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Original Article

Culinary preparations of berevages 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 heminico 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 heminico, 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 greater 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).

Cushuro Sour

• Wash the cushuro 3 times with tap water and pour boiling water over it, then set aside.

• 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.

• 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;

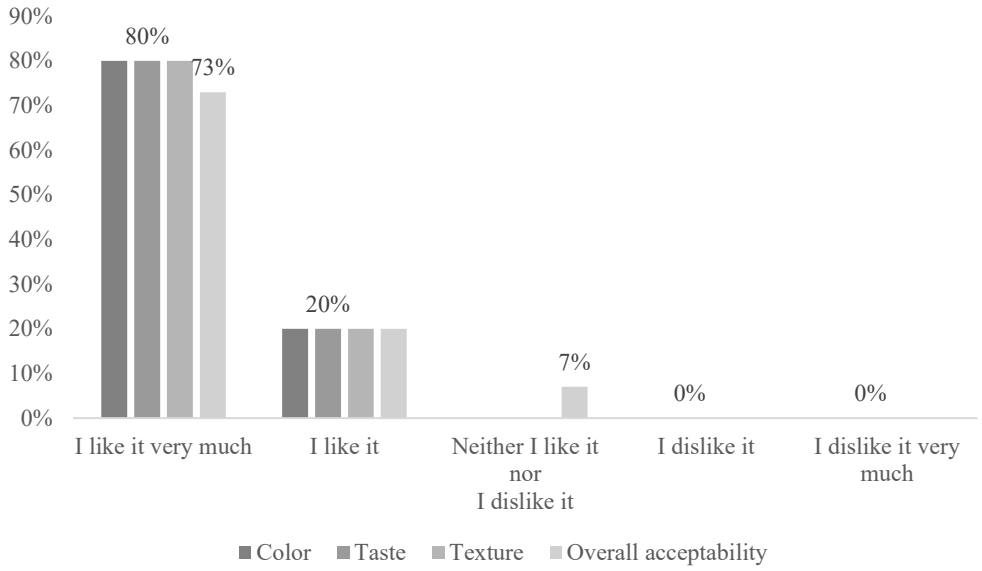

Figure 4. Percentage of acceptability level of the cushuro, apple, and oat drink

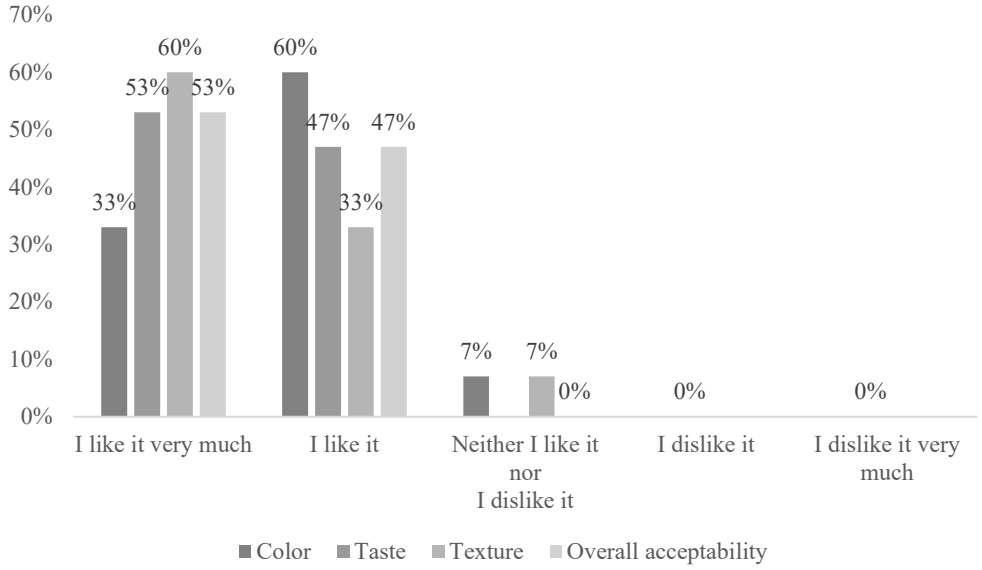

Figure 5. Percentage of acceptability level of the cushuro with quinoa and pineapple drink

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.

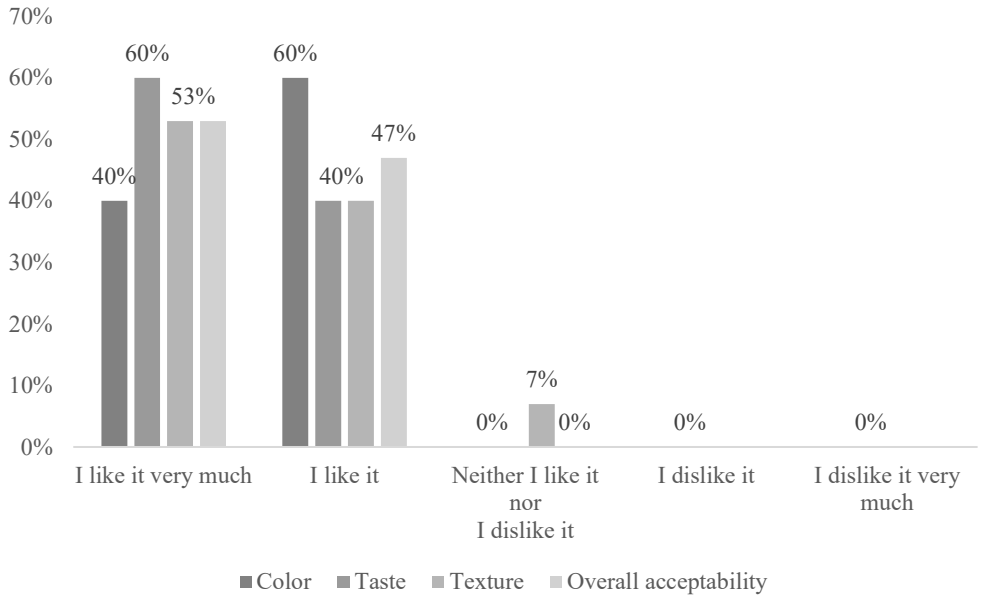

Figure 6. Percentage of acceptability level of the Cushuro Sour drink

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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Author Contribution Statement

• Juan Carlos Bravo-Araníbar: Conceptualization, methodology, validation, formal analysis, and project administration.

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