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Original Article

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 ungurahui (*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% ungurahui), F2 (100% tumbo), F3 (100% guava), F4 (50% ungurahui and 50% tumbo), F5 (50% ungurahui and 50% guava), F6 (50% tumbo and 50% guava), and F7 (25% ungurahui, 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, ungurahui, 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 ungurahui, (*Oenocarpus bataua* var. Bataua), tumbo (*Passiflora mollisima*) 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 % ungurahui), F2 (100 % tumbo); F3 (100 % guayaba), F4 (50 % ungurahui y 50 % tumbo), F5 (50 % ungurahui y 50 % guayaba), F6 (50 % tumbo y 50 % guayaba) y F7 (25 % ungurahui, 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, ungurahui, 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 ungurahui (*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 mollisima*), rccognized 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 physicochemical, 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% ungurahui), F2 (100% tumbo), F3 (100% guava), F4 (50% ungurahui and 50% tumbo), F5 (50% ungurahui and 50% guava), F6 (50% tumbo and 50% guava), and F7 (25% ungurahui, 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.

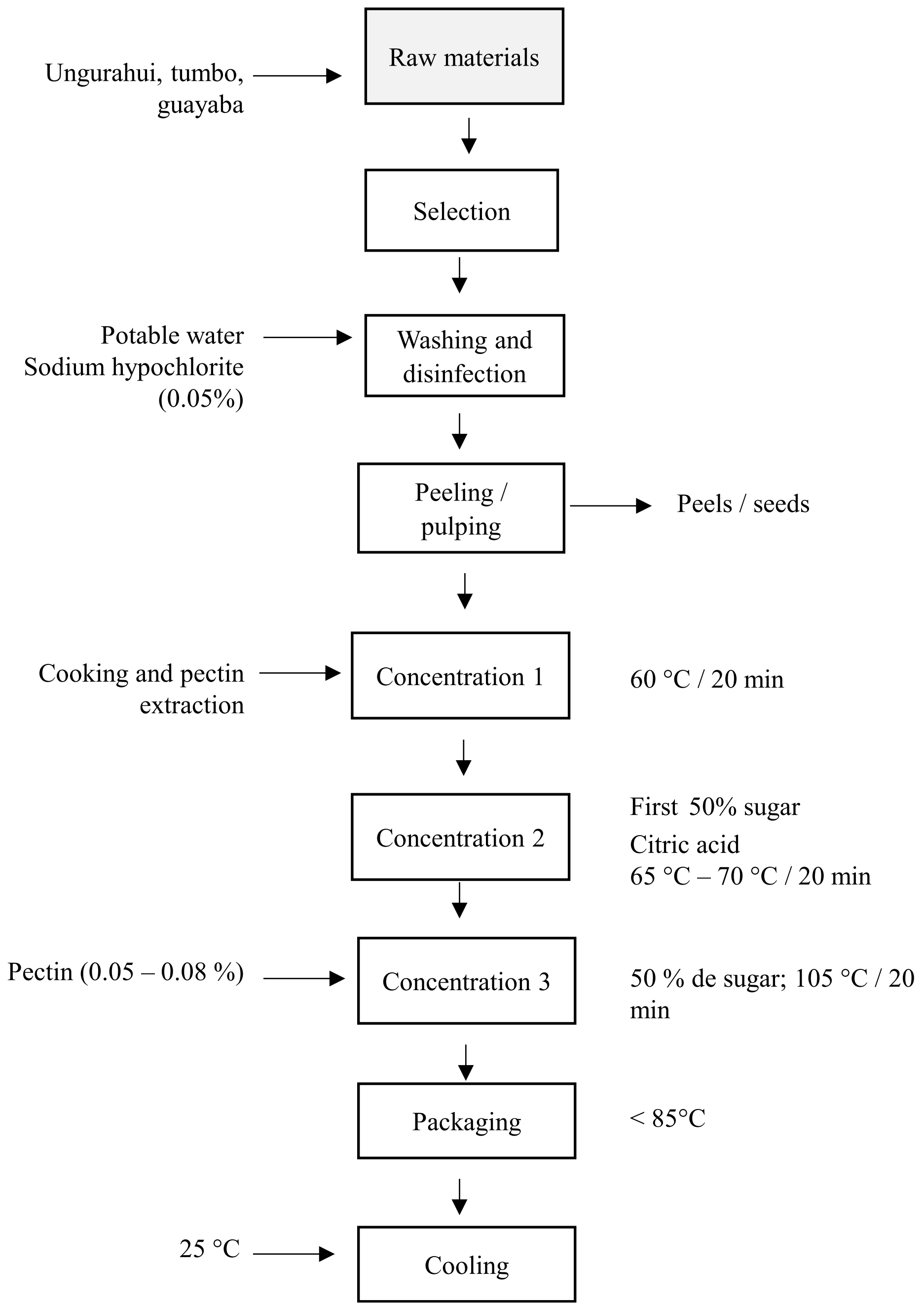

Figure 1. Flow diagram for the preparation of jams with endemic fruits

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).

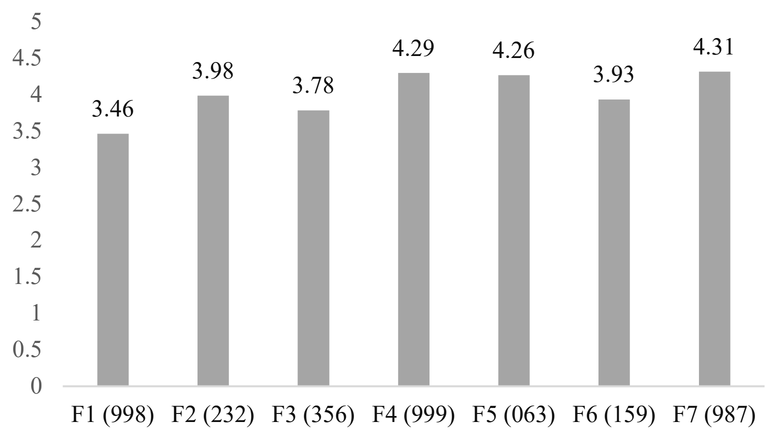

Figure 2. Color attribute score according to the hedonic scale.

ANOVA; p: >0.05

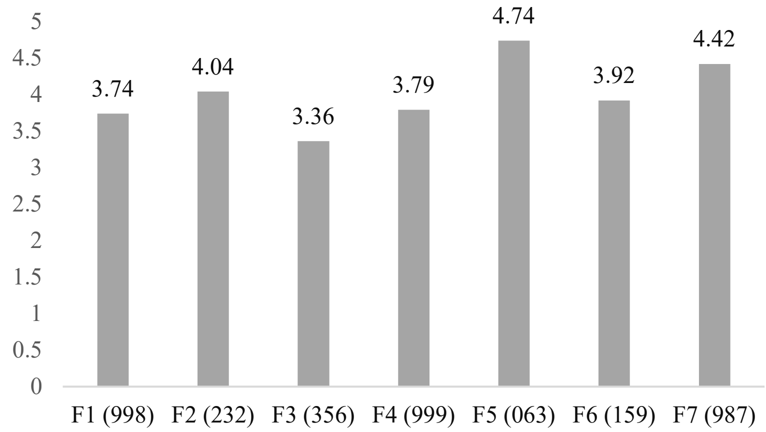

Figure 3. Odor attribute score according to the hedonic scale

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-

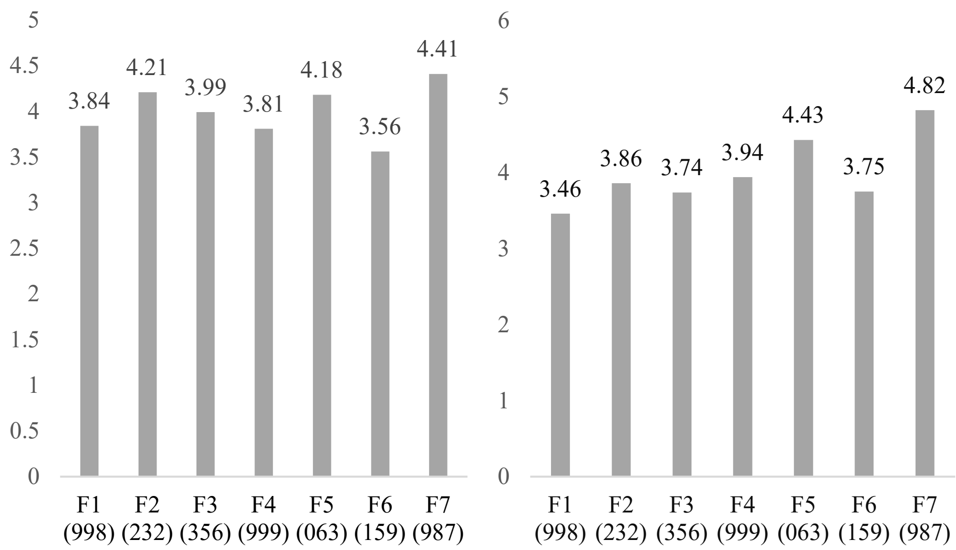

Figure 4. Sweetness and texture attribute scores according to the hedonic scale

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).

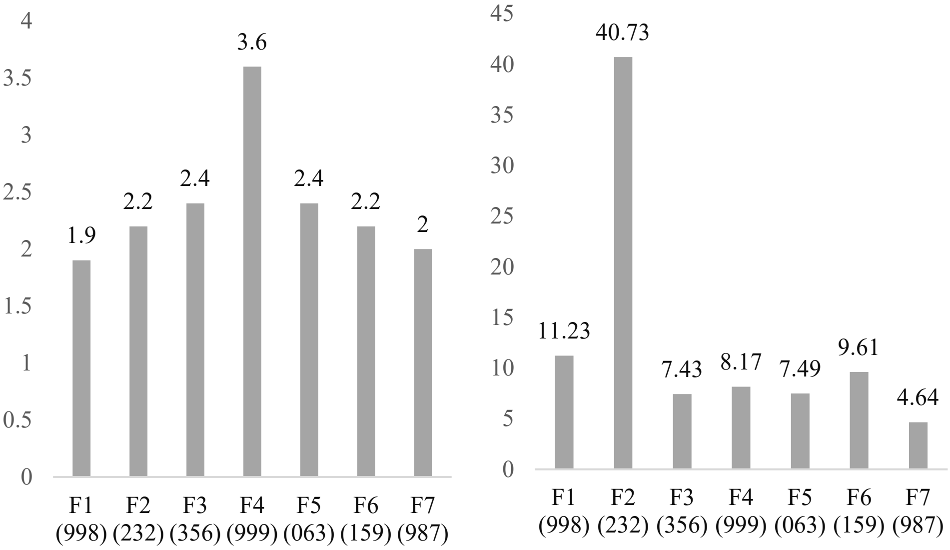

Figure 5. Acidity and appearance attribute scores based on the hedonic scale

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 ungurahui 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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- 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.