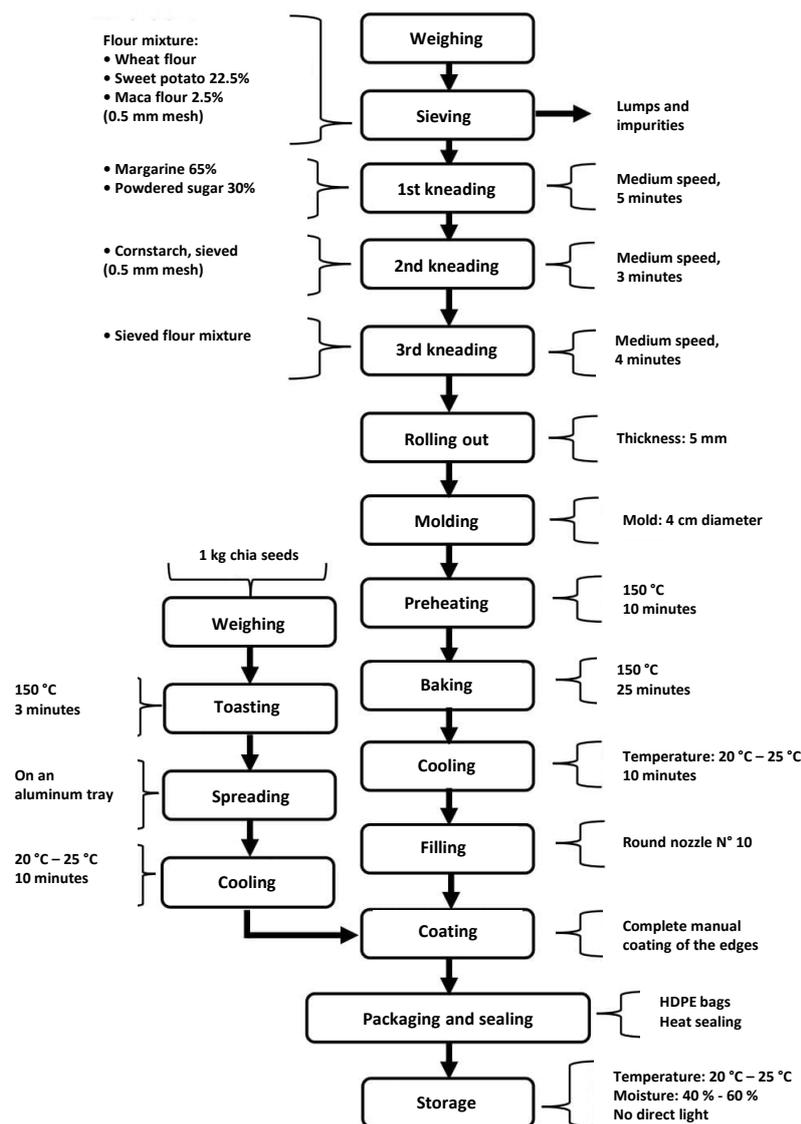


Figure 1. Block diagram of the alfajores preparation process

Number of alfajores per amount of flour

To determine the yield, that is, how many alfajores will be obtained, the following formula was applied, as shown below:

$$\frac{\text{Total weight of the dough ingredients}(g)}{[\text{Weight for each maca dough disc } (g) \cdot 2]}$$

Sensory analysis of the bakery product: Alfajores

Following the evaluation approach suggested by Agudelo *et al.* (2019), an intriguing sensory analysis was carried out

in the city of Chimbote. This study was conducted during an entrepreneurship fair, attracting the active participation of 50 individuals. The elements subjected to evaluation included color, aroma, flavor, texture, and even the predisposition to purchase the product. For this purpose, a hedonic scale (Table 3) was defined with meticulously established criteria.

Meanwhile, to perform the purchase intensity test, Agudelo *et al.* (2019) used a different hedonic scale (Table 4).

Table 3.
Hedonic scale for sensory evaluation

HEDONIC SCALE	
Very pleasant	1
Pleasant	2
Good	3
Unpleasant	4
Very unpleasant	5

Table 4.
Hedonic scale for purchase intention

HEDONIC SCALE	
Yes, I would buy it	1
In doubt	2
I would not buy it	3

RESULTS AND DISCUSSION

Yield obtained in the preparation of alfajores

For the preparation of the alfajores, weight distribution was carried out for the formulation. Table 5 shows the weights indicated for each ingredient. It should be noted that the sum of the flour mixture

amounts to 1 kg, representing 100%. The other ingredients, such as cornstarch, powdered sugar, and margarine, are external additives to the main mixture and are not considered within the 100%. In this way, these additives are properly proportioned according to the total amount of flour.

Table 5.
Quantity of ingredients used in the dough for 1 kg of flour

INGREDIENTS	QUANTITY (Kg)
Wheat flour	0.750
Maca flour	0.025
Sweet potato flour	0.225
Cornstarch	0.250
Powdered sugar	0.300
Margarine	0.650
TOTAL	3.05

It was established that each alfajor disc should have an average of 18 grams of dough. To determine the yield of alfajores obtained from the total amount of flours, it will be calculated by substituting the values into Equation 1, as proposed in the methodology.

$$\frac{\text{Total weight of the dough ingredients}(g)}{[\text{Weight for each maca dough disc } (g) \cdot 2]}$$

Next, we substitute:

$$\text{Units}_{\text{Alfajor}} = \frac{3050 (g)}{20 (g) \cdot 2}$$

$$\text{Units}_{\text{Alfajor}} = 76.25$$

It is reported that per kilogram of flour, a total of 76 alfajores are obtained, that is, 152 dough discs. This value exceeds that obtained by Chávez and Montañez (2021), who reported that, based on 40 kilograms of flour, they achieved a production of 1,466 products including different types of alfajores and King Kong, without accounting for losses; that is, per kilogram of flour, they obtained 36.65 products, which is lower than the yield obtained in this study.

Results of the sensory analysis of the bakery product: Alfajor

COLOR APPEARANCE

Although flavor and texture are the most relevant sensory attributes in the evaluation

of a product, color was also considered as an analysis parameter due to the characteristic pinkish tone observed in the alfajor shells. This color is due to the presence of pigments inherent to purple sweet potato, which give the product a distinctive appearance. As it is the first attribute perceived by consumers, it is expected that this chromatic attribute will increase the acceptance and visual appeal of the alfajores in the market.

Figure 2 shows that the color observed in the alfajores was directly influenced by the presence of purple sweet potato flour in the formulation, which generated a characteristic pinkish hue. This visual aspect positively captured the attention of the evaluators, and was perceived as a differentiating attribute compared to conventional alfajores.

The pinkish hue acquired by the alfajor shells not only constitutes a distinctive aesthetic feature but may also influence the purchase decision, especially among consumers who value appearance as an indicator of novelty or quality. Schnaider (2023) highlights the importance of color in pastry products, showing how attractive tones enhance acceptance. In this case, the natural pigments of purple sweet potato proved to be functional at both the visual and nutritional levels, confirming their viability as an ingredient in innovative bakery products.

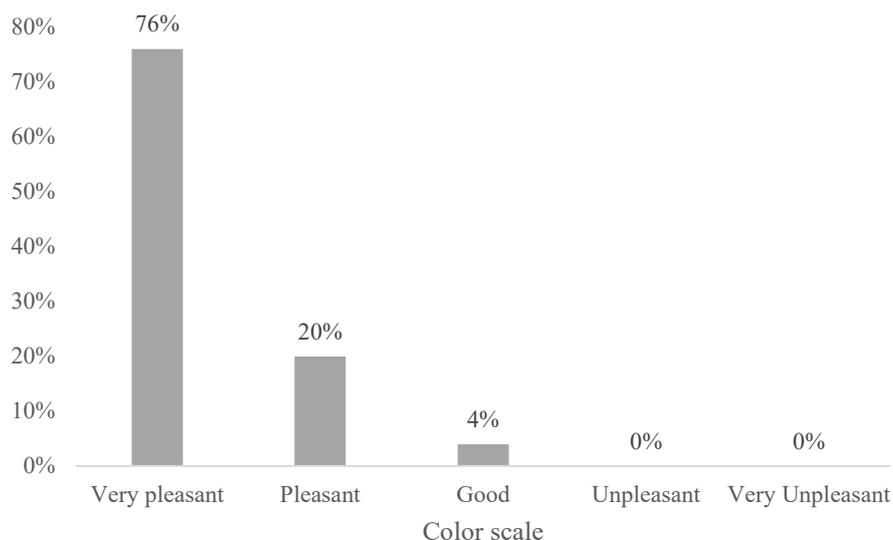


Figure 2. Results regarding color

FLAVOR ASPECT

To ensure that the alfajores would have a pleasant flavor for the taste buds, care was taken to avoid exceeding the percentage of maca flour, which could contribute bitterness to the alfajor. With a higher percentage of sweet potato flour, a noticeably sweet flavor is perceived.

Figure 3 shows that flavor was one of the most carefully balanced attributes in the formulation. The higher proportion of sweet potato flour provided a natural and pleasant sweetness, while the controlled incorporation of maca flour avoided bitter notes, thus preserving a positive gustatory experience.

Flavor constitutes one of the most sensitive factors in the evaluation of bakery products. In this research, an adequate balance was achieved between functional ingredients and the organoleptic characteristics of the product. As noted by Schnaider (2023), the incorporation of alternative ingredients can modify the flavor profile; however, appropriate formulation design allows consumer acceptance to be preserved. The combination of sweet potato and

maca in specific proportions proved effective in maintaining a pleasant flavor, demonstrating that it is possible to innovate without compromising the sensory quality of the product.

TEXTURE ASPECT

The dough of an alfajor is typically soft, tender, and buttery. It may have a cookie-like consistency or be spongier depending on the recipe. Figure 4 shows that the texture of the alfajores was described as soft and homogeneous, with a consistency similar to that of traditional alfajores. The presence of sweet potato starch contributed to this structure, providing a tender and slightly spongy bite.

Texture is a critical property that directly influences the perception of quality in a pastry product. In this formulation, the inclusion of sweet potato flour contributed to achieving a cohesive, soft, and easy-to-consume dough. Schnaider (2023) also mentions that a balanced texture—neither too dense nor too fragile—is fundamental for sensory acceptability. The

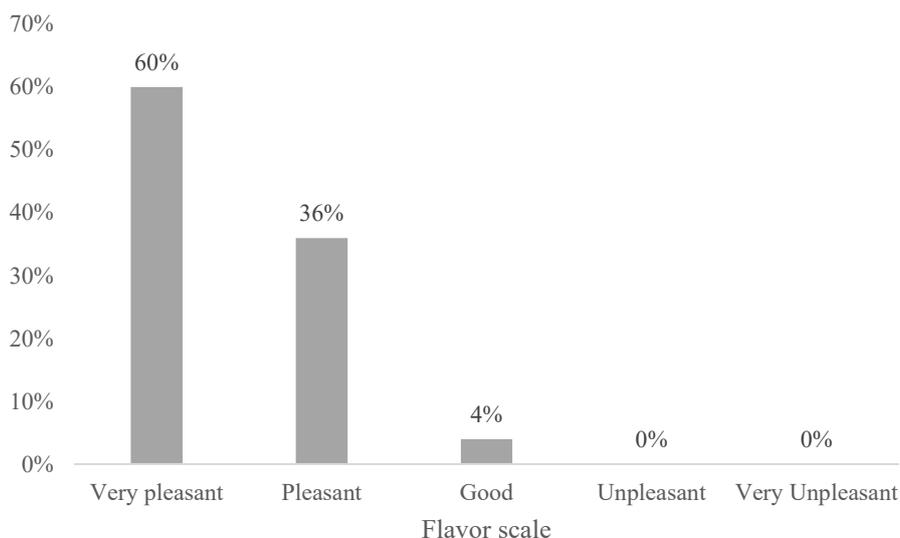


Figure 3. Results regarding flavor

texture achieved in this research allowed for an experience similar to that expected by consumers, validating the use of alternative ingredients in artisanal products.

Purchase intention evaluation

Evaluating purchase intention allows the assessment of how commercially viable the product would be in the market. Therefore, according to the results, the product would be fully accepted in this context.

In Figure 5, it is observed that the evaluation of purchase intention revealed a highly positive response from the evaluators, who expressed a high level of willingness to purchase the product. This result suggests that the sensory attributes as a whole were perceived as satisfactory, generating confidence and satisfaction in the potential consumer.

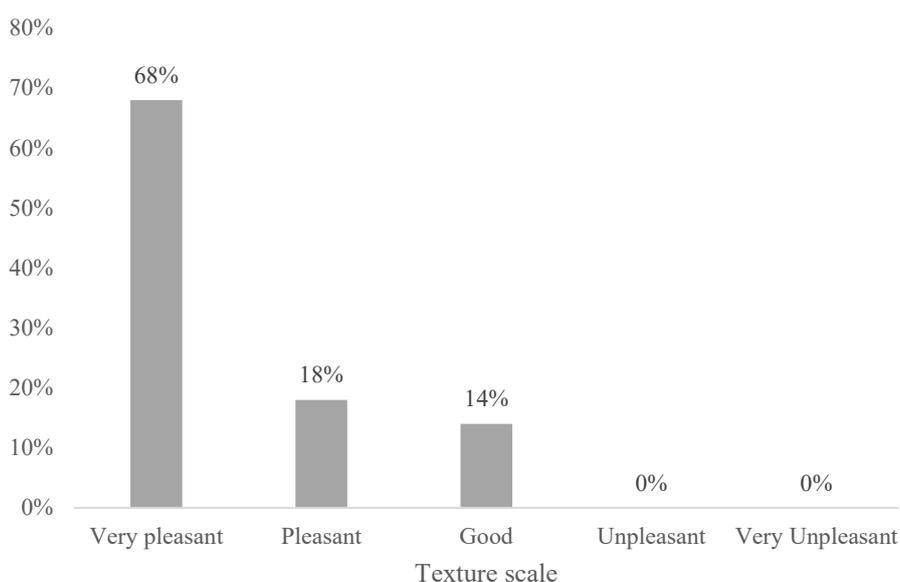


Figure 4. Results regarding texture

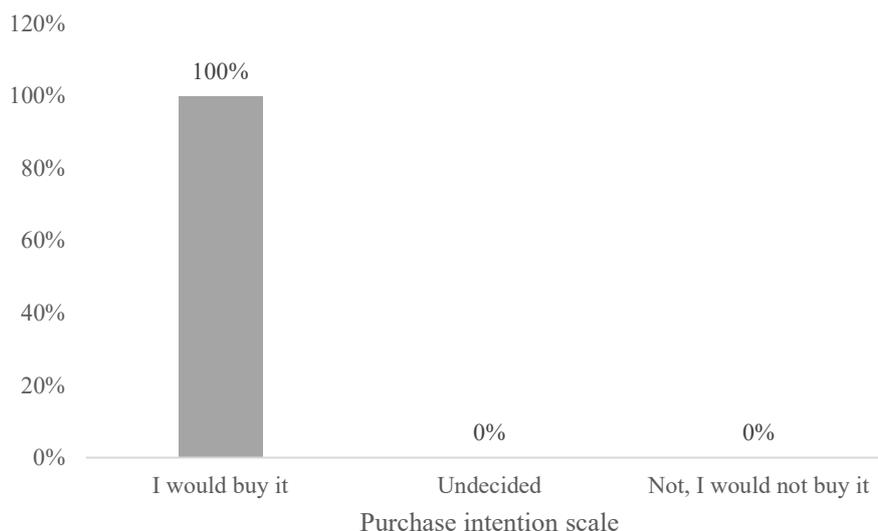


Figure 5. Results regarding purchase intention

CONCLUSIONS

The partial substitution of wheat flour with sweet potato and maca flour in alfajores showed positive sensory acceptance, as reflected in the consumers' evaluation. The theoretical nutritional analysis suggests a higher potential nutrient contri-

bution, which supports the feasibility of using alternative flours in pastry products. This provides a basis for future research in pastry-making, promoting the search for alternative ingredients and benefiting both consumers and the food industry.

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Author Contribution Statement

- Sofia L. Ayala-Arias: Conceptualization; methodology and project administration.
- Amara K. Haro-Quíñones: Writing, conceptualization; methodology.
- Yover A. Dextre-Flores: Methodology, statistics.
- Grecia F. Velásquez-Dávila: Data analysis and original draft.
- Juan L. Julca Herrera: Analysis, data validation, and writing.
- Yosef J. Avalos-Ramírez: Review, supervision, validation, and final editing.

Evaluation of the effects of cryogenic freezing on fruits

Evaluación de los efectos de la congelación criogénica en frutas

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ABSTRACT

Cryogenic freezing is considered one of the most efficient techniques for fruit preservation, as it extends shelf life while preserving sensory and nutritional characteristics. Its effectiveness lies in the formation of small, uniform ice crystals that maintain cell structure, reducing physical damage and limiting microbial and enzymatic activity. Success depends on factors such as freezing rate, fruit type, storage time, and thawing process. In mangoes, rapid freezing methods like Individual Quick Freezing (IQF) have been shown to better preserve texture, color, and antioxidants compared to conventional techniques. In blueberries, the application of liquid nitrogen maintains high levels of vitamin C and firmness, although it can cause surface cracking if the process is not properly controlled. In kiwis, the effects vary according to the soluble solids content and fruit region, influencing cold tolerance and structural damage. In durian, cryogenic freezing has proven more effective than traditional freezing, preserving both internal and external quality for a longer period. Emerging technologies such as ultrasound, high pressure processing, and magnetic fields, and the use of cryoprotectants, especially polysaccharide nanoparticles, enhance this technique by reducing recrystallization and optimize fruit stability during freezing and thawing, making cryogenic freezing a strategic tool for the modern food industry.

Keywords: Shelf life, microbial activity, cell structure, quality, freezing rate, vitamin C.

RESUMEN

La congelación criogénica se presenta como una de las técnicas más eficientes para la conservación de frutas, ya que permite prolongar su vida útil preservando así sus características sensoriales y nutricionales. Su efectividad radica en la formación de cristales de hielo pequeños y uniformes que mantienen la estructura celular, reduciendo daños físicos, limitando la actividad microbiana y enzimática. Su éxito depende de factores como la velocidad de congelación, el tipo de fruta, tiempo de almacenamiento y el proceso



de descongelación. En el mango, los métodos de congelación rápida como el Individual Quick Freezing (IQF) han demostrado conservar mejor la textura, color y antioxidantes en comparación con técnicas convencionales, mientras que en los arándanos la aplicación de nitrógeno líquido permite mantener altos niveles de vitamina C y firmeza, aunque puede provocar fracturas superficiales si no se controla el proceso. En kiwis, los efectos varían de acuerdo con el contenido de sólidos solubles y la zona del fruto, influyendo en la resistencia al frío y el nivel de daño estructural; por su parte, en el durión la criogenia ha demostrado ser más eficaz que la congelación tradicional, preservando por mayor tiempo la calidad interna y externa del fruto. Tecnologías emergentes como el ultrasonido, la alta presión, los campos magnéticos y el uso de crioprotectores, especialmente nanopartículas de polisacáridos, potencian esta técnica al reducir la recristalización y optimizar la estabilidad de las frutas durante la congelación y descongelación, lo que convierte a la criogenización en una herramienta estratégica para la industria alimentaria moderna.

Palabras clave: Vida útil, actividad microbiana, estructura celular, calidad, velocidad de congelación, vitamina C.

INTRODUCTION

Food is one of the fundamental needs of human beings and is satisfied through sources of animal and plant origin (Zhang *et al.*, 2024). Among the most widely used preservation methods to ensure the availability and quality of these products is freezing, which stands out for its broad application in fruits and vegetables (Wu *et al.*, 2022). However, the growing demand for frozen products has led companies to offer a variety of foods that may face difficulties in maintaining quality (Pesce *et al.*, 2025). This occurs because the volume of products, especially food, that is wasted worldwide continues to increase due to inadequate storage (Salami *et al.*, 2025). Since many foods are highly perishable, it is essential to apply appropriate preservation methods that ensure their constant availability throughout the year and in different regions (Muthukumarappan *et al.*, 2019). Therefore, cryogenic freezing is considered one of the most effective technologies to extend the shelf life of perishable fruits such as mango, as it inhibits microbial and enzymatic activity (Grover, 2023). This

process can also induce irreversible alterations at the cellular level, causing a loss in the final quality of the product, since the freezing of plant tissue with high water content causes cellular damage due to the formation of ice crystals (Jha *et al.*, 2019; Schudel *et al.*, 2021). Even so, cryogenic freezing slightly reduces pore size, better preserving the microstructure compared to mechanical freezing (Jha *et al.*, 2024). The success of freezing depends largely on precise control of process conditions, especially the freezing rate and the type of technology employed, as these factors directly influence ice crystal formation and, consequently, the structural integrity of plant tissue (Grover, 2023). Studies have shown that quality loss, particularly tissue damage and changes in texture and color during freezing, is influenced by the rate of this process (Gales *et al.*, 2022). In this regard, food temperature and water content are also key elements in the crystallization phenomenon, which comprises the stages of nucleation and crystal growth (Zennoune *et al.*, 2022). The presence of large crystals

can damage cellular structure and compromise food quality; therefore, it is essential to understand the interaction between food microstructure and the morphology of the formed ice (Pérez-Bermúdez *et al.*, 2023).

Among emerging technologies, ultrasound, high pressure, and microwaves stand out because they allow the production of high-quality frozen products by modifying water distribution within the food structure, without incorporating foreign compounds into its composition (Loayza-Salazar *et al.*, 2023). Nevertheless, these technologies usually involve high costs and their application is still limited by operational scale (Loayza-Salazar *et al.*, 2023; Yu *et al.*, 2022). In contrast, techniques such as osmotic dehydration or dehydrofreezing and magnetic field-assisted freezing are considered more accessible and economical alternatives, as they do not require sophisticated equipment or the use of expensive refrigerants (Loayza-Salazar *et al.*, 2023). Likewise, it has been shown that physical methods, such as the application of alternating and pulsed electric fields in combination with oscillating magnetic fields, are effective in preserving freshly cut fruits in a supercooled state (Narayana *et al.*, 2023). In addition, cryoprotectants—especially polysaccharide nanoparticles—have gained relevance due to their effectiveness in inhibiting ice crystal formation and minimizing cellular damage. Thanks to their high surface-to-volume ratio and efficient diffusion capacity, these nanoparticles form hydrogen bonds with water, which contributes to improving fruit stability during freezing and thawing processes (Demirci *et al.*, 2025).

MATERIALS AND METHODS

A systematic literature review was conducted covering the period from 2016

to 2025, limited to sources published within the last ten years. For the search and information collection process, key terms such as preservation technology, cellular damage, quality after freezing, and cryogenic freezing were used. Data collection was carried out through access to online academic databases available through the library system of the Universidad Nacional del Santa, as well as internationally recognized scientific platforms such as Sciverse, Elsevier, Scopus, ScienceDirect, and EBSCO. Specialized scientific journals and international organizations related to fruit preservation and processing were consulted, with particular attention to cryogenic freezing techniques.

RESULTS AND DISCUSSION

Effects of freezing on quality parameters in fruits

Mango

In a study conducted by Aldoradin-Puza *et al.* (2019), the effect of the Cells Alive System (CAS) technology, based on the application of oscillating magnetic fields (OMF) during the freezing of ‘Kent’ mango variety, was evaluated. This technology was proposed as an alternative to modulate ice nucleation and reduce the negative effects associated with crystallization; however, the results did not show significant differences compared to conventional freezing. Samples treated with CAS exhibited a statistically significant loss of firmness, as well as visible intercellular separation in histological sections, attributed to the collapse of cellular structure due to ice action (Aldoradin-Puza *et al.*, 2019). Similarly, drip loss ranging between 2.45% and 4.15% was recorded, an indicator that reflects a significant leakage of cellular juices during thawing and directly affects fruit juiciness and acceptability. These fin-

dings reinforce evidence that the formation of large ice crystals, resulting from slow freezing or ineffective treatments, negatively impacts the structural and sensory quality of frozen mango (Aldoradin-Puza *et al.*, 2019; Grover, 2023).

In a study conducted by Charoenrein and Owcharoen (2016), it was shown that cryogenic freezing at $-80\text{ }^{\circ}\text{C}$ (fast freezing) allowed the preservation of firmness in mango cv. Nam Dok Mai by forming small, homogeneously distributed ice crystals, which minimized damage to cell walls. In contrast, slow freezing ($-20\text{ }^{\circ}\text{C}$) generated larger crystals that caused cellular collapse, increased drip loss (up to 60.70%), and marked solubilization of pectic substances associated with degradation of the middle lamella; these effects became more pronounced as freeze-thaw cycles increased. Also, Noriega-Juárez *et al.* (2024) evaluated the effect of the IQF method compared to traditional freezing in different mango varieties, finding that the former allowed better preservation of texture, color, firmness, and antioxidant compounds. Rapid freezing significantly reduced mechanical damage to tissues, as well as the degradation of vitamin C and phenolic compounds, which are key contributors to nutritional value and oxidative stability of the fruit.

Blueberries

Zielińska *et al.* (2018) evaluated the effect of cryogenic freezing with liquid nitrogen ($-196\text{ }^{\circ}\text{C}$) on blueberries, comparing it with conventional freezing ($-20\text{ }^{\circ}\text{C}$), and reported that cryogenic treatment significantly reduced subsequent drying time due to greater structural permeability. However, they also observed that ultra-fast freezing caused fractures on the fruit surface and greater volumetric shrinkage

(15.02%), resulting from thermal stress and tissue contraction during subsequent sublimation. These effects compromise the external appearance of the fruit, although they favor drying efficiency and moisture diffusion. Cheng *et al.* (2020), in a specialized review of freezing technologies, emphasized that cryogenic freezing allows the formation of smaller and more uniform ice crystals, predominantly located in the extracellular space, which reduces cellular collapse and better preserves the internal structure of the fruit. Nevertheless, they also warned that if the process is not accompanied by gradual thawing, secondary recrystallization may occur, generating cellular ruptures that affect firmness and increase drip loss.

In a subsequent experimental study, Cheng *et al.* (2020) analyzed the effect of cryogenic freezing by liquid nitrogen spraying at $-80\text{ }^{\circ}\text{C}$, combined with a three-stage thawing process (from $-20\text{ }^{\circ}\text{C}$ to $-5\text{ }^{\circ}\text{C}$ and then to $4\text{ }^{\circ}\text{C}$). This combination allowed the preservation of more than 95% of the initial content of vitamin C, polyphenols, and soluble sugars, in addition to maintaining blueberry firmness and significantly reducing drip loss. This outcome was attributed to the minimization of recrystallization and preservation of cell wall integrity.

Complementarily, Huang *et al.* (2024) explored the use of cryogenic freezing applied at different temperatures with liquid nitrogen (-80 , -100 , and $-120\text{ }^{\circ}\text{C}$), adjusted according to the glass transition temperature of blueberries ($T_g' \approx -52.6\text{ }^{\circ}\text{C}$), and verified that treatments close to $-120\text{ }^{\circ}\text{C}$ more effectively preserved firmness, anthocyanin content, vitamin C, and soluble solids. In addition, minimal juice loss during thawing and lower degradation of cellular membranes were reported,

favoring a more compact and stable internal structure.

Kiwi

The increase in pressure during freeze-drying of kiwi reduces its brightness and rehydration capacity, while increasing penetration resistance and particle size; these changes affect texture and hinder subsequent processing (Domin *et al.*, 2020). Taking this into account, Xu *et al.* (2023) evaluated the effect of different thermal fluctuation regimes (2 °C to 5 °C and 2 °C to 7 °C, every 12 hours) on the 'Xuxiang' cultivar. Their results showed that these variations increase pulp translucency, reduce firmness, and raise relative conductivity, indicating damage to the cell membrane. Also, a higher incidence of rot and weight loss was observed. At the molecular level, gene expression of polygalacturonase, β -galactosidase, and pectin methyl esterase—key enzymes in cell wall degradation—was significantly higher in treatments with wide thermal oscillations, especially from 2 °C to 7 °C. These effects accelerated fruit senescence, compromising postharvest stability.

On the other hand, Huang *et al.* (2024) determined the freezing points of 45 kiwi genotypes, finding that they range between -1.23 °C and -2.61 °C depending on soluble solid content (SSC). A higher SSC concentration correlated with a lower freezing point, indicating that fruits with high sugar content are more resistant to chilling injury. Likewise, thermal variability within the same fruit was identified: the floral end showed lower freezing points than the peduncular end, which has important implications for the distribution of internal damage under partial freezing conditions.

Additionally, Zhao *et al.* (2021) analyzed the quality of 'Xuxiang' cultivar after frozen storage at -18 °C for up to 90 days. Significant losses in firmness, total phenolic content, antioxidant capacity (DPPH and ABTS), and key aromatic compounds such as hexanal and (E)-2-hexenal were reported. Sensory analysis indicated deterioration in aroma and flavor after 60 days of freezing, attributed to structural collapse and degradation of volatile compounds. These results suggest that prolonged storage at low temperatures, although it prevents microbial growth, can compromise the organoleptic and nutritional quality of kiwi.

Durian

Razali *et al.* (2022) evaluated the effect of freezing methods on the physical and sensory qualities of whole durian. The freezing methods included conventional freezing (-18 °C) and cryogenic freezing (-110 °C). Frozen durian was thawed and evaluated after 12, 24, and 36 hours to determine external and internal quality, incidence of dehiscence, and physicochemical parameters. The results showed that conventional freezing at -18 °C negatively affected durian quality. In comparison, during cryogenic freezing, durian was rapidly frozen without presenting dehiscence.

On the other hand, Hendra *et al.* (2023) evaluated the impact of the freezing process and storage time on the degradation of durian properties. One hundred fruits were subjected to two freezing levels: the first consisted of exposure to -15 °C for 10 minutes (treatment A) and 20 minutes (treatment B), followed by storage at -10 °C for periods of 0, 10, 20, and 30 days. Samples were thawed at 4 °C for 24 hours at different time intervals. The results indi-

Table 1.
Effect of freezing on changes in fruit quality

Fruit	Scientific name	Freezing temperature (°C)	Storage temperature (°C)	Storage time	Texture effect	Source
Mango	<i>Mangifera indica</i>	-80, -40, -20 -30	-18	7 days per cycle (3 cycles) 35 minutes	Rapid freezing preserves texture; slow freezing causes cellular collapse, loss of firmness, and increased drip loss. Loss of firmness and rupture of cell walls after freezing-thawing.	Charoenrein y Owcharoen (2016) Aldoradin-Puza et al. (2019)
Kiwi	<i>Actinidia delictosa</i>	Lyophilization (12-103 Pa) -	- 2-5 °C y 2-7 °C fluctuating	- 21 days	Higher pressure reduces rehydration and increases resistance to penetration during freeze-drying (12-103 Pa). Temperature fluctuations accelerate softening and increase translucency by 29%.	Domin et al. (2020) Xu et al. (2023)
Durian	<i>Durio zibethinus</i>	-40 -110 -120	-20 -	12 months 36 h post-thawing 9 months	Initial decrease in ascorbic acid followed by a 151% increase; variable carotenoid content. Physicochemical parameters preserved without affecting color, soluble solids, or acidity. Better preservation of enzymes and sugars compared with conventional freezing.	Tan et al. (2020) Razali et al. (2022) Alhmandan et al. (2016)
Dátil Barhi	<i>Phoenix dactylifera</i>	-43 -18 to -24	-40 -20	9 months 9 months	Better conservation of hardness, elasticity, and resilience; lower deterioration compared with other methods. Greater loss of firmness, elasticity, and resilience, significantly deteriorating texture during storage.	Alhmandan et al. (2016) Alhmandan et al. (2016) Alhmandan et al. (2016)
Arandano	<i>Vaccinium, Hippophae, Vitis</i> <i>Vaccinium macrocarpon</i> <i>Vaccinium</i>	-196 -196 -100, -80, -60, -40 y -20	- - Variable	- - -	Better preservation of volume, shape, and color; epidermis thickness reduced by 20-50%. Freezing accelerates drying by 69-97% but alters fruit structure. Low temperatures (-80 °C) maintain quality, whereas -20 °C leads to deterioration.	Dalmau et al. (2024) Zielinska et al. (2018) Cheng et al. (2020)

cated that treatment B showed significantly superior performance compared to treatment A, evidenced by lower weight loss, brighter and clearer pulp coloration, softer texture, lower moisture content, and a stable succinic acid profile. Likewise, in sensory preference evaluation, treated fruits were well accepted by panelists.

Tan *et al.* (2020) evaluated the impact of frozen storage on physicochemical properties and microbial load in durian pulp and paste from the “Musang King” (MK) and “D24” varieties over one year. During this period, both matrices exhibited weight loss ranging from 1% to 2%, along with increased pulp softness. Regarding color, changes in tonality were recorded: the “MK” variety shifted from a golden yellow tone to a lighter one, associated with an increase in the h° value, which coincided with a decrease in total carotenoids and β -carotene. In parallel, “D24” showed a paler tonality and reductions in L^* and C^* parameters after storage. The study also revealed a decrease in soluble solids and ascorbic acid content in both varieties after prolonged freezing, although pH and titratable acidity remained stable. At the microbiological level, pulp showed lower contamination levels compared to paste, with the “D24” variety being the most affected. These results suggest that freezing may be a viable alternative for preserving durian quality, provided that the storage period does not exceed twelve months.

Barhi date

Alhamdan *et al.* (2016) evaluated the impact of three freezing methods—cryogenic, rapid, and slow—on the quality of fresh Barhi dates stored at -18°C for nine months. Cryogenic freezing was carried out using liquid nitrogen at -196°C for 10 minutes. In the rapid method, a freezing

tunnel with air at 5 m/s and a temperature of -120°C was used until the internal temperature of the fruit reached -18°C (≈ 2 hours). In contrast, slow freezing was conducted in a chamber at -20°C , reaching the desired temperature in approximately 8 hours. The results indicated that cryogenic and rapid freezing better preserved texture and color and reduced exudation during thawing, whereas slow freezing generated greater structural damage due to the formation of large ice crystals.

CONCLUSIONS

Freezing exerted a determining effect on the quality of different fruits, depending on the technology employed, temperature, and storage time.

In the case of mango, it was observed that both conventional freezing and freezing assisted with the Cells Alive System (CAS) did not prevent the loss of firmness or cellular separation, whereas cryogenic freezing better preserved texture and reduced drip loss during thawing.

For blueberries, it was observed that the use of liquid nitrogen effectively preserved antioxidant compounds, firmness, and fruit shape; however, it was noted that inadequate thawing generated secondary recrystallization.

For kiwi, it was found that thermal oscillations and prolonged treatments at -18°C caused alterations in texture, color, antioxidant activity, and aromatic profile, affecting sensory acceptability.

Regarding durian, it was verified that cryogenic freezing prevented dehiscence and preserved physicochemical properties during the first 36 hours after thawing; moreover, a longer freezing time (20 minutes) and storage at -10°C for 30 days allowed better retention of color, moisture,

and acid stability, with the “Musang King” variety being more resistant than “D24”.

In Barhi dates, it was evidenced that rapid freezing at $-120\text{ }^{\circ}\text{C}$ and cryogenic freezing with liquid nitrogen at -196

$^{\circ}\text{C}$ optimally maintained internal structure, texture, and sensory acceptance after nine months of storage, in contrast to slow freezing, which caused greater physical deterioration and quality loss.

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Author Contribution Statement

- Lizeth N. Santiago-Castillo: Conceptualization; methodology and project administration.
- Miguel A. Grados-Poémape: Data analysis, data validation, and writing.
- César Moreno-Rojo: Review, supervision, validation, and final editing.

Educational Intervention on Knowledge and Practices Regarding Healthy Eating Among Mothers at the “Pan de azúcar” Community Kitchen - Lima

Intervención educativa sobre los conocimientos y prácticas en alimentación saludable en madres del comedor “Pan de azúcar” - Lima

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ABSTRACT

Healthy eating is a fundamental pillar for the physical and mental well-being of the population. In this context, mothers enrolled in food supplementation programs play a crucial role in meal preparation; therefore, it is important to strengthen their knowledge of nutrition and promote healthy eating practices. The objective of the study was to determine the changes resulting from an educational intervention on knowledge and practices regarding healthy eating among mothers enrolled in the “Pan de Azúcar” community kitchen – Lima, 2023. This was a descriptive correlational study with a quasi-experimental, longitudinal, and prospective design. The sample consisted of 43 mothers enrolled in food supplementation programs. A survey method was used, applying a pre- and post-intervention questionnaire validated by expert judges, in order to assess knowledge and practices related to healthy eating. In the pretest results, 46.5% (n=20) and 51.2% (n=22) showed low and moderate levels of knowledge and practices, respectively, while only 2.3% (n=1) demonstrated a high level. After the intervention, 67.4% (n=29) and 32.6% (n=14) demonstrated high and moderate levels of knowledge and practices, respectively. The Wilcoxon non-parametric test ($p = 0.000$) showed statistically significant changes. In conclusion, the educational intervention led to significant improvements in the nutritional knowledge and practices of mothers at the “Pan de Azúcar” community kitchen, located in the district of San Martín de Porres, Lima, 2023.

Keywords: Educational intervention, healthy eating, knowledge, practices.

RESUMEN

La alimentación saludable es un pilar fundamental para el bienestar físico y mental de la población. En ese contexto, las madres inscritas en los programas de complementación



alimentaria cumplen un papel crucial en la elaboración de alimentos; por ello, es relevante fortalecer sus conocimientos sobre nutrición y promover prácticas alimentarias saludables. El objetivo fue determinar los cambios que produce una intervención educativa sobre los conocimientos y prácticas en alimentación saludable en madres inscritas en el comedor Pan de Azúcar – Lima, 2023. El estudio fue descriptivo correlacional, con diseño cuasi experimental, longitudinal y prospectivo. La muestra estuvo conformada por 43 madres inscritas en el Programa de Complementación Alimentaria. Se utilizó la técnica de la encuesta, aplicando un cuestionario pre y post intervención, validado por jueces expertos, con el fin de evaluar conocimientos y prácticas en alimentación saludable. En los resultados del pretest, el 46,5 % (n=20) y el 51,2 % (n=22) presentaron conocimientos y prácticas bajos y regulares, respectivamente, mientras que solo el 2.3 % (n = 1) tuvo conocimientos y prácticas buenas. Tras la intervención, el 67,4 % (n=29) y el 32,6 % (n = 14) mostraron conocimientos y prácticas buenas y regulares, respectivamente. La prueba no paramétrica de Wilcoxon ($p = 0,000$) evidenció cambios estadísticamente significativos. Conclusión: La intervención educativa produjo mejoras significativas en los conocimientos y prácticas de nutrición de las madres de familia del comedor Pan de Azúcar, distrito de San Martín de Porres, Lima 2023.

Palabras clave: Intervención educativa, alimentación saludable, conocimientos, prácticas.

INTRODUCTION

In Peru, significant social and economic inequalities persist, affecting the food security of families. According to INEI (2024), the national poverty rate reached 29% in 2023, with a higher impact on rural areas (39.8%) than urban areas (26.4%). This situation limits access to the basic family food basket and compromises the nutritional status of children, who constitute a priority group for human development.

To mitigate this problem, the Peruvian State has implemented food supplementation programs, where the Vaso de Leche Program and the Comedores Populares stand out (MIDIS, 2024). These programs seek to improve the nutritional intake of vulnerable populations through affordable rations and state subsidies. However, their success largely depends on the level of nutritional knowledge and the food practices

of the mothers responsible for food preparation. Studies have indicated that a low level of knowledge regarding healthy eating directly affects diet quality in children and the prevalence of problems such as anemia, obesity, and other chronic diseases (Tara-zona, 2021; Choco & Huerta, 2021).

Despite the importance of this group, research on the knowledge and food practices of mothers in popular kitchens remains scarce and outdated. Educational interventions constitute effective tools for promoting changes in eating habits and improving the nutritional status of families (Bernal *et al.*, 2010).

There is a need to evaluate the impact of educational programs in this sector. Therefore, the present study aimed to determine the changes produced by an educational intervention on knowledge and practices related to healthy eating among

mothers from the Pan de Azúcar community kitchen, Lima, 2023.

MATERIALS AND METHODS

The population consisted of 50 mothers who were beneficiaries of the community kitchen and the Vaso de Leche program of the AA.HH. “Pan de Azúcar”, located in the district of San Martín de Porres, Lima, Peru. Inclusion criteria included: mothers with children under 13 years of age enrolled in the programs (with a minimum of three months of affiliation), regular attendance, and no mental or cognitive disability. Those who did not agree to participate, did not complete the sessions, or did not attend the evaluations were excluded.

The final sample consisted of 43 mothers, selected through non-probability convenience sampling. The unit of analysis was the “Pan de Azúcar” community kitchen.

A data collection form was used in coordination with those responsible for the social programs, ensuring the confidentiality of the information. Written informed consent was obtained prior to the start of the research.

The educational intervention was carried out in three sessions. For the theoretical sessions, the “Módulo de Capacitación: Orientación y manejo alimentario nutricional” (Training Module: Nutritional Food Guidance and Management) from the Ministry of Health (MINSA, 2005) was used. Demonstrative sessions were conducted under the “Learning-by-doing” methodology, using the technical document of the Ministry of Health (2023), in which the mothers practiced the appropriate preparation of local foods.

The evaluation of knowledge and practices was conducted using a question-

naire adapted from Herrera and García (2022), with a reliability of $\alpha = 0.8713$. The questions were modified and images were incorporated to adapt it to the population context, and the adapted version was validated by five expert judges. This instrument included 20 questions (10 on knowledge and 10 on practices, multiple-choice, plus one open-ended question). Scores were categorized as low (0–10), fair (11–15), and good (16–20).

Statistical analysis was performed using descriptive statistics (frequencies, percentages, means) and inferential statistics to demonstrate data distribution. The non-parametric Wilcoxon test was used to compare pretest and post-test results, considering a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

Table 1 shows the age distribution of the participants, which ranges from 18 to 65 years. The age group with the greatest representation corresponds to the 26 to 35-year interval, accounting for 30.23% ($n = 13$) of the total respondents. It is observed that the majority of the mothers have completed secondary education, which constitutes the predominant level of instruction in the sample, with 34.9% ($n = 15$).

The results obtained suggest notable agreement with various previous studies regarding the characterization of the target population. As evidenced by the studies of Esquivel (2022), the populations addressed in those works are also mostly composed of users of social assistance programs, such as community kitchens, the Vaso de Leche program, or analogous initiatives under different names depending on the geographical or institutional context.

With respect to the educational level and occupations of the individuals eva-

Table 1.
Distribution of mothers according to general characteristics

N° Participant	Age (years)	Educational level
1	39	Completed higher institute
2	25	Completed high school education
3	31	Incomplete high school education
4	34	Higher institute (in progress)
5	40	Completed high school education
6	18	High school (in progress)
7	51	Completed high school education
8	62	Completed high school education
9	39	Higher institute (in progress)
10	37	Higher institute (in progress)
11	50	Completed high school education
12	33	Higher institute (in progress)
13	47	University studies (in progress)
14	45	Higher institute (in progress)
15	54	Completed high school education
16	50	Completed high school education
17	21	High school (in progress)
18	66	Completed high school education
19	51	Incomplete Higher institute
20	42	Completed high school education
21	58	Incomplete high school education
22	22	Completed high school education
23	22	Incomplete high school education
24	40	Completed high school education
25	32	University studies (in progress)
26	29	Higher institute (in progress)
27	34	Incomplete university studies
28	48	Completed higher institute
29	29	Completed high school education
30	35	Completed high school education
31	36	Incomplete high school education
32	47	Incomplete higher institute
33	28	Incomplete higher institute
34	46	Incomplete high school education
35	35	Incomplete high school education
36	59	Completed high school education
37	36	Incomplete institute
38	32	Incomplete high school education
39	27	Incomplete high school education
40	58	Incomplete high school education
41	22	Incomplete institute
42	40	Incomplete institute
43	33	Completed high school education

luated, similar patterns are also identified to those observed in the referenced study by Robles and Zevallos (2024). This similarity can be explained by the prevailing socioeconomic condition among beneficiaries of social programs, who mostly belong

to low-income sectors with limited access to higher education. This structural reality directly affects the homogeneity of occupational profiles and the restriction of educational opportunities.

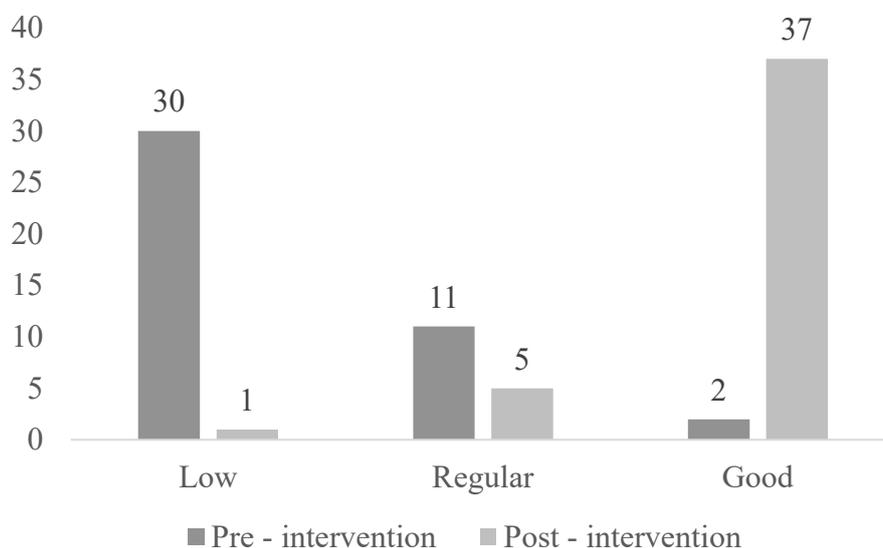


Figure 1. Educational intervention on knowledge of healthy eating among mothers of the “Pan de Azúcar” community kitchen

When analyzing in a disaggregated manner the levels of knowledge related to healthy eating, classified into the categories of low, fair, and good, Table 2 shows that during the initial evaluation (pretest) the corresponding percentages were 69.77%, 25.58%, and 4.65%, respectively. However, after conducting the post-intervention evaluation (post-test), a notably positive transformation in the distribution of these levels is observed. Specifically, a substantial decrease in the low level was recorded, dropping to 2.33%, while the fair level decreased to 11.63%. The results of the present study demonstrate a positive impact of the educational intervention on strengthening knowledge and practices related to healthy eating among mothers from the Pan de Azúcar community kitchen. More than 80% of the participants showed significant

improvements in the evaluated indicators, confirming the effectiveness of the educational strategies implemented.

These findings are consistent with those reported in previous research (Agdeppa *et al.*, 2019; Prías and Contreras, 2020), where notable increases in knowledge levels were also documented following the implementation of educational programs. Also, they are in agreement with what was reported by Mendoza and Chavez (2020), who demonstrated a considerable increase in the level of knowledge and dietary practices among mothers in community contexts, highlighting the usefulness of educational interventions as a means to promote appropriate nutritional behaviors.

Although 18.6% of the participants did not show relevant changes, it is important to emphasize that no regressions were

recorded in the analyzed indicators, which reinforces the relevance of the training process. In this regard, the need to design participatory educational programs, contextualized to the sociocultural characteristics

of the population, is recognized in order to ensure sustainable public health interventions that empower mothers in their active role in the preparation and distribution of food in community spaces.

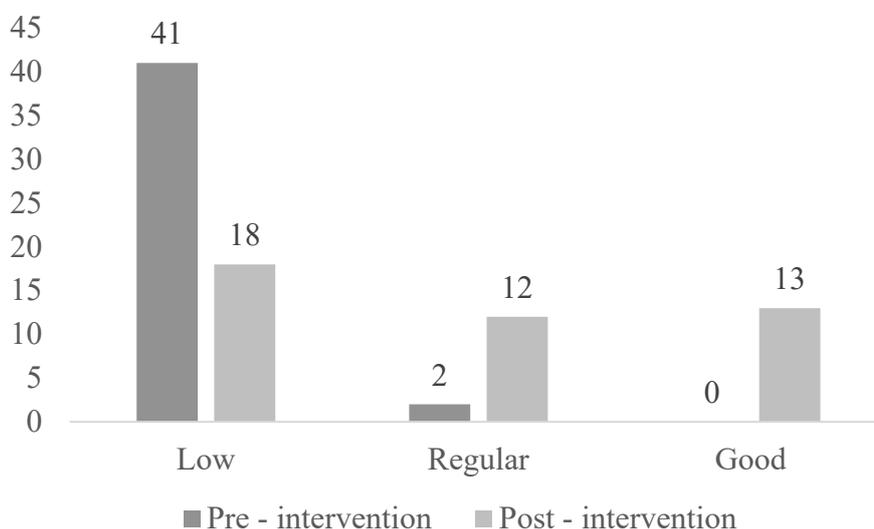


Figure 2. Educational intervention on healthy eating practices among mothers of the “Pan de Azúcar”

Table 2.

Changes produced by the educational intervention with respect to knowledge and practices, expressed in positive and negative ranks

	n	%
(Knowledge and practices) 2 vs (Knowledge and practices) 1		
Negative ranks	0 ^a	0
Positive ranks	35 ^b	81.4
Ties	8 ^c	18.6
Total	43	100

a. Practice 2 + Knowledge 2 < Practice 1 + Knowledge 1
 b. Practice 2 + Knowledge 2 > Practice 1 + Knowledge 1
 c. Practice 2 + Knowledge 2 = Practice 1 + Knowledge 1

When carrying out an individualized evaluation of practice levels, classified into the categories of low, fair, and good, Table 3 shows a positive and notable change after the educational intervention. The educational intervention generated a

substantial change in the levels of dietary practices. Initially, the low level predominated (95.3%), but after the educational intervention it was reduced to 41.9%, while the fair (27.9%) and good (30.2%) levels increased, demonstrating significant im-

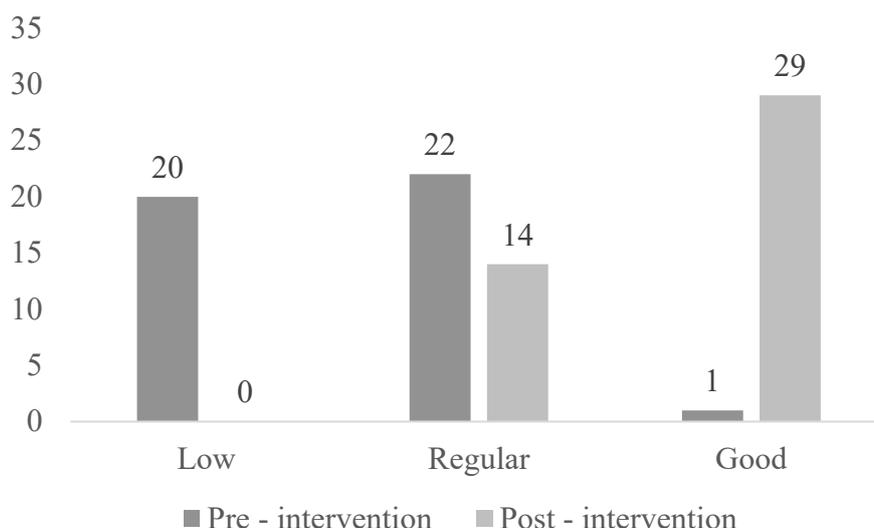


Figure 3. Effect of the educational intervention on knowledge and healthy eating practices among mothers from the “Pan de Azúcar” community kitchen.

Table 3.
Normality test

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistical	df	Sig.	Statistical	df	Sig.
Diference P2-P1	.143	43	.027	.971	43	.331
Diference C2-C1	.154	43	.011	.964	43	.193
Diference (P2+C2) - (P1-C1)	.156	43	.010	.936	43	.019

a. Practice 2 + Knowledge 2 < Practice 1 + Knowledge 1
 b. Practice 2 + Knowledge 2 > Practice 1 + Knowledge 1
 c. Practice 2 + Knowledge 2 = Practice 1 + Knowledge 1

provements in the adoption of appropriate practices. This finding reflects a reduction of more than 50% in inadequate behaviors, consistent with the results reported by Ramírez (2023), Villagra *et al.* (2020), and Mori *et al.* (2025), who also documented significant decreases in inadequate dietary practices following educational interventions.

The observed progress may be attributed to the limited prior training of the participants in nutrition, which leads to the replication of erroneous practices. In this sense, the intervention fulfilled a corrective

and preventive role, providing conceptual and practical tools that facilitated the acquisition of healthier habits. These results consolidate the relevance of educational interventions as effective strategies for the promotion of food-related health in community contexts.

Table 4 presents the results obtained, revealing that 81.40% (n = 35) of the participants experienced notable improvements as a direct consequence of the intervention. In contrast, 18.60% (n = 8) did not show substantial changes in either their knowledge or their dietary practices

after the educational activity. It should be noted that no regressions or decreases were recorded in the evaluated indicators, which confirms the absence of adverse effects associated with the implemented training process.

The educational intervention produced substantial improvements in the levels of knowledge and dietary practices of the participating mothers. As shown in Table 5, the low (46.5%) and fair (51.2%) levels initially predominated; however, after the intervention, the low level disappeared and the good level increased to 67.4%, evidencing an increase of 65.1% in the group with the highest performance. These findings are consistent with those reported by Robles and Zevallos (2024) and Herrera and García (2022), confirming that interventions based on educational and demonstrative sessions, when designed by qualified professionals and contextualized to the social reality of the population, constitute effective strategies for promoting positive transformations in vulnerable communities.

The normality of the data was assessed using the Shapiro–Wilk test. The as-

sumption of normality was confirmed for the differences in knowledge scores ($p = 0.331$) and practice scores ($p = 0.193$), but not for the differences in total scores ($p = 0.019$). Consequently, the Student’s t-test for paired samples was applied to compare pre- and post-test results for knowledge and practices, while the non-parametric Wilcoxon test was used for total scores.

The null hypothesis (H_0) stated that the educational intervention does not produce changes in nutrition knowledge among mothers from the Pan de Azúcar community kitchen in the district of San Martín de Porres, Lima – 2023. The alternative hypothesis (H_1) proposed that the educational intervention does produce changes in such knowledge. The decision rule established the rejection of H_0 when the significance value was less than 0.05.

As shown in Figure 2, the educational intervention demonstrated a positive impact on participants’ knowledge. Of the total sample, 42 participants (97.7%) showed positive ranks after the intervention, no negative ranks were recorded, and only one tie was observed.

Table 4.
Effect of the intervention on knowledge

Ranks	n	Mean rank	Sum of rank
Knowledge 2 – Negative ranks	0 ^a	.00	.00
Knowledge 1 – Positive ranks	42 ^b	21.50	903.00
Ties	1 ^c		
Total	43		

a. Knowledge 2 < Knowledge 1

b. Knowledge 2 > Knowledge 1

c. Knowledge 2 = Knowledge 1

The educational intervention showed a positive impact on the participants’ knowledge. Of the total, 42 (97.7%)

presented positive ranks after the intervention; one tie was recorded and no negative ranks were observed.

Table 5.
Effect of the intervention on practice

Ranks	n	Mean rank	Sum of rank
Practice 2 – Negative ranks	1 ^a	6.50	6.50
Practice 1 – Positive ranks	41 ^b	21.87	896.50
Ties	1 ^c		
Total	43		

CONCLUSIONS

The educational intervention implemented among mothers from the Pan de Azúcar community kitchen, located in the district of San Martín de Porres, Lima (2023), proved to be effective in generating positive and statistically significant changes in the participants’ nutritional knowledge and practices ($p < 0.05$). The vast majority of participants showed improvements after the intervention, while a small group maintained their previous level, with no regressions observed.

These findings allow us to conclude that the applied educational strategy constitutes a useful tool for strengthening both knowledge and practice of healthy eating habits in community contexts. The results support the importance of continuing to promote this type of intervention, as they contribute to improving nutritional education and, consequently, may enhance the health status of populations in vulnerable situations.

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RECOMMENDATIONS

It is suggested that the district mayor consider the incorporation of nutrition professionals within social food assistance programs, in order to provide theoretical–practical support through educational interventions aimed at all beneficiaries, thereby contributing to the optimization of their nutritional status.

Program administrators are recommended to organize periodic meetings supported by didactic materials, with the purpose of reinforcing the knowledge acquired, keeping it up to date, and including newly enrolled mothers, while addressing their questions at the theoretical level.

Finally, mothers are advised to coordinate quarterly strategic meetings with nutrition professionals, which would allow for strengthening the practical application of knowledge, correcting errors, and promoting the proper preparation of foods from a practical and healthy perspective.

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Author Contribution Statement

- Karen V. Quiroz–Cornejo: Conceptualization; methodology and project administration.
- Candy L. Luyo–Veliz: Methodology; statistics, and review and editing.
- Rosa L. Gurmendi–Remón: Data analysis and original draft preparation.

Taste and smell in the perception of restaurant diners in Lima

El gusto y olfato en la percepción del comensal de un restaurante de Lima

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ABSTRACT

The objective of this study was to determine the influence of taste and smell on diners' perceptions in a restaurant in Lima, focusing on two emblematic dishes of Peruvian gastronomy: arroz con pato (duck with rice) and ceviche caliente (hot ceviche). The research was conducted under a quantitative approach, with a correlational and cross-sectional design. The sample consisted of 378 diners from Fiesta Restaurant, selected using a finite population formula with a 95% confidence level. Data were collected through a structured eight-question digital questionnaire, and results were analyzed using descriptive and inferential statistics. Findings indicate that 97% of respondents considered aroma an important factor during dish tasting, while 100% identified taste as a decisive element in their dining experience. Additionally, 66% reported a very high level of perception related to taste, and 52% expressed a high perception regarding aroma. These results confirm that taste and smell are closely linked in shaping gastronomic experiences, reinforcing the theoretical contributions of neurogastronomy and gastrophysics. The study provides empirical evidence in the Peruvian context, highlighting the relevance of sensory dimensions in culinary evaluation and suggesting that restaurants may design multisensory strategies to enhance customer satisfaction and strengthen gastronomic innovation.

Keywords: Perception, gastrophysics, smell, taste, neurogastronomy.

RESUMEN

El presente estudio tuvo como objetivo determinar la influencia del gusto y el olfato en la percepción del comensal en un restaurante de Lima, tomando como referencia dos platos emblemáticos de la gastronomía peruana: el arroz con pato y el ceviche caliente. La investigación se desarrolló bajo un enfoque cuantitativo, con diseño correlacional y de corte transversal. La muestra estuvo compuesta por 378 comensales del restaurante Fiesta, seleccionados mediante fórmula para poblaciones finitas con un nivel de confianza del 95



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%). El instrumento de recolección fue un cuestionario estructurado de ocho preguntas, aplicado en formato digital, cuyos resultados se analizaron con estadística descriptiva e inferencial. Los hallazgos indican que el 97 % de los encuestados consideró importante el aroma en la degustación de los platos, mientras que el 100 % valoró el sabor como factor determinante en su experiencia culinaria. Asimismo, el 66 % reportó un nivel de percepción muy alto en relación con el sabor, y el 52 % manifestó una percepción alta respecto al aroma. Estos resultados confirman que los sentidos del gusto y el olfato se encuentran estrechamente vinculados en la construcción de experiencias gastronómicas, aportando evidencia para el desarrollo de estrategias multisensoriales en restaurantes y contribuyendo al campo de la neurogastronomía y la gastrofísica.

Palabras clave: Percepción, gastrofísica, olor sabor, neurogastronomía.

INTRODUCTION

A culinary experience is the reflection of a complex process in which multiple sensory stimuli intervene, ultimately impacting the diner's perception. While taste is the traditional sense associated with food, research conducted in recent years has shown that the evaluation of a dish does not depend exclusively on the basic flavors, but on the simultaneous interaction of other senses such as smell, sight, touch, and even hearing. In this context, neurogastronomy and gastrophysics have gained greater relevance as means to analyze the impact that sensory stimuli have within gastronomic perception, allowing an explanation of why the same dish can be perceived differently depending on the context in which it is consumed.

Among the senses involved, taste and smell occupy a central place in the construction of this perception. Physiology demonstrates that both are closely linked through the tongue, as is olfactory memory, which is responsible for associating aromas with previous experiences. Spence (2017) maintains that smell contributes to generating lasting emotional memories, while García (2018) asserts that the brain simultaneously integrates gustatory and

olfactory signals to produce a comprehensive perception of food. This multisensory interaction explains why, in the absence of smell, taste is perceived in a limited way.

Various international studies support this perspective. Castany (2017) demonstrated that factors such as music, colors, and aromas present in a restaurant can modify the perception of the flavor of the same dish. Similarly, Duran-Badillo *et al.* (2020) confirmed the complementary relationship between smell and taste in food perception, concluding that the absence of one significantly reduces sensory evaluation. Villanueva (2017) evidenced that aromas are part of sensory marketing strategies in the gastronomic industry, having a direct influence on customer satisfaction and loyalty. These findings help to understand that gastronomic perception is a multisensory phenomenon in which physiological, psychological, and environmental factors all intervene.

In the Peruvian context, gastronomy is consolidated as an element of cultural identity and a driver of tourism development, recognized worldwide today. This positioning has led restaurants to seek differentiation not only through the quality

of their ingredients but also through their ability to create memorable experiences by stimulating the senses. Understanding the role of taste and smell in the diner's perception is fundamental to improving the gastronomic offer of our country and meeting the expectations of an increasingly demanding public.

The present research was conducted at the Fiesta restaurant in Lima, specialized in gourmet Chiclayo cuisine, which represents a significant space for the analysis of multisensory culinary experiences. The study aimed to determine the relationship between taste and smell in the diner's perception, identify the evaluation of the senses during tasting, and analyze perception differences according to age and gender. Thus, the research seeks to provide empirical evidence for Peruvian gastronomy, generating knowledge easily applicable in the field by students, entrepreneurs, researchers, and restaurant managers interested in designing innovative and memorable experiences.

MATERIALS AND METHODS

Methodological design

The model used is a quantitative correlational research design. According to Babativa (2017), this research model is used to find the relationship between two variables, in this case between taste and smell with respect to the level of diner perception. On the other hand, the design employed is a non-experimental cross-sectional one, since data collection occurs at a single point in time, with the study sample encompassing different ages.

Object and study site

The study was carried out at the Fiesta-Lima restaurant, which operates under the concept of gourmet Chiclayo

cuisine. Two dishes from the menu were selected to evaluate the level of diner perception. The dishes studied were arroz con pato (duck with rice) and ceviche caliente (hot ceviche).

Data collection technique

After evaluating the optimal moment to apply the data collection instrument, a survey was chosen. The survey included both open and closed questions to obtain the necessary information for the present research.

Data analysis

Regarding the procedure, the techniques used for information analysis included statistical analysis through correlation coefficients. The survey was administered via Google Forms, allowing diners to access the corresponding link and complete it with the requested data.

After administering the survey, the results were tabulated in spreadsheets, where in a first review cases with incomplete information or incoherent responses were eliminated. The data are presented through frequency distribution tables, bar graphs, or pie charts with their respective interpretations. Subsequently, inferential statistics were applied along with hypothesis testing to verify the research hypotheses, considering a two-tailed significance level of less than 0.05.

Population

The Fiesta restaurant has 23,040 annual diners, according to information provided by the establishment and taking into account comparative data from previous years.

Sample

To establish the sample, the formula for small populations was used, with a con-

confidence level of 95%, employing a probability in favor of 0.5, a probability against of 0.5, and a maximum error of 5%.

$$n = \frac{p * q * N * Z^2}{e^2 * N + p * q * Z^2}$$

N = Population size

Z = Confidence level

e = Maximum allowable error

p = q = Population variance

Solution:

N = 23,040

Z = 95% = 1.96

e = 5% = 0.05

p = 0.5

q = 0.5

$$n = \frac{0.5 * 0.5 * 23040 * 1.96^2}{0.05^2 * 23040 + 0.5 * 0.5 * 1.96^2} = 378$$

The result obtained shows that for the present research, the sample will consist of 378 diners.

RESULTS AND DISCUSSION

For this study, which aims to determine the diner's perception when tasting an arroz con pato or a ceviche caliente, associated with taste and smell at Fiesta-Lima restaurant, 378 diners were surveyed, of whom 59% were men and 41% women, of various ages.

The results obtained from the survey were as follows:

Table 1.
Dish ordered at Fiesta restaurant by gender

Dish	Gender – Dish Ordered				Total	Percentage
	Female	Percentage	Male	Percentage		
Arroz con pato (Duck with rice)	101	66 %	136	61 %	237	63 %
Ceviche caliente (Hot ceviche)	33	21 %	67	30 %	100	26 %
Other	20	13 %	21	9 %	41	11 %
Total	154	100 %	224	100 %	378	100 %

Table 1 shows that 63% of the diners ordered duck with rice, while 26% ordered the hot ceviche, and finally, a minority ordered another dish.

In Table 2, it can be observed that 52% of the diners at the restaurant had a high level of aroma perception, meaning

that the dish they ordered was very aromatic.

Table 3 shows that 66% of the restaurant attendees had a very high level of taste perception while tasting their dish, and 56% of the 249 people who reported a very high taste perception were male.

Table 2.
Diner's aroma perception level during tasting by gender

Level of perception	Gender – Aroma perception					
	Female	Percentage	Male	Percentage	Total	Percentage
Very high	68	44 %	53	24 %	121	32 %
High	69	45 %	129	58 %	198	52 %
Neutral	15	10 %	41	18 %	56	15 %
Low	1	1 %	1	0 %	2	1 %
Very low	1	1 %	0	0 %	1	0 %
Total	154	100 %	224	100 %	378	100 %

Table 3.
Diner's taste perception level during tasting by gender

Level of perception	Gender – Taste perception					
	Female	Percentage	Male	Percentage	Total	Percentage
Very high	109	71 %	140	63 %	249	66 %
High	36	23 %	74	33 %	110	29 %
Neutral	8	5 %	10	4 %	18	5 %
Low	0	0 %	0	0 %	0	0 %
Very low	1	1 %	0	0 %	1	1 %
Total	154	100 %	224	100 %	378	100 %

In Table 4, it can be seen that among the respondents who chose duck with rice, 234 had a high or very high perception, representing 98.73% of the respondents in that group. Among those who chose hot ceviche, 70 had a high or very high perception, representing exactly 70% of that group.

For respondents who chose other dishes, 15 had a high or very high perception, representing 36.59% of that group, 56.10% had a neutral perception, and only

7.31% had a low or very low aroma perception.

In Table 5, the group that chose duck with rice, 100% had a high or very high taste perception. Similarly, respondents who chose hot ceviche also showed 100% high or very high taste perception. Finally, among those who chose other dishes, 53.66% had a high or very high taste perception, 43.90% had a neutral perception, and the rest had a very low taste perception.

Table 4.
Aroma perception level according to the dish chosen

Aroma perception - Chosen dish						
Dish	Very high	High	Neutral	Low	Very low	Total
Arroz con pato (Duck with rice)	111	123	3	0	0	237
Ceviche caliente (Hot ceviche)	7	63	30	0	0	100
Other	3	12	23	2	1	41
Total	121	198	56	2	1	378

Table 5.
Taste perception according to the dish chosen

Taste perception – Chosen dish						
Dish	Very high	High	Neutral	Low	Very low	Total
Arroz con pato (Duck with rice)	206	31	0	0	0	237
Ceviche caliente (Hot ceviche)	38	62	0	0	0	100
Other	5	17	18	0	1	41
Total	249	110	18	0	1	378

Inferential Analysis

Hypothesis Testing

In the descriptive analysis, it was observed that the majority of respondents had a high or very high perception level regarding the tasting of duck with rice and hot ceviche. Therefore, in this section, it is tested whether this characteristic holds for the population.

Aroma perception level in the tasting of duck with rice

H0: The population proportion of diners who consider their aroma perception when tasting duck with rice to be high or very high is equal to 80%.

H1: The population proportion of diners who consider their aroma perception when

tasting duck with rice to be high or very high is greater than 0%.

Using a 95% confidence level for a one-tailed test with the normal distribution, the acceptance region will be:

$$R.A. = < -\infty ; 1.64 >$$

To perform the test, we have $n = 237$, $\pi_0 = 0.5$, and $x = 234$. The test statistic used was z_c and was obtained as follows:

H0: The population proportion of diners who consider their aroma perception when tasting hot ceviche to be high or very high is equal to 50%.

H1: The population proportion of diners who consider their aroma perception when tasting hot ceviche to be high or very high is exceeds 50%

Using a 95% confidence level for a one-tailed test with the normal distribution, the acceptance region will be:

$$R.A. = < -\infty ; 1.64 >$$

To perform the test, we have $n=100$, $\pi_0=0.5$, and $x=70$. The test statistic used was z_c and was calculated as follows:

$$Z_c = \frac{x - n\pi_0}{\sqrt{n\pi_0(1 - \pi_0)}} = \frac{70 - 100 * 0.5}{\sqrt{100 * 0.5(1 - 0.5)}} = 4$$

4 does not fall within the acceptance region. Therefore, H0 is rejected.

In conclusion, there is statistically significant evidence to affirm that the population proportion of diners who consider their aroma perception when tasting hot ceviche to be high or very high is greater than 50%.

Taste perception level in the tasting of duck with rice

H0: The population proportion of diners who consider their taste perception when

tasting duck with rice to be high or very high is equal to 50%.

H1: The population proportion of diners who consider their taste perception when tasting duck with rice to be high or very high is greater than 50%.

To perform the test, we have $n = 237$, $\pi_0 = 0.5$, and $x = 237$. The test statistic used was z_c and was obtained as follows:

$$Z_c = \frac{x - n\pi_0}{\sqrt{n\pi_0(1 - \pi_0)}} = \frac{237 - 237 * 0.5}{\sqrt{237 * 0.5(1 - 0.5)}} = 15.39$$

15.39 does not fall within the acceptance region. Therefore, H0 is rejected.

The statistical evidence supports the claim that more than 50% of diners perceive the taste of duck with rice as high or very high. In other words, there is strong evidence to affirm that the majority of people who taste this dish experience a favorable gustatory perception.

Taste perception level in the tasting of hot ceviche

H0: The population proportion of diners who consider their taste perception when tasting hot ceviche to be high or very high is equal to 50%.

H1: The population proportion of diners who consider their taste perception when tasting hot ceviche to be high or very high is greater than 50%.

Using a 95% confidence level for a one-tailed test with the normal distribution, the acceptance region will be:

$$R.A. = < -\infty ; 1.64 >$$

To perform the test, we have $n = 100$, $\pi_0 = 0.5$, and $x = 100$. The test statistic used was z_c and was obtained as follows:

$$Z_c = \frac{x - n\pi_0}{\sqrt{n\pi_0(1 - \pi_0)}} = \frac{100 - 100 * 0.5}{\sqrt{100 * 0.5(1 - 0.5)}} = 10$$

10 does not fall within the acceptance region. Therefore, H_0 is rejected.

In conclusion, there is statistically significant evidence to affirm that the population proportion of diners who consider their taste perception when tasting hot ceviche to be high or very high is greater than 50%.

Specific Hypothesis

H_0 : The population proportion of diners who prefer duck with rice is equal to 50%.

H_1 : The population proportion of diners who prefer duck with rice is greater than 50%.

Using a 95% confidence level for a one-tailed test with the normal distribution, the acceptance region will be:

$$R.A. = < -\infty ; 1.64 >$$

To perform the test, we have $n=237$, $\pi_0=0.5$, and $x=378$. The test statistic used was z_c and was calculated as follows:

$$Z_c = \frac{x - n\pi_0}{\sqrt{n\pi_0(1 - \pi_0)}} = \frac{237 - 378 * 0.5}{\sqrt{378 * 0.5(1 - 0.5)}} = 4.94$$

4.94 does not fall within the acceptance region. Therefore, H_0 is rejected.

The results show that more than 50% of diners prefer duck with rice, as supported by statistically significant evidence.

According to Castany (2017) and García (2018), the chef must be concerned

with the experience they intend to provide to the diner, from the moment they enter the restaurant, while tasting the dishes, until they leave. Gastronomy is a combination of several factors; it is not just about cooking dishes, but also about knowing which tableware to use, the restaurant's decoration, background music, etc.

CONCLUSIONS

Based on the results, the general objective of this study was to determine the diner's perception when tasting duck with rice or hot ceviche, associated with taste and smell. The specific objective was identifying the dish most consumed by customers at Fiesta-Lima restaurant.

The results indicate that diners' perception when tasting duck with rice or hot ceviche was positive, as shown in Tables 4 and 5, where restaurant attendees have a high or very high level of perception when tasting the dishes considered in the study. The hypothesis test shows that for both duck with rice and hot ceviche, the levels of aroma and taste are very high or high, exceeding 50%.

Duck with rice is the most requested dish at Fiesta restaurant, as evidenced in Table 1, where 63% of diners chose this option. Accordingly, the hypothesis test determined that there is statistically significant evidence that the population proportion of diners who prefer duck with rice is greater than 50%.

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Author Contribution Statement

- Sofía Cordova: Methodology; statistics; review and editing.
- Nanette Feraldo-Remón: Data analysis and original draft.
- Roberto Pastor: Conceptualization; methodology; project administration.

Relationship between the pattern of consumption of nutritional supplements and the degree of bigorexia in bodybuilders of Metropolitan Lima

Relación entre el patrón de consumo de suplementos nutricionales y grado de vigorexia en fisicoculturistas de Lima Metropolitana

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ABSTRACT

In the world of bodybuilding, there is a high prevalence of muscle dysmorphia due to the pressure that participants in this discipline are exposed to strict diets, long training sessions, and the use of ergogenic aids can trigger an obsession that can negatively impact an individual's psychosocial well-being. The objective of this research was to determine the relationship between the pattern of nutritional supplement consumption and the degree of muscle dysmorphia in bodybuilders from metropolitan Lima. The study followed a non-experimental, correlational, prospective, cross-sectional design. The sample consisted of 30 bodybuilders from metropolitan Lima who were administered the "Adonis Complex Questionnaire" to determine their degree of muscle dysmorphia and the "Nutritional Supplement Pattern Questionnaire." All bodybuilders presented some degree of muscle dysmorphia: 53% moderate, 30% severe, 10% pathological, and 7% mild. All participants consumed nutritional supplements, primarily creatine (57%) and protein powder (54%). However, no statistically significant relationship was observed between supplement consumption patterns and the degree of muscle dysmorphia in bodybuilders from metropolitan Lima.

Keywords: Muscle dysmorphia, supplementation, bodybuilding.

RESUMEN

En el mundo del fisicoculturismo se presenta una alta prevalencia de vigorexia debido a la presión que los participantes de esta disciplina se someten. Las dietas estrictas, sesiones largas de entrenamiento y el consumo de ayudas ergogénicas pueden desencadenar una obsesión que puede influir negativamente en el área psico-social del individuo. El objetivo de la investigación fue determinar la relación entre el patrón de consumo de suplementos



nutricionales y el grado de vigorexia en fisicoculturistas de Lima Metropolitana. El enfoque de la investigación fue cuantitativo no experimental de tipo correlacional y transversal prospectivo. La muestra estuvo conformada por 30 fisicoculturistas de Lima a quienes se les aplicó el “Cuestionario Complejo de Adonis” para conocer el grado de vigorexia y el “Cuestionario del patrón de consumo de suplementos nutricionales”. Todos los fisicoculturistas presentaron algún grado de vigorexia, 53 % grado moderado, 30 % grado grave, 10 % grado patológico y 7 % grado leve. Todos consumían suplementos nutricionales, principalmente creatina (57 %) y proteína en polvo (54 %). Sin embargo, se observó que no existe relación estadísticamente significativa entre el patrón de consumo de suplementos y el grado de vigorexia en fisicoculturistas de Lima metropolitana.

Palabras claves: Vigorexia, suplementación, fisicoculturismo.

INTRODUCTION

Muscle dysmorphia, also known as bigorexia, is a subtype of body dysmorphic disorder characterized by a pathological concern about insufficient musculature and physical appearance (American Psychiatric Association, 2014). This condition primarily affects young males and is associated with excessive exercise behaviors, restrictive diets, and the use of supplements or anabolic substances (Cooper *et al.*, 2020).

Previous studies have reported low prevalence rates of bigorexia in the general population, but higher rates among individuals who engage in strength training and bodybuilders (Cooper *et al.*, 2020). Recent research has identified an association between the consumption of muscle-gain supplements and higher scores in muscle dysmorphia (Ganson *et al.*, 2024).

Bodybuilding is a sport that requires consistency, effort, discipline, and sacrifice. It is based on the pursuit of muscular hypertrophy through methodical anaerobic training supported by scientific principles to increase muscle mass symmetrically, accompanied by a strictly calculated diet (Villavicencio, 2018). To improve performance in competitions, nutritional supplements are frequently used, which are optimal

when combined with a dietary regimen to achieve specific nutrient goals and enhance athletic performance. However, supplements with limited scientific evidence are also commonly consumed, which is common among those practicing fitness sports (Moradi *et al.*, 2024).

Nutritional supplements are classified annually by the Australian Institute of Sport (AIS, 2021) into four groups (A, B, C, and D) to evaluate the scientific evidence supporting ergogenic aids distributed in gyms and retail outlets. Group A includes supplements classified as safe for athletes with strong scientific evidence supporting their performance benefits. Group B includes supplements considered safe for athletes but lacking sufficient scientific backing. Group C includes supplements that do not provide benefits for athletes after thorough study. Finally, Group D includes supplements prohibited for athlete use due to a high risk of contamination with substances that may yield a positive result in anti-doping tests (AIS, 2021).

Given the pressure to achieve expected performance outcomes, this study aims to determine the relationship between the pattern of nutritional supplement con-

sumption and the degree of bigorexia in bodybuilders in Metropolitan Lima.

MATERIALS AND METHODS

A non-experimental, cross-sectional, correlational, prospective study was conducted with bodybuilders who attended gyms in Metropolitan Lima in 2021. The study sample included 30 bodybuilders, selected through non-probabilistic convenience sampling. Inclusion criteria included an age range of 18–50 years, gym attendance in 2021, and participation in bodybuilding competitions. Individuals who did not wish to participate were excluded.

Data were collected through a virtual survey administered via Google Forms, after obtaining informed consent. The degree of bigorexia was assessed using the “Adonis Complex Questionnaire” validated by Latorre-Román *et al.* (2015), which measures bigorexia scores as follows: mild bigorexia from 0 to 9 points, moderate from 10 to 19, severe from 20 to 29, and pathological from 30 to 39.

To determine the supplements consumed and the purpose of their consumption, the “Nutritional Supplement Consumption Pattern” questionnaire validated by Gómez (2017) was applied. Based on the responses, supplements were classified according to the AIS 2021 categories: A, B, C, and D.

The data obtained were processed using the SPSS (Statistical Package for the Social Sciences) software, version 25, through descriptive statistics. To assess the relationship between the study variables in their categorical form, Fisher’s exact test was used with a significance level of 0.05.

RESULTS AND DISCUSSION

After analyzing the data, it was observed that all participants were male. As shown in Table 1, half were in the 18 to 30-year age range, mainly students, while the other half were between 31 and 50 years old and, in addition to bodybuilding, were employed.

Table 1.
Age Range and Employment Status of Bodybuilders

Age	Occupation	n	%
18 - 30	Worker	5	17
	Student	10	33
31- 50	Worker	15	50
	Student	0	0
	Total	97	100

Table 2.
Degree of Bigorexia According to the Adonis Complex Questionnaire in Bodybuilders

Degree of Bigorexia	n	%
Low degree	2	7
Moderate degree	16	53
Severe degree	9	30
Pathological degree	3	10
Total	30	100

In Table 2, it is shown that all surveyed bodybuilders exhibited some degree of bigorexia, with moderate bigorexia being the most common at 53%, while mild bigorexia accounted for only 7%. In the study by Devrim *et al.* (2018), which involved a larger population of bodybuilders, more than half (58%) were found to have bigorexia, without specifying the degrees. Similarly, when compared with studies of gym users who are not bodybuilders, the results differ. This is reflected in Hinojosa (2020),

whose work showed that the prevalence of bigorexia in gyms was low, reaching only 1.5%. This can be explained by the fact that, although performance is a key factor in most sports, in bodybuilding it is not necessarily so, as it is not only about performance but also about appearance (Lambert, 2004). Both competitive and non-competitive bodybuilders are vulnerable due to the obsession with being more muscular and leaner (Cafri, 2008).

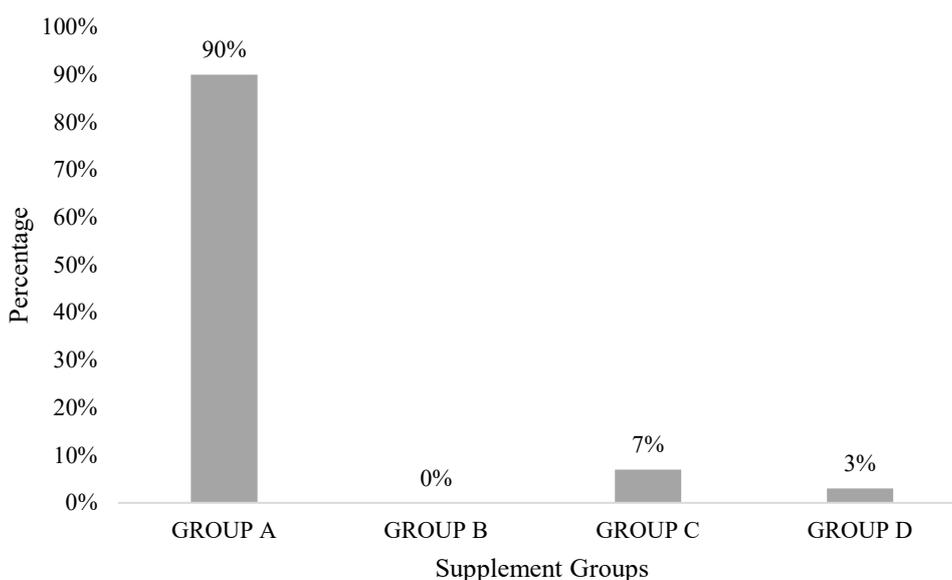


Figure 1. Percentage Distribution of Consumed Supplement Groups

In Figure 1, it can be seen that bodybuilders have a higher consumption of Group A supplements, which is consistent with the fact that this group includes supplements with the strongest scientific evidence. This group includes proteins, vitamins and minerals, creatine, meal replacements, caffeine, carbohydrates, and guarana among the options in the survey applied in the present study. On the other hand, no participant reported consuming Group B supplements. In the study by Bermúdez (2023), most participants consumed

nutritional supplements from Group A, highlighting protein as the most consumed (38.3%), followed by creatine (36.2%), and to a lesser extent, multivitamins (8.5%) and caffeine (2%). These findings also align with those in the present study, as shown in Table 3, where creatine and protein powder were the most consumed. Creatine is known for its ability to improve athletic performance, while protein powder helps achieve the recommended daily protein intake, thus promoting muscle mass gain.

Table 3.
Supplements Consumed by Bodybuilders

Type of supplements	n	%
Creatine	17	57
Protein en Powder	15	50
Hydroxycitric Acid	1	4
Arginine	2	8
Vitamins y Minerals	1	4
Total	30	100

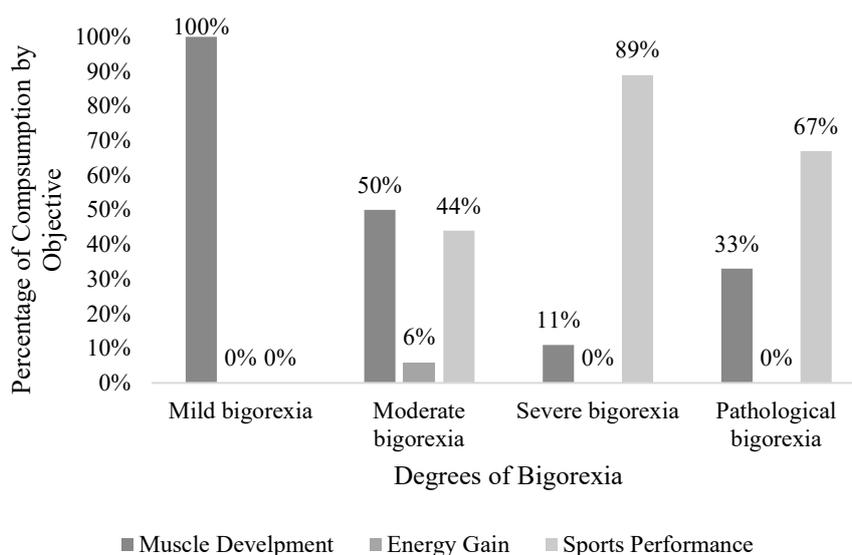


Figure 2. Objectives of Supplement Consumption According to Degree of Bigorexia

Table 4.
Fisher's Exact Test for Objectives and the Adonis Complex Questionnaire

	Value	Df	Asymptotic Significance (Two-tailed)	Exact Significance (Two-tailed)
Pearson Chi-Square	8.292	6	0.217	0.233
Likelihood Ratio	9.798	6	0.133	0.128
Fisher's Exact Test	9.564			0.107
Linear-by-Linear Association	4.626	1	0.031	0.039
Number of Valid Cases	30			

When examining the relationship between degrees of bigorexia and the objectives of supplement consumption, Figure 2 reveals heterogeneous patterns. Among participants with mild bigorexia, all participants identified muscle mass development as their primary objective. By contrast, in the moderate bigorexia group, this goal was observed in only 50% of the participants, whereas the remaining participants prioritized sports performance, followed to a lesser extent by supplement consumption aimed at increasing energy levels.

Among individuals with severe and pathological bigorexia, the primary objective was improving sports performance, placing other objectives in a secondary position. According to Fisher's exact test ($p = 0.107$), there is no statistically significant relationship between the objectives of supplement consumption and the degrees of bigorexia.

These findings are consistent with observations reported in previous studies. For example, Alejo (2021) notes that individuals with more severe degrees of bigorexia often prioritize sports performance due to a distorted perception of physical self-efficacy, which may explain the higher prevalence of this objective in the severe and pathological bigorexia groups. Meanwhile, Gauciry (2019) found that muscle mass development is the predominant goal in men with mild degrees of bigorexia, which aligns with the results of this study. This pattern may be explained by the fact that, in the early stages of bigorexia, associated behaviors are more focused on aesthetic improvement, whereas in more advanced stages the emphasis shifts toward physical performance and competitive achievement.

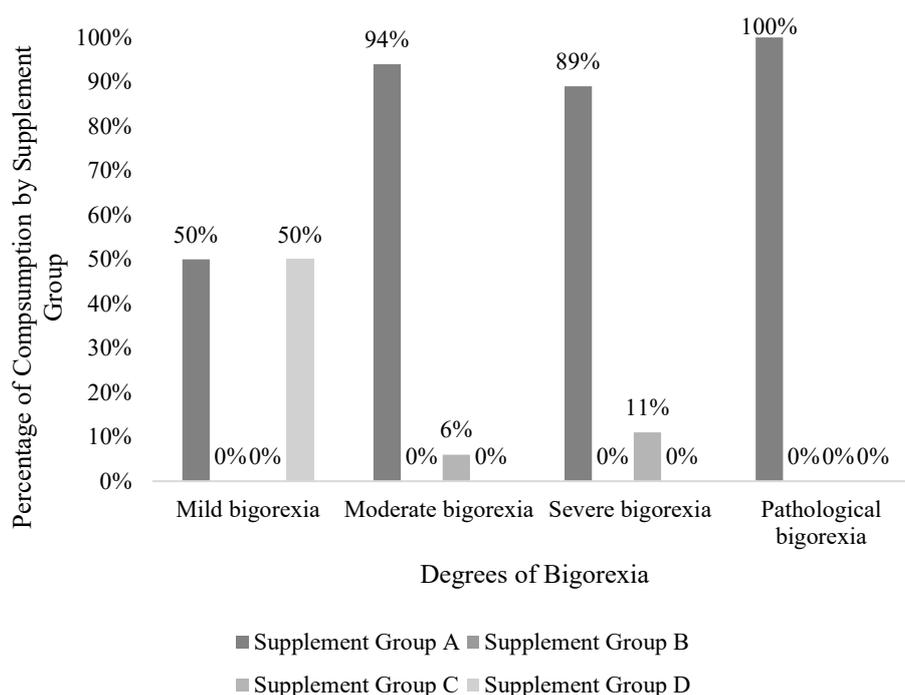


Figure 3. Consumption of Supplement Groups According to Degree of Bigorexia

Table 5.

Fisher's Exact Test for Supplement Group and the Adonis Complex Questionnaire

	Value	Df	Asymptotic Significance (Two-tailed)	Exact Significance (Two-tailed)
Pearson Chi-Square	15.019	6	0.020	0.089
Likelihood Ratio	6.791	6	0.341	0.249
Fisher's Exact Test	8.385			0.220
Linear-by-Linear Association	1.768	1	0.184	0.171
Number of Valid Cases	30			

Figure 3 shows that Group A supplements were the most frequently used among participants, with 100% of participants in the pathological degree reporting their use, whereas use among the mild degree group reached 50%, lower than the aforementioned group. In contrast, participants in the mild group were the only ones

who reported the use of Group D supplements (50%), whereas the other groups did not consume any (0%). Regarding Group C supplements, the moderate and severe groups were the highest consumers at 6% and 11%, respectively, compared to the mild and pathological groups, who did not consume them. This shows that Group A

is the supplement group most consumed by respondents, across all degrees of bigorexia. According to Fisher's exact test ($p = 0.220$), no statistically significant association was identified between supplement group consumption and degrees of bigorexia. To date, no other study has investigated the degree of bigorexia with the different supplement groups as classified by the Australian Institute of Sport. However, in the study by Gonzales *et al.* (2021), when analyzing the relationship between supplement consumption and bigorexia, it was shown that supplement consumption is an independent variable from the risk of developing bigorexia. Although available evidence remains limited, due to the characteristics of Group A supplements, they

were the most chosen for consumption in our study, likely because they have stronger scientific evidence supporting their use.

CONCLUSIONS

The results reveal that there is no statistically significant relationship between supplement consumption patterns and the degree of bigorexia among bodybuilders in Metropolitan Lima. However, bigorexia was identified in all participating bodybuilders at different degrees, with moderate bigorexia being the most prevalent. Additionally, all bodybuilders in the study consume nutritional supplements, with creatine and protein powder being the most consumed, belonging to Category A, which has the strongest scientific evidence according to the AIS classification.

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- Luis A. Fajardo: Data analysis and original draft.
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Strategic profile of market orientation for micro, small, and medium-sized enterprises

Perfil estratégico de orientación al mercado para micro, pequeñas y medianas empresas

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ABSTRACT

The approval of new forms of management in Cuba contributes to boosting the business sector through the emergence of Micro, Small and Medium Enterprises (MSMEs). Knowledge of the market is essential for the development of MSMEs to meet customer needs and demands, with the optimal use of available capabilities. Therefore, the objective of this research was to design a market-oriented strategic profile for MSMEs. A mixed-methods approach was used, along with a systematic review in Scopus, SciELO, Google Scholar, SCISPACE, Redalyc, and Dialnet to identify gaps in market orientation models for MSMEs. A market-oriented strategic profile for MSMEs was developed as a user-friendly tool that allows them to work on key aspects to position themselves in the market. It was applied in the MSME SolCaleb, legally constituted as a Sociedad Unipersonal de Responsabilidad Limitada (SURL, a limited liability entity similar to an LLC) where a medium position was identified, based on market participation, brand preference, and customer retention. The results showed that market orientation not only boosts competitiveness but also fosters innovation and adaptability in a constantly changing business environment. The market-oriented strategic profile for MSMEs allows for ongoing diagnostics to create strategies that improve their positioning and thereby boosting the business sector in Cuba.

Keywords: Market, MSMEs, market orientation, strategic profile.

RESUMEN

La aprobación de nuevas formas de gestión en Cuba contribuye a impulsar el sector empresarial con la aparición de Micro Pequeñas y Medianas Empresas (MIPYME). Resulta imprescindible para el desarrollo de las MIPYME, el conocimiento del mercado al satisfacer las necesidades y demandas de los clientes, con un máximo aprovechamiento



de las capacidades disponibles, por lo que el objetivo de la presente investigación es diseñar un perfil estratégico de orientación al mercado para las MIPYME. Se empleó un método mixto, así como una revisión sistemática en Scopus, SciELO, Google académico, SCISPACE, Redalyc y Dialnet para identificar brechas en modelos de orientación al mercado para empresas. Se desarrolló un perfil estratégico de orientación al mercado para MIPYME, herramienta de fácil aplicación que les permita trabajar aspectos claves para posicionarse en el mercado. Se aplicó en la MIPYME SURL SolCaleb, donde se identificó una posición media, por la participación en el mercado, la preferencia de la marca y la retención de los clientes. Con los resultados de la investigación se evidenció que una orientación al mercado no solo impulsa la competitividad, también fomenta la innovación y la adaptabilidad en un entorno empresarial en constante cambio. El perfil estratégico de orientación al mercado para MIPYME permite realizar diagnósticos constantes para crear estrategias que mejoren su posicionamiento y con ello el impulso al sector empresarial en Cuba.

Palabras clave: Mercado, MIPYME, orientación al mercado, perfil estratégico.

INTRODUCTION

The business economic environment exerts strong pressure on the continuity and development of companies due to economic globalization, market liberalization, continuous transformations and the uncertainty derived from them. The increase in competition, as well as the growing use of new information technologies, have become key elements for improving performance and, consequently, achieve survival.

Small and medium-sized enterprises (SMEs) are defined as a type of company with distinctive characteristics, having dimensions with occupational and financial limits pre-established by states or regions (Westreicher, 2020). They are also recognized under the term micro, small, and medium-sized enterprises (MSMEs), which extends the original term to include microenterprises.

At the global level, MSMEs are widely regarded as a highly productive sector in a country's economy and regards them as a priority for economic growth due to their impact in both developed and develop-

ping countries. Growing, developing, and sustaining themselves is a daily challenge in a dynamic environment that requires strategies to achieve business development.

MSMEs account for approximately 90% of firms, up to 70% of employment, and 50% of the Gross Domestic Product (GDP). In Latin America, they make up 98% of the business fabric and generate 61% of employment. Moreover, only at the MSME level is more than 67% of formal employment generated, making their existence and sustainability critical for socio-economic development (Souza & Abreu, 2024).

The establishment of these entities leads to a more flexible restructuring of the national economy, aligned with the productive and service activities of each region of the archipelago. With the creation of these small enterprises, the channeling of productive linkages is promoted and the strategic development design is reinforced.

In Cuba, by July 2024, 11,044 private MSMEs and only 222 state MSMEs

had been approved as part of the strategy to stimulate the Cuban economy. These economic actors were created under the protection of new legislation, which promotes the participation of all sectors for the country's development (Dávila, 2024).

Many entrepreneurs have invested in creating an MSME, but in this tireless pursuit, limited experience and knowledge of essential aspects for their development have resulted in economic and productive difficulties that hinder their market positioning in the market for products and services.

The establishment and growth of micro, small, and medium-sized enterprises (MSMEs) in emerging economies constitute a complex phenomenon shaped by a series of determinants, encompassing internal capabilities, external contexts, and available opportunities.

Studies conducted by García *et al.* (2023) and López and Nicolás (2025) indicate that in the Americas and in Cuba, the failure rate in the first two years of MSME creation is high. They all agree that most were established empirically without prior feasibility or market studies.

In this context, Rodríguez *et al.* (2015) and Amiru (2024a) state that market orientation has been identified as a key factor for high business performance. This strategy allows anticipating market changes and responding more effectively, strengthening competitive advantage. Furthermore, it is part of the organizational culture and closely linked to business strategy, as it requires deep knowledge of the market and competition.

MSMEs struggle daily for their survival and adaptation to changing and uncertain postmodern contexts, which impose

constant challenges due to the versatility of their economic markets and human resources. Their development and sustainability are hindered by the lack of a strategic plan that allows them to set objectives both corporately and for each of their areas; and by the limited financial projection of small businesses in the medium and long term due to a lack of knowledge of the tools necessary for this task.

Therefore, the present research aims to design a strategic market orientation profile for MSMEs.

MATERIALS AND METHODS

A mixed-method approach was employed in this research. A systematic review was conducted in Scopus, SciELO, Google Scholar, SCISPACE, Redalyc, and Dialnet to identify gaps in market orientation models for companies. Subsequently, a strategic market orientation profile was developed and applied specifically for MSMEs.

The notion of market orientation has developed from the broader framework of marketing, which prioritizes understanding and meeting consumer demands. It is considered a practical application of the concept of marketing and a basis for a sustainable competitive advantage, which could result in better organizational performance; moreover, it represents a strategic approach in business that prioritizes the customer as the focal point of all organizational operations. This approach is considered essential to achieve both efficiency and effectiveness across the various sectors of organizations (Osugwu, 2019).

Market orientation represents a strategic framework that involves the commitment of companies to respond to and understand customer needs, competitive behaviors, as well as internal competen-

cies to improve organizational effectiveness. This framework includes three main dimensions or key components: customer orientation, competency orientation, and interfunctional coordination. This guidance is especially crucial for micro, small, and medium-sized enterprises (MSMEs), given its substantial impact on their operational effectiveness and flexibility in competitive markets, according to studies conducted by Amiru (2024b), Ortega *et al.* (2025).

The culture of market orientation is essential for marketing strategists seeking to achieve exceptional market performance. This process involves adopting principles such as customer-centric focus, empathy, and collaborative efforts, which significantly enhance the organization's capacity for innovation and the preservation of competitive advantages. Market orientation constitutes a strategic framework that prioritizes the customer as the focal point of all business operations. It is considered vital to achieve both efficiency and effectiveness in the various sectors of organizations (Kanagal, 2017).

The adoption of the market orientation concept is assumed from a dual cognitive and operational or behavioral perspective, as both are necessary and not mutually exclusive. This leads to the consideration of market orientation as an intangible resource, a skill, a capability, which provides the commitment and information necessary for the development of a value proposition that fully satisfies the needs and preferences of the target audience, thus becoming a source of sustainable competitive advantages that result in better and superior outcomes.

Market orientation alone is insufficient to guarantee a competitive advantage in challenging environments; an adaptive strategic framework is necessary to align

its fundamental principles with empirical circumstances, thereby transforming theoretical concepts into practical mechanisms for survival.

In Cuba, market orientation develops under particular conditions, marked by a mixed economic environment (with centralized elements and partial openings), and limitations in access to global markets. Despite these challenges, Cuban companies, both state-owned and private (self-employed and MSMEs), have adopted as a model of market orientation what is stipulated in Decree-Law No. 281 [Consejo de Ministros, (2013)]. Therefore, the marketing system is established as a modern conception in business management, guiding the mission and vision of entities by taking as a starting point the needs, desires, perceptions, preferences, and demands of society and customers, to design programs aimed at satisfying these needs and desires.

The development of strategic profiles functions as an analytical tool for companies to evaluate their internal competencies together with the dynamics of the external market, enabling informed decision-making and strategic planning.

The strategic profile is defined by its clarity and simple implementation. This attribute makes it easily available to decision-makers who need a quick assessment of their organization's strategic position without conducting excessively complex analyses (Sudarwanto, 2023).

Another study presents the development of strategic profiles as a methodology to create a strategic profile that encapsulates the coherence and congruence of strategic decisions across various functions within MSMEs. This methodological framework is essential to understand the de-

gree to which the strategies of all business functions are harmoniously integrated, thus ensuring that all components of the organization collectively strive to achieve unified objectives (Untoro and Kusmantini, 2020).

In response to the identified limitations, a strategic profile is proposed that not only evaluates traditional market orientation but also integrates dynamic capabilities to manage risks of MSMEs in emerging economies.

The proposed profile comprises eleven key components, including a characterization of the MSMEs with a brief analysis of market trends; the determination of the business value proposition according to the Canvas model, a visual tool that allows analyzing and creating business models from nine fundamental blocks, including the value proposition (Puga, 2022); it analyzes the profitability and flexibility

of the product or service portfolio; supplier reliability; competition, production costs, actual and potential customers, market expansion perspective; weaknesses, threats, strengths, and opportunities through the SWOT matrix; and market positioning, in which the market positioning index is calculated to quantitatively diagnose the real situation of the MSMEs.

Strategic Profile of Market Orientation for MSMEs:

This profile constitutes an easy-to-use tool, as it is not necessary to be a specialist in the subject to complete the data needed to diagnose the state of the MSMEs in its market orientation, and it provides key aspects to develop an effective strategy that allows the positioning of the company. In Figure 1, the cause-effect diagram of the Strategic Profile of Market Orientation for MSMEs is presented.

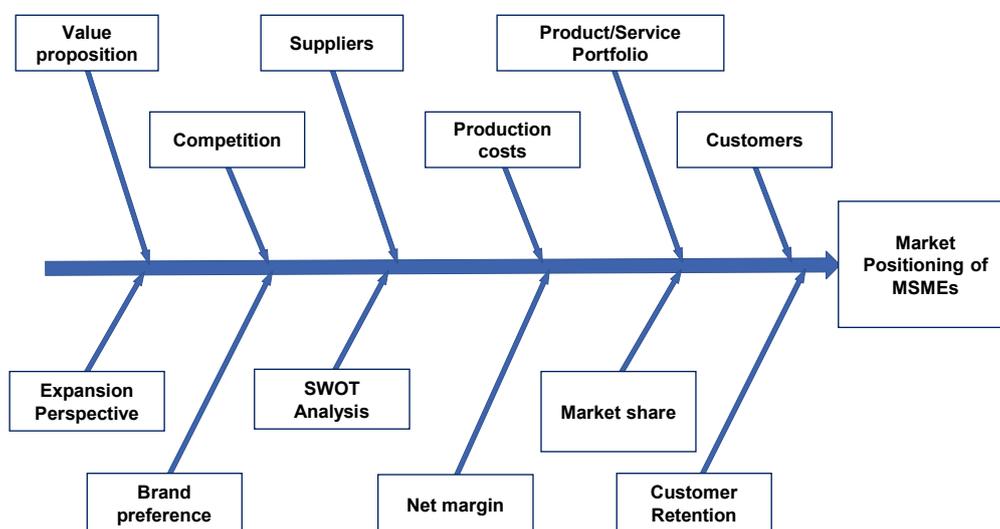


Figure 1. Cause-effect diagram of the strategic market orientation profile for MSMEs

1. General Information of the MSME (Structured approach with validation sources) (At this point, information about the MSME should be collected)

- Name, exact location, year of foundation.
- Economic activity according to the Nomenclature of Current Economic Activities (NAE), based on the United Nations' International Standard Industrial Classification (ISIC) Revision 3; (NIT and CNAE Code)
- Identified gap: Which unmet market need justifies the existence of the MSME? (e.g., lack of local suppliers, products with differentiating attributes).

2. Value Proposition (Canvas Model)

To apply the value proposition of the Canvas Model, it is necessary to determine the real needs of customers: identifying their tasks, frustrations, and joys, to propose a unique solution from the offered product or service that alleviates frustrations and creates joys.

3. Product/Service Portfolio (Focus on profitability and flexibility)

In this section, products will be classified according to contribution to sales and profits using the ABC method, also called Pareto Analysis or the 80/20 Rule (Castro & Salas, 2022), where products are grouped into three categories according to their importance:

- A (Critical): High impact (e.g., 20% of products generate 80% of sales).
- B (Intermediate): Moderate contribution.
- C (Minor): Low impact (e.g., 50% of products generate only 5% of sales).

For this analysis, data such as sales per product (units or money) and gross profit per product (sales – direct costs) is required.

Adaptation capacity: Using a scale of 1 to 5, determine how easy it is to migrate from traditional productions to new products (e.g., modular machinery, team skills).

Diversification opportunities: Based on trends (e.g., sustainability, customization, innovation).

4. Suppliers (Risk analysis and mitigation strategies)

- Identify critical inputs for the MSME's operation, evaluate the risks associated with each supplier, and define mitigation strategies to ensure business continuity.
- Suppliers will be evaluated using the criteria of Morgan and Strong (1998), Khan (2023), and Fernández (2024); Quality (Check standards and certifications), Cost (Compare options without compromising quality), Delivery times (Ensure timely fulfillment), as the most suitable for the study conducted.

To mitigate supplier risks, the following points should be reviewed:

- Identify at least 2 alternative suppliers in other areas.
- Review medium-term contracts to guarantee supply.
- Maintain safety stock.
- Negotiate penalty clauses for delays.
- Conduct quarterly supplier evaluations.

5. Competition

- Analyze producers offering the same or similar products in the geographical area of the actual and potential market where the products are offered; if it is a captive market, determine if you are the only one offering these products or if there are other producers offering the same or similar products.

- Variables for comparison: Price, quality, distribution, brand perception.

6. Production Costs

- At this point, it is essential to review the cost structure of each product or service offered: fixed and variable costs; compare them with competitors and determine the breakeven point.
- Fixed costs are expenses that do not vary with production level (CUP/month), such

as labor, rent, basic services (water, electricity), equipment maintenance, marketing and advertising, depreciation of machinery.

- Variable costs are expenses that depend on production volume (CUP), such as raw materials, packaging, energy or fuel for production.
- Multi-product breakeven point (multi-product BEP).

$$(1) \text{ Multi-product BEP} = (\text{Total Fixed Costs}) / (\text{Total Weighted Contribution Margin})$$

Where:

$$(2) \text{ Contribution Margin per product} = \text{Selling Price} - \text{Variable Cost}$$

$$(3) \text{ Total Sales} = \text{Sales A} + \text{Sales B} + \text{Sales C} + \text{Sales D}$$

$$(4) \text{ Participation Rate of A} = (\text{Sales of A}) / (\text{Total Sales})$$

$$(5) \text{ Weighted Contribution Margin of A} = (\text{CM of A}) \times (\text{Participation Rate of A})$$

$$(6) \text{ Total Weighted Contribution Margin} = (\text{WCM of A}) + (\text{WCM of B}) + (\text{WCM of C}) + (\text{WCM of D})$$

The break-even point is the capacity from which profits begin to be obtained; at this point, sales equal costs, therefore, under these conditions, they must sell above this value. The result is interpreted as how much you need to sell to cover costs.

7. Clients

Current clients must be determined:

- Companies: Volume, frequency, margin per client.
- Retailers: Demographic and behavioral profile.

Potential clients: Those entities to whom sales are not yet made, but where signs of

interest in acquiring the offered products have already been observed. Evaluate the population as retail clients, the total population of the municipality, and whether you are capable of covering the demand for your products in the total population or in the market segment where you have the real capacity to position yourself as a supplier.

8. Expansion Perspective (Focus on feasibility)

At this point, the possible expansion areas, the feasibility of each possibility, and the requirements necessary to access the declared areas must be stated. Table 1 shows an example for the analysis.

Table 1.
Analysis for the Expansion Perspective

Expansion Area	Feasibility	Requirements
Local	High	Improve distribution
Regional	Medium	Investment in logistics
International	Low	Certifications

9. SWOT Matrix

At this point, the SWOT matrix must be constructed using an expert method in order to evaluate the strengths, opportunities, weaknesses, and threats of the MSMEs and to determine the root causes of the weaknesses and threats, in order to propose actions that counteract them, that is, to outline a strategy.

10. Market positioning

The positioning that the MSME has in the market in which it operates must be determined, as well as the specific causes of such a situation. For this purpose, the Mar-

ket Positioning Index (MPI) is determined. The MPI is calculated using four important factors, each evaluated on a scale from 0 to 10. Then, these scores are averaged to obtain a final result. The four factors are:

Market Share: It measures how large the company is compared to the competition; it can be determined in two different ways depending on which is more relevant (physical volume or economic value) for the sector to which the company belongs. In addition, it is necessary to determine the market in which the company participates.

$$(1) \text{ Market share (\%)} = (\text{Company sales}) / (\text{Total market sales}) \times 100$$

$$(2) \text{ Market share (\%)} = (\text{Units of weight produced by the company}) / (\text{Total units of weight produced in the market}) \times 100$$

Example: If 15% of everything sold in the market is sold, this yields a score.

Score:

Less than 5% = 0 points

5–10% = 5 points

10–20% = 8 points

More than 20% = 10 points

Brand Preference (BP): It measures how many customers choose to buy the brand instead of others.

Example: If 4 out of 10 customers prefer the brand, this is converted into a score.

Score:

Less than 5% = 0 points

5–30% = 5 points

30–60% = 8 points

More than 60% = 10 points

Net Margin: It measures how much is earned after covering costs.

Example: If the product is sold for \$100 and costs are \$88, the net margin is 12%.

Score:

Less than 5% = 0 points

5–10% = 5 points

More than 10% = 10 points

$$BP = (\text{customers who prefer the brand}) / (\text{total customers}) = \% \text{ of preference}$$

Customer Retention (CR): It measures what percentage of customers return to make another purchase.

Example: If 65 out of every 100 customers return, this gives a score.

$$CR = (\text{returning customers}) / (\text{total customers}) = \text{retention percentage}$$

Final MPI Calculation:

The score obtained is multiplied by the weight of each factor and then summed.

If:

0–4: Weak positioning (changes are needed).

4–7: Medium positioning (there are opportunities for improvement).

7–10: Strong positioning (you are doing well, but there is always room for improvement).

• **Economic activity:** Processing and marketing of food products such as natural juices, preserves, jams, vinegar, dressings, among other products made from fruits and vegetables (NIT: 50009445815; CNAE: 1030 – Preservation of fruits, legumes, and vegetables).

• **Sector trends:**

Increase in tourism in the northern cays, driving the demand for local products for hotels.

• **Identified gap:**

Lack of local suppliers of food products with certified quality and affordable prices.

11. Recommendations

They should be aimed at providing solutions to the specific situation of the MSME regarding its market positioning—what to do and how to do it—through creative and dynamic actions, with compliance deadlines that allow improvement of market positioning.

Value Proposition (Canvas Model)

• Customer segments: Young adults (25–40 years), middle-aged adults (41–60 years), and older adults (61–80 years); both Cuban men and women, although there may be a slight predominance of women in the domestic sphere; workers from the municipality of Esmeralda and the province of Camagüey mainly, with an average salary of 5,000.00 pesos; hotel chains; consumers committed to responsible and sustainable consumption; restaurants and cafeterias that value sustainability and local production; public institutions (health, education).

• Needs: Quality food, natural preserves, affordable prices and variety, safe food products, and stable production.

RESULTS AND DISCUSSION

Next, the strategic market orientation profile of the MSME SURL SolCaleb was developed.

General Information

- **Name:** MSME SURL SolCaleb
- **Location:** Maceo Street No. 48, Esmeralda Municipality, Camagüey Province, Cuba.
- **Year of establishment:** 2021 (registered on 11/24/2021).

- Value proposition: Wide range of jams, juices, and preserves; quality certifications and compliance with sanitary standards; support for local farmers and responsible agricultural practices; products in various formats, affordable and high quality, promoting health and well-being; recyclable packaging with a focus on waste reduction; diversity of payment methods (credit card, bank transfer, cash).
- Customer frustrations: Instability in competitors' supply; limited diversity in product presentations; previous experiences with low-quality products or unsatisfactory taste; high prices for products that meet quality expectations.
- Creators of Joy: Adaptability to seasonal raw materials; ensuring that all products are 100% natural and clearly labeled as free of preservatives and additives; information on proper storage to maximize product freshness.

Product/Service Portfolio (Focus on Profitability and Flexibility)

The ABC analysis of the products manufactured in February 2025 is shown in Table 2:

- A (tomato purée): represents 79.20% of sales, generates 73.19% of profits, and has an adaptive capacity of 4 points.
- B (jam, coconut oil, and corn pellets): account for 20.8% of sales, 26.81% of profits, and an adaptive capacity of 3 points.
- SURL has an adaptive capacity of 4 points in its production line, as it quickly and accurately identifies new production lines to which the processing area adapts effectively, depending on the raw materials (fruits and vegetables) harvested by small business suppliers according to the season, and their commercialization with the company. There are diversification opportunities such as eco-friendly packaging and export-oriented production lines.

Table 2.
ABC analysis of the products of the MEM SolCaleb

Product	Sales (\$)	% Sales	Gross Profit (\$)	% Profit
Tomato purée	62 940.00	79.20	8 068.19	73.19
Jam	4 940.00	6.20	1 140.00	10.34
Coconut oil	5 800.00	7.30	859.85	7.80
Corn pellets	5 800.00	7.30	955.55	8.67
Total	79 480.00	100	11 023.59	100.00

Suppliers (Risk Analysis and Mitigation Strategies)

The fruits, vegetables, sugar, and packaging are recognized as critical inputs. The identified suppliers of these raw materials are the Cooperativa de Créditos y Servicios (CCS) (Credit and Services Cooperative) Lázaro Peña, the Unidad Basica

Produccion Corporativa (UBPC) (Basic Cooperative Production Unit) Ernesto Ché Guevara, the Empresa Mayorista Provincial de Alimentos (EMPA) (Provincial Wholesale Food Company) in Esmeralda, and the Grupo Empresarial de Logistica del

Ministerio de Agricultura (GELMA) (Business Logistics Group of the Ministry of Agriculture) in Esmeralda. The risks associated with these suppliers have been identified as high dependency, national-level resource scarcity, and logistical delays.

To mitigate the identified risks, the strategy to be adopted includes signing contracts with additional suppliers as alternatives, negotiating penalty clauses for breach of contract, and maintaining a stocked safety inventory.

Supplier evaluation:

- **Quality:** 6 (sanitary certifications).
- **Cost:** 7 (competitive but unstable prices).
- **Delivery times:** 5 (can be improved with medium-term contracts).

Competition

The MSME SolCaleb (LLC) has a real market classified as a captive market, since there are no companies offering products equal or similar to its own; however, in the potential market identified by the company itself (localities of the municipality of Esmeralda, the municipal capital of Camagüey, and hotels in the northern cays of the province of Camagüey), there are small enterprises that constitute competition for its products, such as the following: Las Delicias, La Esmeralda, EDEN, Os&mani, MERXBIT, and COPAL, as they have similar production lines; nevertheless, the LLC SolCaleb has certified products. To evaluate the results of this aspect, see Table 3.

Table 3.
Competitor Analysis

Variable	MIPYME SolCaleb	MIPYME Las Delicias	EDEN
Price	Medium	High	Low
Quality	High(certified)	Media	Low
Distribution	Local (Esmeralda)	Regional	Limited

Production Costs

The cost structure analyzed corresponds to tomato purée, a high-impact product identified through the application of the ABC method in section three.

Table 4 presents the analysis carried out to determine the multi-product break-even point for the small enterprise.

The small enterprise must sell 268 units/month of tomato purée, 17 units of jam, 19 units of coconut oil, and 19 units of corn pellets to cover total production costs and begin to generate profit.

It should be noted that, when preparing the cost sheet for each product, a margin of up to 25% is included, representing the profit to be obtained for each one, in accordance with Resolution 148/2023 of the Ministry of Finance and Prices for the activity of goods production.

Customers

The company SolCaleb (LLC) has clearly identified its different types of customers and has developed specific strategies for each one, with the aim of maxim-

Table 4.
Multi-product Break-even Point

Product	Tomato purée	Jam	Coconut oil	Corn pellets	General
Selling Price SP (\$/unit)	260.00	130.00	200.00	40.00	
Variable Cost VC (\$/unit)	205.00	100.00	170.35	33.41	
Monthly Demand Q (units)	330.00	40.00	30.00	145.00	
Contribution Margin (\$/unit)	55.00	30.00	29.65	6.59	
Total Sales (\$/month)	85 800.00	5 200.00	6 000.00	5 800.00	102 800.00
Participation Rate \$/\$	0.83	0.05	0.06	0.06	1.00
Weighted Unit Contribution Margin (\$)	45.90	1.52	1.73	0.37	49.52
Break-even Point (units/month)	267.11	16.19	18.68	18.06	320.04
Fixed Cost FC (\$/month)					15 850.00

Table 5.
Customer analysis

Type	Profile	Strategy
Wholesellers (70% sales)	Isla Azul Hotels, EMPA	Loyalty through punctual deliveries
Retailers (30%)	Local population	Promotions at UEB Hanoi/Palermo
Potential	Cayo norte(tourism)	Free samples for hotels

zing its sales and expanding its presence in the market.

Expansion Perspective

Table 6 presented refers to the company’s expansion perspective and details three specific zones, together with their feasibility and the requirements necessary to carry out such expansion.

SWOT Matrix

The SWOT analysis reveals that the company has significant strengths, such as an exclusive product and competitive costs,

which can be leveraged to capitalize on opportunities in a favorable environment such as tourism growth and the demand for organic foods. However, it also faces internal weaknesses, such as a lack of machinery and low levels of training, which must be addressed to improve its competitiveness. In addition, it must remain attentive to external threats, such as supply instability and increasing competition from new MSMEs, in order to develop strategies that mitigate these risks and ensure sustainable growth in the market.

Table 6.
Market Expansion Perspective

Zone	Feasibility	Requirements
Camagüey (<i>cabecera</i>)	High	Distribution logistics
Cayería norte (hotels)	Medium	Additional certifications
Exports (vinegars)	Low (mediano plazo)	Health permits

Market Positioning

Market Share: Market share reflects the relative size of the company compared to its competitors, Given that the MSME operates as a production company, the second formula based on physical volume was applied. The market of the province of Camagüey is analyzed, since the products are marketed in this area, and for this purpose data from the Camagüey Statistical Yearbook 2023 (p. 142) are used.

The Market Positioning Index (MPI) highlights several factors that contribute to the overall assessment of the company. First, market share has a weight

of 35%, for which it received a score of 5, resulting in a contribution of 6.37% to the total, equivalent to 1.75.

Second, brand preference, with a weight of 30%, obtained a score of 8, contributing 2.4 to the total. On the other hand, net margin, which represents 20% of the analysis, reached the maximum score of 10, corresponding to a contribution of 2.0 points.

Customer retention, which has a weight of 15%, received a score of 5.5, which is equivalent to a contribution of 0.825. By adding all these contributions,

Table 7.
SWOT matrix

INTERNAL FACTORS	EXTERNAL FACTORS
<p>STRENGTHS (S)</p> <ol style="list-style-type: none"> 1. Exclusive product: Coconut Bar with no direct competition. 2. Certifications: Health license. 3. Local supply chain: Partnerships with CCS and UBPC. 4. Adaptability: 22 products adjustable to seasonal variations. 	<p>OPPORTUNITIES (O)</p> <ol style="list-style-type: none"> 1. Growing tourism: Demand in the North Cay of Camagüey. 2. MSME openings: Opportunity to export (e.g., organic products). 3. Health trends: Premium consumers. 4. Digital commerce: Platforms such as Instagram or Cuban marketplaces.
<p>WEAKNESSES (W)</p> <ol style="list-style-type: none"> 1. Dependence on inputs: Scarcity of packaging and raw materials. 2. Training: Low proficiency in digital marketing. 	<p>THREATS (T)</p> <ol style="list-style-type: none"> 1. Government regulations: Import restrictions. 2. Competition: MSMEs such as Las Delicias or EDEN. 3. Economic instability: Inflation and fluctuations.

Table 8.
Market Positioning

Factor	Score (0-10)	Weight (%)	Contribution
Market share (6.37%)	5	35	1.75
Brand preference (40%)	8	30	2.4
Net margin (20%)	10	20	2.0
Customer retention (55%)	5.5	15	0.83
Total MPI	6.97 (Medium positioning)		

the total MPI is established at 6.975, which indicates a medium market positioning.

Recommendations

To scale from a medium positioning (6.97/10) to a high one (>8) within 12 months, the company must strengthen customer loyalty through brand differentiation and

loyalty programs; maintain high margins through cost control; diversify suppliers to reduce dependency; coordinate courses to train personnel; seek financing with Banco de Crédito to increase the productive capacity of the industry; and design a logistics system that allows expansion toward its potential market.

CONCLUSIONS

The strategic profile of market orientation is a key factor for the development and sustainability of MSMEs. It drives competitiveness, fosters innovation, adaptability in a constantly changing business environment, and allows for continuous diagnostics to create strategies that achieve

market positioning. The application of the profile confirmed that the MSME SURL SolCaleb is in a medium position, with clear opportunities for improvement, especially in expansion, logistics, and customer loyalty.

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- Madelaine Vasallo Conde: Conduct of the research, review, and analysis of the results.
- Lianet Sanzo Martín: Writing, review, and editing.
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Culinary preparations of beverages made from cushuro (*Nostoc lichenoides*) as a consumption alternative for the inhabitants of Rimac

Preparaciones culinarias de bebidas a base de cushuro (Nostoc lichenoides) como alternativa de consumo de los pobladores del Rímac

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ABSTRACT

New food contexts require innovations in culinary preparations aimed at improving nutritional value for the benefit of human health. Furthermore, such products must have a high level of sensory acceptability by consumers. Fresh cushuro, an alga species that grows at altitudes greater than 3,500 meters above sea level, is a source of high concentrations of heme iron, which makes it a good candidate for preventing health problems such as anemia. The objective of the research was to verify the iron concentration, which resulted in a content of 14.50 mg per 100 g of sample. This is an important technical and nutritional aspect for the development of alternative culinary preparations of cushuro-based beverages to improve health and well-being through the consumption of functional foods. The research also evaluated sensory analysis in relation to the degree of acceptance of cushuro beverages (cushuro soda with oats and apple, cushuro soda with quinoa and pineapple, and Cushuro Sour). The study was quantitative and cross-sectional. The results showed that flavor is the most acceptable attribute of the beverages, followed by color and texture, with hedonic ratings of “I really like it” and “I like it,” offering high-nutritional-value beverage alternatives addressing future nutritional requirements of consumers.

Keywords: Cushuro, iron, anemia.

RESUMEN

Los nuevos escenarios de alimentación requieren innovaciones de preparaciones culinarias con el objetivo de mejorar el valor nutricional en beneficio de la salud de las personas. Además de ello deben tener un alto nivel de aceptabilidad sensorial por parte de los consumidores. El cushuro fresco alga que crece en altitudes mayores a los 3500 metros



sobre el nivel de mar es una fuente de alta concentración de hierro hemínico lo cual lo destaca para prevenir problemas de salud como la anemia. El objetivo de la investigación es comprobar la concentración de hierro que determino un contenido de 14,50 mg por una muestra de 100 g aspecto técnico nutricional importante para la proyección de alternativas de preparaciones culinarias de bebidas a base de cushuro en mejorar el bienestar de salud por consumir alimentos funcionales. Asimismo, el trabajo de investigación evaluó el análisis sensorial en relación con el grado de aceptación de las bebidas de cushuro (refresco de cushuro, avena y manzana, refresco de cushuro con quinua y piña y Cushuro Sour). La investigación fue de tipo cuantitativa y transversal. Los resultados fueron que el sabor es la dimensión de mayor aceptabilidad de los refrescos, seguidos del color y textura con calificaciones de “Me gusta mucho” y “Me gusta” ofreciendo alternativas de bebidas de alto valor nutricional con visión al futuro de los nuevos requerimientos nutricionales de los consumidores.

Palabras clave: Cushuro, hierro hemínico, anemia.

INTRODUCTION

The efforts made by the authorities to reduce anemia and malnutrition are part of their management actions aimed at decreasing the percentage of this health problem in Peru among adults and children; however, they are not sufficient. From a strategic perspective, collaboration among professionals in the food sector is required.

Cushuro is a historical and cultural food that has endured through many generations, which encourages the preservation of tradition while promoting innovations in culinary preparations, in order to provide a nutritional alternative by offering high-quality dishes that stand out for maintaining their nutritional properties (Valencia *et al.*, 2024). In this context, the relevance of cushuro becomes evident, motivating the need to understand its nutritional value and to evaluate the acceptability of this food in breakfast preparations or beverages, since it is a very healthy food and could be a highly indispensable alternative in the future for people's nutrition.

Anemia in Peru is a problem that affects the adult population, but with great

concern among Peruvian children aged 6 to 35 months. It increased from 43.1% in 2023 to a percentage level of 43.7% in 2024. This reflects an increase in anemia cases, estimated at approximately 7,000 children who have this health problem (Instituto Nacional de Estadística e Informática [INEI], 2024). Children with this deficit, characterized by low hemoglobin levels, experience a lack of concentration during their school stage.

The research project aims to incorporate into Peruvian gastronomy culinary preparations of dishes based on cushuro, similar to the research conducted by another author, who indicates the following: it will contribute to the standardization process for the preparation of culinary dishes with “cushuro,” as well as to the process of evaluating acceptability through sensory evaluation of organoleptic characteristics (odor, color, flavor, and texture).

Species in their natural state, such as cushuro, are of current economic importance (profitable), and their value would be greater through incorporation into use

by adding value through transformation and agro-industry (technified production), while promoting and considering their natural preservation (sustainability) (Leiva & Sulluchuco, 2018). In this sense, further research on this resource is required in order to preserve it when the exploitation of cushuro increases in its use in gastronomy and the food industry.

Currently, both children and adults follow very unhealthy diets due to a lack of knowledge about Andean products and their methods of preparation. We refer specifically to the Novo-Andean product cushuro (*Nostoc lichenoides*). The importance of promoting and encouraging the consumption of its preparations, measuring the level of knowledge acquired by the population regarding this food, as well as assessing the acceptability of its preparations and the reasons for preference or non-preference, constitute key steps toward safeguarding a new dietary alternative for a population affected by crucial nutritional problems such as iron-deficiency anemia and chronic malnutrition (Adriano, 2019).

Thus, future projections aimed at ensuring healthy nutrition require incorporating foods with high nutritional value and affordable costs as culinary alternatives that respond to the needs of new populations.

It is necessary to conduct studies on the nutritional values of cushuro and to prioritize determining the iron concentration contained in this Andean food, specifically heme iron. Murmunta (*Nostoc sphaericum*) is a Peruvian Andean alga that has not yet been industrialized. It is a renewable resource found in numerous lakes, springs, and various aquatic environments.

Its long history of consumption indicates food safety as an economical nutritional supplement (Álvaro and Rodríguez, 2017). In this way, through these studies, we will be able to project its incorporation into Peruvian cuisine in various culinary preparations, prioritizing iron enrichment to benefit the nutrition of the Peruvian population.

MATERIALS AND METHODS

The equipment and utensils used in the preparation of cushuro-based beverages are detailed in Table 1.

The culinary beverage recipes based on cushuro were standardized and include: cushuro with oats and apple refreshment drink, cushuro with quinoa and pineapple drink, and cushuro sour. The recipe models for these culinary preparations can be seen in Figures 1, 2, and 3. The formulations of the cushuro-based beverages are described in Table 2.

The study design of this research is non-experimental. It is also characterized as cross-sectional, since data collection was carried out at a specific point in time. Furthermore, it is descriptive in nature, as surveys were used to obtain results and determine the acceptability of the cushuro beverage.

For the preparation of cushuro beverages, the following steps were carried out: first, the cushuro was disinfected at a concentration of 50 ppm (with 5% sodium hypochlorite), adding 1 ml of bleach to a 1-liter jug of water, then allowing it to stand for approximately 5 minutes. As an alternative, it can be disinfected by placing it in hot water for a few minutes and then setting it aside. After this, we proceed to prepare the beverages as detailed below.

Table 1.
Equipment and utensils used in the study

Equipment and utensils	Units
Stove	1
Blender	2
Shaker	1
Pot	2
Dryer	2
Onzera	1
Glass	4
Scale	1

Table 2.
Formulation of cushuro-based beverages

Cushuro, oat and apple drink		Cushuro with quinoa and pineapple drink		Cushuro sour	
Item	Quantity (g)	Item	Quantity (g)	Item	Quantity (g)
Cushuro	160	Cushuro	600	Cushuro	100
Oats	120	Quinoa	240	Gum syrup	250
Sugar	70	Pineapple	1 000	Lemon juice	125
Apple	2	Sugar	600	Angosture bitters	5
Cinnamon	10	Clove	5	Pisco	1 000
Water	2 000	Cinnamon	3		
		Water	10 000		

Cushuro Drink with oats and apple

- A pot is prepared with water together with the oats, and it is mixed until dissolved, avoiding the formation of lumps.
- The apples are peeled and cut.
- The cushuro, cinnamon, and apple are added and placed over the heat until it boils for 25 minutes.
- After the time has elapsed, it is allowed to cool, removing the cushuro from the pot and reserving it separately.
- Once cooled, the oats are blended with the apple and a little of the reserved cushuro; sugar is added to taste.

- Finally, it is served in the glass of preference, and the desired amount of the remaining cushuro is added (Figure 1).

Cushuro Drink with Quinoa and Pineapple

- In a pot, boil the pineapple peel with cinnamon and cloves.
- Wash the cushuro 3 times with running water and pour boiling water over it, then set aside. Wash the quinoa 3 times to remove the saponin present in this pseudocereal.
- When the water infusion with pineapple, cinnamon, and cloves is done, add the washed quinoa.



Figure 1. Cushuro refreshment with oats and apple



Figure 2. Cushuro Drink with Quinoa and Pineapple

- Strain the infusion and add cold water (6 liters).
- Add the cleaned cushuro and the pineapple cut into medium cubes.
- Serve in a glass, decorating with cinnamon and mint (Figure 2).
- In a measuring cup, weigh as follows: 2 [parts] pisco, 1 [part] lemon juice, 1 [part] syrup, and 1 [part] cushuro.
- Pour everything into a blender and blend.
- Pour into a glass with the cushuro and add a few drops of Angostura bitters.

Cushuro Sour

- Wash the cushuro 3 times with tap water and pour boiling water over it, then set aside.
- Decorate with a slice of lemon (Figure 3).



Figure 3. Cushuro sour

The analysis of heme iron content was carried out in the laboratory Certificaciones Alimentarias Hidrobiológicas y Medioambientales SAC, an entity accredited by the National Institute of Quality (INACAL) according to the Peruvian technical standard (NTP) 17025, which describes the requirements for accredited laboratories. See Table 3.

To determine the acceptability of the cushuro-based beverages, a sensory evaluation was conducted. The evaluation was carried out with 15 untrained panelists located in the Rímac district. They evaluated the color, texture, flavor, and overall acceptability of the previously mentioned drinks. The method used was the 5-point verbal hedonic scale: “I like it very much,” “I like it,” “Neither like nor dislike,” “I dislike it,” and “I dislike it very much.” The respondents evaluated four attributes, which included color, flavor, texture, and the most important aspect of the research: the overall acceptability of our drinks.

RESULTS AND DISCUSSION

Physicochemical Analysis

Fresh cushuro proves to be a fresh food source with a high iron concentration of 14.40 mg per 100 g sample, which is somewhat atypical for a plant-based food. This result is shown in Table 4. When compared with reports of dried cushuro described in the Food Composition Tables of 2017, it is reported to contain 83.60 mg of iron in dehydrated cushuro, indicating that fresh cushuro is a high-level iron concentrate alternative, in addition to not being of animal origin.

Sensory Analysis

Figure 4 shows the results of the cushuro drink with apple and oats, in which a high level of acceptability of 70–80% “I like it very much” can be observed in relation to the attributes of color, flavor, texture, and overall acceptability. Leiva and Sulluchuco (2018), in their research work evaluating the acceptability of cushuro in

Table 3.
Test methods

Composition per 100 g of Product		
Item	Test Reference Standard	Test Reference Standard
1	Non-heme iron	Official Mexican Standard NOM-117-SSA1-1994, Goods and Services. Test method for the determination of cadmium, arsenic, lead, tin, copper, iron, zinc, and mercury in food, drinking water, and purified water by atomic absorption spectrometry.

Note: Provided by CAHM Laboratory, 2022

Table 4.
Physicochemical Analysis

Composition per 100 g of Product			
Item	Parameter	Units	Results
1	Non-heme iron	mg/100 g	14.5

savory and sweet culinary preparations by university students, described that people preferred savory dishes over sweet ones; the savory dishes were better in texture, and the sweet ones were better in color. This coincides with the acceptability of the prepared drink, which had a higher percentage in color, flavor, and texture.

Figure 5 shows the results of the cushuro drink with quinoa and pineapple, in which the level of acceptability is emphasized at 50–60% “I like it very much” in relation to the attributes of flavor, texture, and overall acceptability. In the case of “I like it,” the level reaches 60% for color and 47% for flavor and overall acceptability, in relation to the rating of “I like it.” Nakahodo *et al.* (2017) mention in their research on fruit jams enriched with cushuro, in the market research section, that the three jam flavors most accepted by people were

strawberry, orange, and pineapple. Thus, the cushuro-based drink had a high level of acceptability because the pineapple provides color and flavor. Additionally, quinoa and the cushuro algae adjust to the flavor and become important due to their nutritional value contribution, such as minerals like iron.

Figure 6 shows the results of the Cushuro Sour drink, in which the level of acceptability is emphasized at 50–60% “I like it very much” in relation to the attributes of color, flavor, texture, and overall acceptability. In the case of “I like it,” the level reaches 60% for color, and 47% responded “I like it” in relation to flavor and overall acceptability. Quineche and Valle (2014) mentioned in their research on the preparation and in vitro digestibility of cushuro and flax protein gels that, regarding the acceptability of four types of gels, gel number three had the highest acceptability;

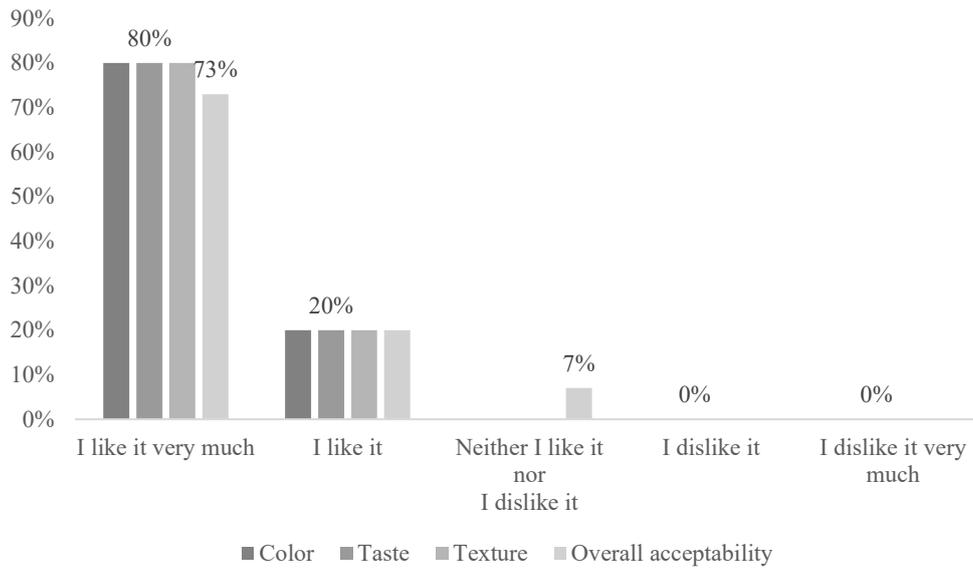


Figure 4. Percentage of acceptability level of the cushuro, apple, and oat drink

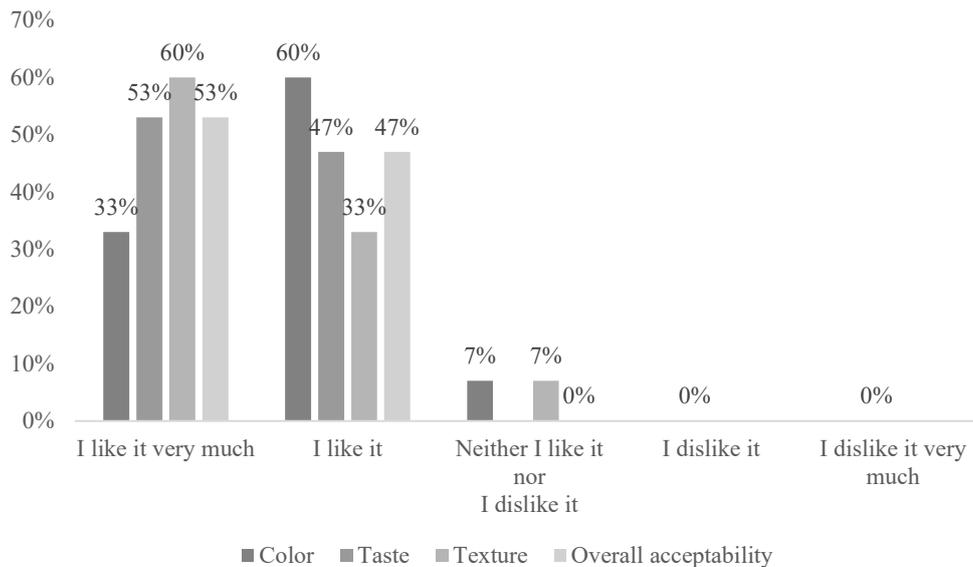


Figure 5. Percentage of acceptability level of the cushuro with quinoa and pineapple drink

however, compared to the more conventional preparations, that is, those gels had lower acceptance. In comparison with what was carried out in the workshop, it could be stated that the beverages made with this

alga, when compared in situ, had higher acceptance, as this ingredient adapts to the flavor of the preparation, provided that the respondent is aware of the nutritional value of the beverages with cushuro.

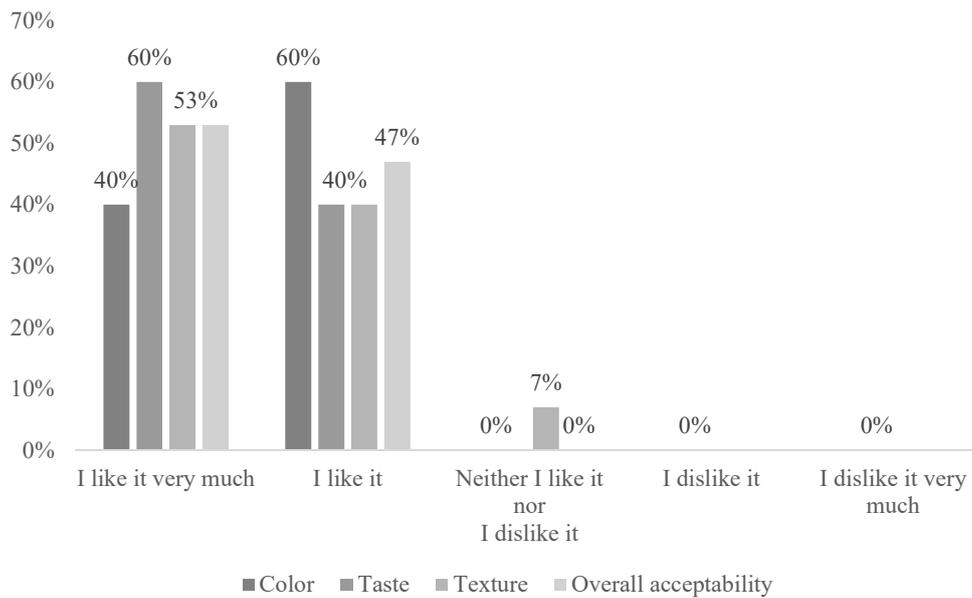


Figure 6. Percentage of acceptability level of the Cushuro Sour drink

CONCLUSIONS

It has been verified that cushuro is a very nutritious food with a high concentration of non-heme iron, something unusual for a plant-based food, which greatly helps in the reduction of anemia and also in improving a person's quality of life, health,

and nutrition, ensuring their food supply. Cushuro beverages were accepted, as determined by the 5-point hedonic scale, with the highest influence ranging from "Like it very much" to "Like it" according to the respondents.

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- Noemí Bravo-Araníbar: Resources, supervision, and final editing.

So, what's the right one: cebiche, ceviche, sebiche or seviche?

¿Cómo es la nuez: cebiche, ceviche, sebiche o seviche?

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ABSTRACT

What is it: cebiche, ceviche, sebiche, or siviche? seeks to explain, using normative documentation of the Spanish language and journalistic sources, why a concept is spelled in four ways, given that, in the search for information for the development of the study, no similar case was found. The work does not seek to criticize or correct the spelling of the name of one of the most emblematic dishes of Peruvian gastronomy, neither by standard, nor by custom, nor by history. To achieve this objective, the methodology employed was based on the review of valuable and current public information. The result is that there is no consensus about the origin of the dish, nor its spelling, although there is an idiomatic and historical explanation. Finally, it was concluded that both society and academia accept the spellings cebiche, ceviche, sebiche, or seviche.

Keywords: Seviche, sea beach, gastronomy, fish, lemon.

RESUMEN

¿Cómo es: cebiche, ceviche, sebiche o seviche?, busca explicar, desde la documentación normativa del idioma español y periodística, el porqué se escribe de cuatro formas un concepto, toda vez que, en la búsqueda de información para el desarrollo del estudio, no se ha encontrado un caso similar. El trabajo no busca criticar o corregir la escritura del nombre de uno de los platos más emblemáticos de la gastronomía peruana ni por norma, ni por costumbre o historia. Para cumplir el objetivo, la metodología empleada se basó en la revisión de información pública valiosa y actual. El resultado es que no existe consenso acerca del origen del plato, ni de su escritura, aunque sí la explicación idiomática e histórica. Finalmente, se concluyó que, tanto la sociedad como la academia aceptan que se escriba cebiche, ceviche, sebiche o seviche.

Palabras clave: Seviche, sea beach, gastronomía, pescado, limón.



INTRODUCTION

One of the concerns of linguists is to analyze the evolution of language use, which manifests in various ways and in terms that change over time, both in meaning and pronunciation. For example, the word *causa*, meaning “foundation or reason for something” (Real Academia Española (RAE), 2024), has evolved from its original sense to refer to a representative dish of Peruvian cuisine and even to be used as a synonym for “friend” (peru.travel, 2020).

However, language evolution occurs not only conceptually but also phonetically. Regarding the arrival of Spanish from Castile to the American continent, it was already part of the evolution of Latin, a language that reached the Iberian Peninsula around 218 B.C. with the Romans. By then, languages such as Iberian, Celtiberian, Basque (or Euskera), Tartessian, Lusitanian, and languages derived from Phoenician and Greek, associated with Phoenician and Greek colonies, were already present (Fernández, 2018).

Later, in 711, with the arrival of the Muslims, the Arabic language was introduced. For eight centuries, Arabic coexisted with the languages of the peninsula, leaving around four thousand words of Arabic origin (Blanco, 2025).

By the end of the 15th century, with Columbus’s arrival in the Americas and Francisco Pizarro’s conquest of the southern part of the continent in 1532—specifically in what is now Peru—the Spanish brought by the conquerors encountered native languages, unknown, new, and unfamiliar to the Europeans, which had no Western influence. Quechua, the language of the Inca Empire, predominated; it was experiencing internal succession conflicts

while expanding northward across the sub-continent. However, although the Cusco people dominated their vast empire, the conquered cultures retained their customs and languages. In other words, multiple languages were spoken.

The objective of this research is to show how something everyday and emblematic of gastronomy can become “unknown,” generating linguistic questions that justify studies of this nature, particularly regarding the distinctions between the terms *cebiche*, *ceviche*, *sebiche*, or *seviche*. It should be noted that the aim is not to differentiate between various preparation methods, ingredients, or consumption sites, but rather to establish distinctions and similarities in spelling.

Regarding this topic, there are many studies, some older and others more recent, from both academic and popular sources. Therefore, this article reviews the literature on the subject, which, although incomplete, seeks to analyze what is considered most relevant about the spelling of one of the most internationally recognized dishes of Peruvian cuisine, and to contrast it with descriptions collected through conversations with various intellectuals over time.

DEVELOPMENT

Spelling

Language use occurs through the combination of orthographic rules, established by the Real Academia Española (RAE) in the case of Spanish, with the practices or customs in speech and writing, which are accepted by language users in different specific contexts. Additionally, it often requires criteria for using certain terms, which are subject to historical, cultural, and educational reasons.

For example, normatively it is San Juan, while the custom in towns of the Peruvian Amazon is to say san fan. Although the spelling remains San Juan, the pronunciation differs in that part of Peru. Should the pronunciation be changed? This would be absurd for two main reasons. First, it is cultural; it is the product of the cultural encounter between Spanish and the native languages of the Amazon. Second, beyond pronunciation, the concept is understood by Spanish speakers in the region.

Normatively, in the *Diccionario de la Lengua Española (DLE)* of the RAE, the word is spelled *cebiche*, defined as “A dish typical of some American countries, made with raw fish or seafood cut into small pieces and prepared in a marinade of lemon or bitter orange juice, chopped onion, salt, and chili” (*Diccionario de la Lengua Española (DEL)*, 2025). The same dictionary lists *ceviche* and *seviche* as synonyms.

Similarly, the *Diccionario panhispánico de dudas* of the RAE (2005) records the word as *cebiche*, defined as “A dish made with raw fish or seafood in a marinade, typical of several American countries.” It notes that it can also be spelled *ceviche*, and valid variants include *seviche* and *sebiche*.

Meanwhile, the *Diccionario de americanismos* (2025) indicates that in Mexico, Guatemala, Honduras, Spain, Nicaragua, Costa Rica, Panama, Cuba, the Dominican Republic, Puerto Rico, Colombia, Venezuela, Ecuador, Peru, Bolivia, Chile, Argentina, and Uruguay, the word is spelled *cebiche* and is defined as “A dish prepared with small pieces of raw fish or seafood, marinated in acidic lemon or bitter orange juice, and seasoned with chopped

onion, salt, and hot chili.” It also notes that using *ceviche*, *sebiche*, and *seviche* is correct.

Terrés (2016) noted that the first document to mention the word *sebiche* dates back to 1820, in the song *La chicha*, sung by Peruvian soldiers: “Venga el Sebiche, la guatia, en seguida que también convida y excita a beber. Todo indio sostenga con el poto en mano que a todo tirano hay que aborrecer.” The first written reference to *seviche* appears in *Guía del viajero en Lima* by Manuel Atanasio Fuentes, in 1860. It is described as:

“Small pieces of fish, or shrimp, placed in bitter orange juice, with plenty of chili and salt; they are kept this way for a few hours, until the fish absorbs the chili, and is almost cooked by the caustic action of it and the acidity of the orange” (Fuentes, 1860, p. 184).

Later, Federico More (1952), cited by Arrizabalaga (2020), stated that the word derives from *cebo*, since it refers to fish cut into small pieces (Figure 1). More’s proposal was supported by Martha Hildebrandt (1962), who added that the Mozarabic suffix *-iche*, meaning “cebo” (food, delicacy) combined with the diminutive or form suffix *-iche*, is common in other Americanisms such as *caliche* and *boliche*. This is the reason why it is spelled *cebiche*, although it is also accepted with *s* and *v* (*seviche*).

On the other hand, in the online dictionary (2025) of the Peruvian Academy of Language, *cebiche* and *ceviche* are listed as Peruvianisms. Meanwhile, according to Javier Pulgar Vidal (Guargüero, 2023), the word comes from the Quechua term



Figure 1. Cebiche, ceviche, sevicehe o sebiche dishes

Note: Taken from Minaya, 2025

siwichi, meaning fresh or tender fish. This Quechua term changed through phonetic evolution, since for Iberians and Spanish speakers in general, Quechua or any foreign word is read and pronounced according to Spanish pronunciation.

Also, in Guargüero (2023), it is noted that the National Institute of Culture established the spelling *sevicehe*, with ‘s’ and ‘v’, in reference to Ricardo Palma and Juan de Arona, founders of the Peruvian Academy of Language in 1887, and to the writers Manuel Atanasio Fuentes and Carlos Prince. Ariansen (2016) referred to the fact that when English sailors arrived at Peruvian ports, they looked for the typical dish they called “sea beach” (fish on the beach), and in his view, the word comes from that phonetic combination /seabich/, which over time evolved into *sebiche* due to the adaptation from English to Spanish. In the same publication, historian Juan José Vega explains that the origin of the word *sevicehe* comes from the Arabic word *sibech*, meaning acidic food.

Other words, such as *restaurante*, are an adaptation of the French word *restaurant*, used since the 16th century to designate food that restores (Infobae, 2022). Pronunciation changes occur through lan-

guage contact. For example, *pacae*, recorded in the RAE dictionary (2024) with that pronunciation, is pronounced by most Peruvians as /pakay/, derived from the Quechua word *pakay* or *paqay*, meaning “to hide,” according to Martha Hildebrandt (2018). In other words, they speak Quechua without realizing it. Similarly, *quinoa* is the Spanish adaptation of the Quechua word *quinua*.

That is, words not native to Spanish first undergo alterations in pronunciation and later in its writing. Most likely, the Quechua term *siwichi* /sibichi/ over time became *cebiche* / *sebiche*, or *sea beach* / *seabich*/ evolved into *cebiche* / *sebiche*, due to the cultural fusion that has occurred and continues in Peru.

Finally, it is based on the principle that writing is merely the representation, according to established conventions, of the oral form of a language. Writing only approximates speech and pronunciation; it is not an exact reflection. This premise underlies the analysis of the spelling of *cebiche*, *ceviche*, *sebiche*, or *sevicehe*.

In Spanish pronunciation, syllabication is used to first distinguish vowel and consonant combinations and second to locate the stressed syllable, which can affect pronunciation and sometimes meaning.

The Real Academia Española (2019), in its *Libro de estilo*, notes that in most of the Hispanic world, there is no distinction between the consonants /s/ and /z/, and words written with s or with z or c (+ e, i) are pronounced /s/. However, for orthographic reasons, some words are “written with the letter c before e or i to represent the phoneme /s/ (with the [s] sound for those who sesean)” (Real Academia Española, 2019). This explains why c combined with e is pronounced /se/.

Regarding the pronunciation of v, the Real Academia Española (2019) notes that “there is no difference in Spanish pronunciation between the letters b and v. Both now represent the voiced bilabial phoneme /b/.” Therefore, vi or bi are always pronounced /bi/.

As for spelling, the type of fish, its condition, or its origin, as well as the seafood used, does not determine how this emblematic Peruvian dish is prepared, whether served from a street cart, a small eatery (*huarique*), or a luxury restaurant, nor the education level of those presenting the menu. Cebiche, ceviche, sebiche, or seviceh will always sound the same: /se-biche/. Historically, seviceh represents Peruvian identity more closely, although the other forms are now accepted by both the Academy and popular speech.

Finally, with the advent of the Internet in its various forms, language use is rapidly changing, particularly among young people, who prioritize communication over strict adherence to norms. If the message is understood, that is sufficient. At the same time, the Real Academia continues to accept emerging or altered terms. In this case, cebiche, ceviche, sebiche, or seviceh is

conceptually clear, while the spelling becomes secondary for diners, cooks, and restaurant owners.

History

It is difficult to determine the exact origin of the dish, although history and logic place its origin in the north of what is now Peru. After the Spanish divided on the *Isla del Gallo*, today the Bay of Tumaco in Colombia, to seek fortune and expand the Spanish crown's domain, Pizarro and a group of twelve to fourteen men headed south across the continent, as Durwin (2023) records: “On this side you go to Panama, to be poor; on this other, to Peru, to be rich; let any good Castilian choose what best suits him.”

While the Spanish invaded the subcontinent from the north, the Inca Empire was engaged in an internal war between Huascar and Atahualpa over the succession of the Inca throne left by Huayna Capac, who had initiated the empire's northern expansion. Any traveler in Peru will find that the most imposing Inca constructions are in the south, with few in the north.

This group of conquistadors did not arrive only with horses and weapons; they also brought provisions and various tools necessary to survive in unfamiliar lands. It is not the purpose here to describe all of them, only to highlight what is relevant for this research—specifically the lemon, a citrus fruit incorporated into the Iberian diet after eight centuries of conquest of the peninsula by Arab, Syrian, and Berber Muslims, which began in 711 and ended in early 1492 (Biblioteca Virtual Miguel de Cervantes, 2025). The case of the lemon deserves separate study, since the lemons brought by the Spanish, when planted and

harvested in northern Peru, specifically in what is now Piura, produced a new variety: *Citrus latifolia*, known as the Persian lime, or Peruvian lime.

By that time, in the northern coast of the empire—today Tumbes, Piura, and Lambayeque—there was a dish consumed by local fishermen made with pieces of fish whose main purpose was not for human consumption but as bait to catch larger fish. To this, the juice of tumbo (*Passiflora mollissima*), a citrus fruit that grows in the Andes, was added, and it gradually began to be consumed. As Crisólogo (2017) noted, chili, already in use for centuries—as evidenced by remains found in Guitarrero, Yungay, Ancash, dating back 8,000 years—was added to those fish pieces with tumbo juice.

The Spanish also brought onions, commonly consumed across Europe, which over time were added to cebiche, ceviche, sebiche, or seviceh. From a dish of fish and seafood marinated in citrus, other ingredients were later added: onion, zarandaja, yucca, fried plantains (chifles), and boiled corn (choclo sancochado). Further north,

in Ecuador, tomato was added; in central Peru, it is combined with papa a la huancaína; in Lima, varieties range from the classic fish-only version to combinations of fish and seafood, sometimes fried in oil and coated with flour. Other additions include ice, evaporated milk, lettuce, seaweed, and toasted Andean corn. In short, there is as much variety in the dish as there is creativity among those who prepare it.

CONCLUSIONS

Since the sound and pronunciation of the word, in its four written forms, do not vary, custom has led to its spelling as cebiche, ceviche, sebiche, or seviceh, and conceptually it does not cause confusion.

The Real Academia Española, in its various dictionaries and documents, recognizes all four spellings: cebiche, ceviche, sebiche, or seviceh.

The origin of the word will continue to be discussed—whether from the Quechua *siwichi*, the English sea beach, or the Arabic *sibech*—all phonetically similar, which over time have merged in pronunciation /sebiche/ and evolved in spelling to cebiche, ceviche, sebiche, or seviceh.

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Author Contribution Statement

• Jesús M. Crisólogo-Galván: Conceptualization; methodology, data analysis, writing, and original draft.

Journal of Research of Universidad Le Cordon Bleu

The Journal of Research of Universidad Le Cordon Bleu is a peer-reviewed scientific publication, edited by the University's Centro de Investigación. The journal is published semiannually and focuses on original scientific articles and literature reviews in agricultural sciences and related areas of food science (biotechnology, contamination, diets, genomics and genetics of food production, nutrition, food processing, and conservation, among others). It accepts submissions from national and international researchers in Spanish or English.

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It should begin by describing the materials to be used and their origin, as well as the site where the work was carried out. The methodological procedures, equipment, and any modifications or adjustments made must be explicitly described. The sample size, data collection instruments, and techniques for processing and statistical analysis should be taken into account. In cases involving humans, experimental animals, or plants collected from nature (not cultivated), it is necessary to note that the internationally required ethical

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The chronological order presented in the Materials and Methods section must be maintained. Each result should begin with a brief introduction that allows the presentation of tables and figures containing the relevant information, taking the objectives into account. If it is necessary to divide Results and Discussion into sub-sections for better understanding, this may be done, avoiding in any case the repetition of information already presented in the text.

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Numbers in the thousands or higher should be separated by a space every three digits, avoiding the use of any punctuation marks (e.g., 1 000 000), except for years (e.g., 2024).

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Example:

Table 1.

Relationship between sleep hours and academic performance of university students.

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