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ELABORACIÓN DE MERMELADA PREBIÓTICA CON DIFERENTES NIVELES DE PULPA DE COPOAZÚ

PREPARATION OF PREBIOTIC JAM WITH DIFFERENT LEVELS OF COPOAZÚ PULP

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RESUMEN: La presente investigación tuvo como objetivo elaborar una mermelada prebiótica utilizando diferentes niveles de pulpa de copoazú (Theobroma grandiflorum), con la finalidad de obtener un producto funcional con características fisicoquímicas, sensoriales y económicas adecuadas para el consumo humano. Se aplicó un Diseño Completamente al Azar con tres tratamientos correspondientes a diferentes porcentajes de pulpa de copoazú: T1 (30 %), T2 (40 %) y T3 (50 %), cada uno con cinco repeticiones de 500 gramos. Las muestras elaboradas fueron sometidas a análisis fisicoquímicos, evaluación sensorial y análisis económico. Entre los parámetros fisicoquímicos evaluados se determinaron humedad, pH, acidez titulable, cenizas, actividad de agua, fibra bruta y sólidos solubles (°Brix). Los resultados mostraron diferencias significativas entre tratamientos para algunas variables, evidenciando que el incremento del porcentaje de pulpa influye en las características finales del producto. En cuanto al mejor tratamiento fue al 40% de adición de pulpa de copoazú (T2), presentó el valor más alto en fibra (1,38%), ceniza (0,24%), menor Aw (0,863%), lo que demuestra el aporte funcional del copoazú como fuente natural de fibra dietética. La evaluación sensorial se llevó a cabo mediante escala hedónica donde no se evidencio diferencias significativas entre tratamientos en ninguno de los atributos evaluados. Asimismo, el análisis económico permitió determinar la viabilidad del proceso mediante el cálculo de costos de producción y relación beneficio-costo. Se concluye que la incorporación de pulpa de copoazú permitió obtener una mermelada con características de calidad adecuadas, potencial prebiótico asociado al contenido de fibra y aceptación sensorial favorable, constituyéndose en una alternativa innovadora para el aprovechamiento agroindustrial de esta fruta amazónica.

Palabras clave:* *Copoazú, mermelada prebiótica, fibra dietética, alimento funcional, innovación alimentaria

ABSTRACT: The present research aimed to develop prebiotic jam using different levels of copoazu pulp (Theobroma grandiflorum) to obtain a functional product with

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physicochemical, sensory, and economic characteristics suitable for human consumption. A completely randomized design was applied with three treatments corresponding to different percentages of copoazu pulp: T1 (30%), T2 (40%), and T3 (50%), each with five replicates of 500 grams. The samples were subjected to physicochemical analyses, sensory evaluation, and economic analysis. Among the physicochemical parameters evaluated were moisture content, pH, titratable acidity, ash content, water activity, crude fiber, and soluble solids (°Brix). The results showed significant differences among treatments for some variables, indicating that increasing the pulp percentage influences the final characteristics of the product. Regarding the best-performing treatment, the 40% copoazu pulp formulation (T2) showed the highest fiber content (1.38%), the highest ash content (0.24%), and the lowest water activity (0.863%), which highlights the functional contribution of copazu as a natural source of dietary fiber. Sensory evaluation was carried out using a hedonic scale, and no significant differences were found among treatments for any of the attributes assessed. Likewise, the economic analysis made it possible to determine the feasibility of the process through the calculation of production costs and the benefit-cost ratio. It is concluded that the incorporation of copoazu pulp yielded a jam with suitable quality characteristics, prebiotic potential linked to its fiber content, and favorable sensory acceptance, positioning it as an innovative alternative for the agro-industrial utilization of this Amazonian fruit.

Keywords: Copoazú, prebiotic jam, dietary fiber, functional food, food innovation

INTRODUCTION

Interest in functional foods has grown significantly in recent years, as consumers look for options that not only provide basic nutrients but also contribute to health and prevent diseases. Within this, prebiotic foods stand out because they help maintain the balance of the intestinal microbiota, they also strengthen the immune system and provide benefits against chronic non-communicable problems. This is an approach that opens the door to the development of new products or the improvement of traditional products such as jam, products that, although their formulation cannot be completely changed, can be made to be somewhat more beneficial than the products that are normally consumed and have a health benefit (1).

Jams are classified as frequently consumed products in homes, they are accepted by a large part of the population of Ecuador and the world (2); This means that prebiotics can be incorporated in a practical way, and thus have the possibility of transforming a food into a functional food that provides health benefits, allowing innovation to expand in agribusiness and being within current trends in the food consumption market.

Under this concept, the idea of making a jam was created using the fiber of Copoazú (Theobroma grandiflorum), an Amazonian fruit that is similar to cocoa, with pleasant aromatic properties that are slightly acidic and with an exotic flavor that makes it a spectacular candidate for developing new foods. This without mentioning all the benefits that it would bring to Amazonian communities by promoting the valorization of native species and generating an impact on the communities that depend on their

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DOI:
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Agosto 2026

cultivation and commercialization, according to (3) mentions that this fruit can become a useful ingredient in the manufacture of rich and healthy foods.

This process favors the production of metabolites with positive effects on intestinal health. The proposal of a prebiotic jam based on cupoazú becomes an innovative idea that combines flavor, aroma, color and texture with an additional physiological value. Prebiotic ingredients (such as fruit pectin or inulin) have been added to this fruit jam, which is healthy for the consumer.

This work aims to:

1. Evaluate the physicochemical properties of jam made with different levels of copoazú pulp (30, 40 and 50% fruit pulp).

2. Establish organoleptic characteristics through sensory tests.

3. Establish production costs and their profitability using the benefit-cost indicator.

MATERIALS AND METHODS

Location and duration of the experiment

The research was carried out in the Food Laboratory of the Faculty of Livestock Sciences of the Higher Polytechnic School of Chimborazo (ESPOCH), located at km 1½ of the Panamericana Sur. Laboratory analyzes were carried out in the Food and Bromatology Laboratory of the same faculty. The experimental phase had a total duration of 360 hours.

Experimental units

Each experimental unit was composed of three treatments which had in their mixture 30%, 40% and 50% of cupoazú pulp and other components used as ingredients for jam, which in turn were distributed into five repetitions per treatment; each composed of 500g of product, giving a total of 2500g per treatment.

Treatment and experimental design

In this experimental work, the effect of different levels of copoazú pulp (30, 40 and 50% addition) in the production of jam was evaluated, using 5 repetitions, resulting in a total of 2500 ml for each treatment, under a completely randomized design (DCA) in a combinatorial arrangement using an additive linear model.

The results of the physical tests were analyzed using:

- Analysis of variance (ADEVA) with $P < 0.05$.

- Multiple comparisons between the means, using the Tukey test ($P < 0.05$).

- The results of the sensory analysis were obtained according to the Kruskal wallis test

ISSN:
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DOI:
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Agosto 2026

- INFOSTAT statistical software was used for data tabulation.

Table 1. Scheme of the experiment.

Niveles de pulpa añadida	Repeticiones	TUE*	Total/g
30%	5	500	2500
40%	5	500	2500
50%	5	500	2500
Total			7500

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Statistical analysis and significance tests

The data obtained were subjected to an Analysis of Variance (ANOVA) corresponding to the completely randomized design (DCA), with the objective of determining if there are significant differences between treatments in the variables evaluated; If significant differences are detected ($p < 0.05$), the Tukey test is applied to compare the means of the treatments and establish the optimal level of cupoazú pulp in the jam formulation

Table 2. Scheme of the analysis of variance (ADEVA).

Fuente de variación	Grados de libertad (gl)	Suma de cuadrados (SC)	Cuadrado medio (CM)	F calculado
Tratamientos	$t-1$	SCT	$SCT/(t-1)$	CMtrat/CMerror
Error	$N-t$	SCE	$SCE/(N-t)$	
Total	$N-1$	SCTotal		

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Experimental procedure

Ripe and undamaged copoazú fruits were selected, washed with drinking water, the pulp was extracted by opening the fruit and manually removing it from the seeds. The base formulation was made and the different percentages of copoazú (30,40 and 50%) were added.

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Agosto 2026

Once the formulation was made, the pulp was placed in a stainless steel kettle and sugar and part of the water was added, then pectin dissolved in warm water was added to avoid lumps and cooking continued until reaching 65-68˚Brix.

Glass jars and lids were sterilized (hot water at 100 ˚C) and filled with hot jam (85-90˚C), then allowed to cool and stored in a cool, dry place.

The physicochemical parameters evaluated were pH, soluble solids (°Brix), titratable acidity, water activity (Aw), humidity, ash, crude fiber.

The sensory evaluation was carried out with 50 untrained panelists using a structured five-point hedonic scale, considering the attributes of color, smell, flavor, texture and appearance. Finally, an economic analysis was carried out using the benefit/cost indicator to determine the viability of the evaluated formulations.

RESULTS

Humidity

Averages of 36.17 were obtained for treatment 1 (T1); 35.61 for treatment 2 (T2) and 34.82 for treatment 3 (T3); means that did not show significant differences between the samples, which is a clear indicator that the level of water that was added is not different from the level of water that the fruit pulp brings once extracted, it could be inferred that the water content in the fruit within its natural composition is very high, (4) mentions that it also has to do with microbiological stability, according to the analyzes carried out the humidity is below 40%, an indicator that other components such as sugar are in higher concentration and may have a favorable effect on conservation indirectly.

Hydrogen potential (pH)

The pH known as hydrogen potential is fundamental in the physical-chemical evaluation of foods; it is a determining factor in its conservation, palatability and microbiological stability (5). In the results obtained, significant differences were observed between treatments, where T2 presented the lowest pH value (3.69), while T1 and T3 recorded values of 3.87 and 3.82, respectively, without statistical differences between them. It can also be said that the pH obtained contributes positively to the microbiological stability of the jam. According to what (6) mentions, foods with a pH lower than 4.5 present a lower risk of microorganism growth.

This behavior can be directly associated with the proportion of cupoazú pulp and the interaction of the organic acids naturally present in the fruit with the citric acid incorporated in the formulation, in addition to influencing unmeasured parameters but that are quality characteristics such as the level of pectin gelation and consequently influencing the texture.

Although T3 presented a higher pulp content (50%), the considerable reduction in added water could generate a buffer effect due to the concentration of solids and structural compounds of the fruit. (7) point out that food systems rich in

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Agosto 2026

polysaccharides, sugars and minerals can modify the activity of free protons, causing variations between pH and total acidity.

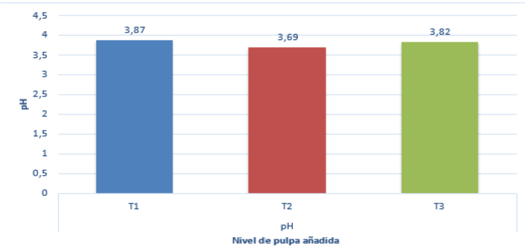

Figure 1. Behavior of pH between the three treatments.

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Titratable Acidity

The behavior of the pH is closely related to the titratable acidity obtained in the treatments, although both parameters are associated, the pH measures the concentration of free hydrogen ions, while the titratable acidity quantifies the total acids present in the food (8). This explains why T3 presented the highest titratable acidity, but not the lowest pH value. The presence of fiber, soluble solids and minerals from the pulp can exert a buffer effect on the system, partially stabilizing the pH value.

From a technological point of view, the values obtained were suitable for the production of jams with high methoxylation pectin, used in the experimental formulation. This type of pectin requires an approximate pH range between 2.8 and 3.8 to form stable gels, because acidity reduces the electrostatic repulsion between pectin chains and favors the formation of the gelled network. (9) mentions that higher pH values decrease the gelling capacity and affect the final texture of the product.

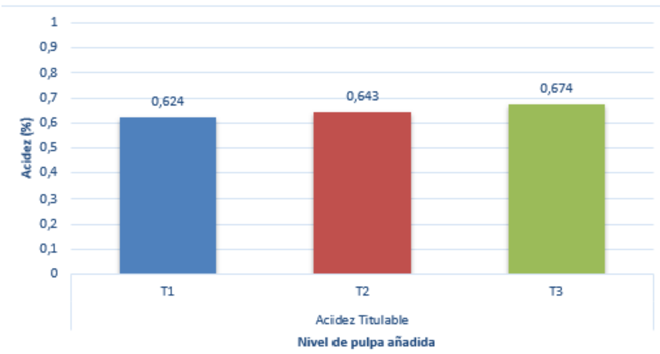

Figure 2. Behavior of titratable acidity between the three treatments.

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Although the analysis of variance showed significant differences between treatments for pH, the linear regression presented a low R^2 (0.0724), indicating that these differences do not follow a linear behavior with the increase in the percentage of

ISSN:
3091-1796
Vol. 4 No. 10 PP. 172-189

DOI:
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Agosto 2026

cupoazú pulp. Consequently, the effect of pulp percentage on pH cannot be adequately explained by a simple linear model.

Linear regression (y = 0.0025x + 0.547; R^2 = 0.98) shows a very strong positive linear relationship between the percentage of copoazú pulp and acidity. As pulp increases, acidity also increases, and the model explains 99% of the observed variation.

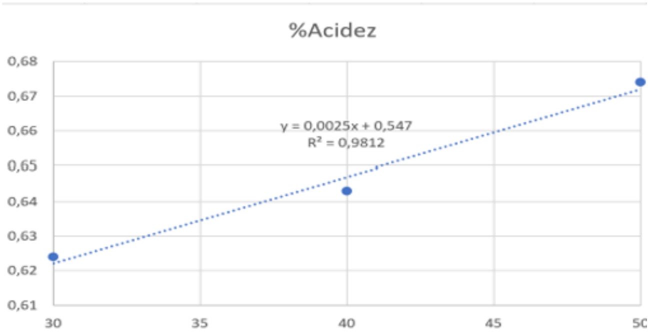

Figure 3. Linear correlation of acidity between the three treatments.

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Ashes

The ash content presented significant statistical differences between treatments, with T2 being the one that registered the highest value (0.24%), followed by T1 (0.21%) and T3 (0.19%); The parameter studied represents the total content of minerals present in the product.

The increase observed in T2 can be attributed to a greater availability of minerals from the cupoazú pulp, especially potassium, calcium and phosphorus, which remain relatively stable during cooking, but in T3, despite containing a higher percentage of pulp, the decrease in ash could be related to structural dilution phenomena and possible mineral losses during prolonged heat treatment. According to (10), it is mentioned that thermal concentration processes can modify the mineral distribution in fruit products due to interactions with peptic compounds and salt precipitation.

Furthermore, the behavior of the ashes is related to the solids content and the physicochemical composition of the treatment.

ISSN: 3091-1796
Vol. 4 No. 10 PP. 172-189
DOI: https://doi.org/10.56519/wt5jt088
Agosto 2026

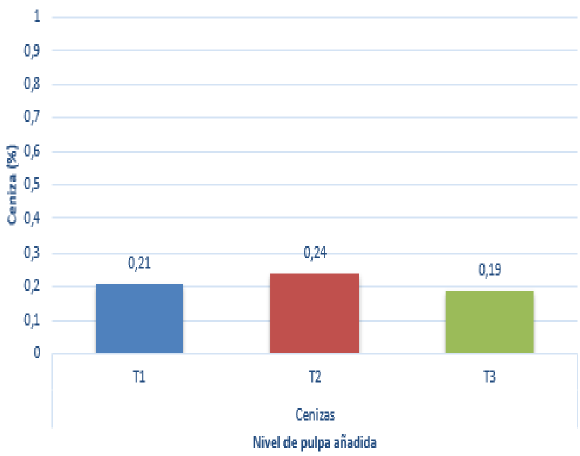

Figure 4. Ash behavior between the three treatments.

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The linear regression (y = -0.0025x + 0.1133; $R^2 = 0.9868$) indicates a very strong negative linear relationship between the percentage of copoazú pulp and the ash content. As the pulp increases, the ash content decreases slightly, the model explaining 98.68% of the observed variation

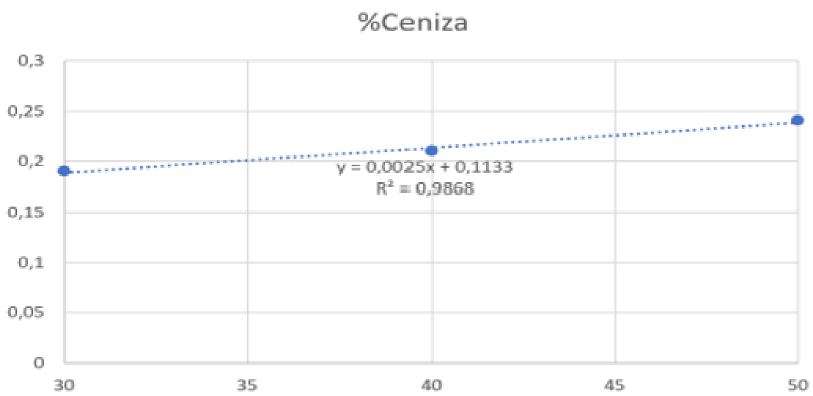

Figure 5. Linear correlation of ash between the three treatments.

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Water activity (Aw)

Water activity (Aw) presented significant statistical differences between treatments, where T2 presented the lowest value (0.863), while T3 reached the highest value (0.900). This behavior is directly related to the proportion of pulp, the content of added water and the concentration of soluble solids present in each formulation.

The smaller value of Aw in T2 indicates a greater retention of bound water within the final product, which was inferred to have been favored by an adequate balance

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Vol. 4 No. 10 PP. 172-189
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Agosto 2026

between sugar, pectin and structural compounds of the pulp. In jam-type systems, sugars reduce the availability of free water through osmotic effects, thus limiting water mobility and contributing to product stability. According to (11), the decrease in Aw in concentrated foods is one of the main conservation mechanisms, since it restricts microbial development and reduces the speed of chemical deterioration.

In treatment 3, on the other hand, it can be associated with the higher content of cupoazú pulp, which provides intracellular water and hydrophilic compounds capable of retaining moisture within the system. Although this treatment had a lower added water content, the fruit contributed significantly to the total available water. Furthermore, the reduction of soluble solids observed in T3 decreased the depressing effect of sugar on water activity, favoring higher Aw values.

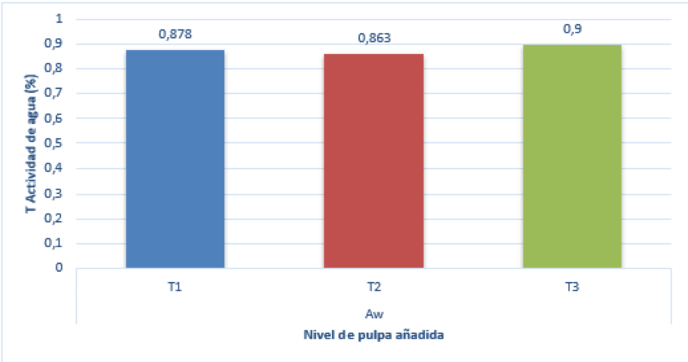

Figure 6. Behavior of water activity (Aw) between the three treatments.

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The Aw also showed an inverse relationship with the soluble solids obtained in the treatments. T1 presented a higher °Brix and a lower Aw than T3, confirming what was said by (12) that the increase in sugars favors the immobilization of free water. This behavior coincides with what was reported by (13), who points out that foods with a high concentration of soluble solids present lower water activity due to the formation of bonds between water molecules and solutes.

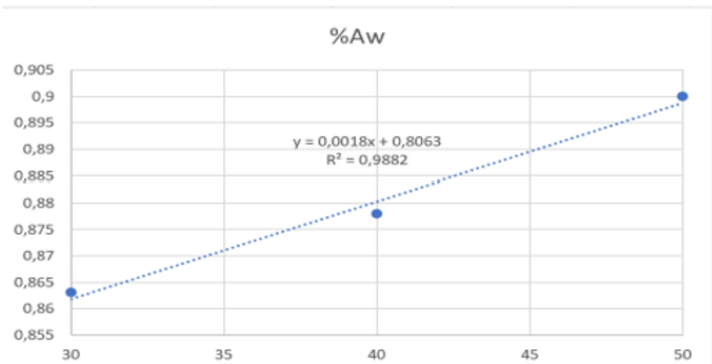

Figure 7. Linear correlation of Aw between the three treatments.

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The regression equation showed a positive linear relationship and a high coefficient of determination (R^2=0.9882), indicating that the percentage of pulp significantly influenced this parameter. This behavior can be attributed to the contribution of moisture from the copoazú pulp.

Gross fiber

The crude fiber presented significant statistical differences between treatments, obtaining the highest value in T2 (1.38%), followed by T1 (1.26%) and T3 (1.11%), the behavior is assured to be directly influenced by the proportion of cupoazú pulp and by the effect of thermal processing on the structural components of the fruit.. The increase observed in T2 can be attributed to an adequate concentration of plant tissue in the formulation, allowing the preservation of a greater amount of structural polysaccharides such as cellulose, hemicellulose and insoluble pectins.. Although, in T3, despite containing a higher percentage of pulp, a decrease in fiber was evident, possibly associated with thermal degradation.. According to (14), cellulose, hemicellulose and lignin are part of this fruit and during cooking and concentration of the product they can degrade since the temperature in the burner could have varied at a critical moment.. The behavior of the fiber is related to the consistency and water retention of the product since dietary fibers have the capacity for hydration and formation of structural networks, influencing parameters such as viscosity and water activity.. (15) menciona que, en productos derivados de frutas, la estabilidad de la fibra depende tanto de la intensidad térmica como del equilibrio entre sólidos solubles y contenido de humedad.

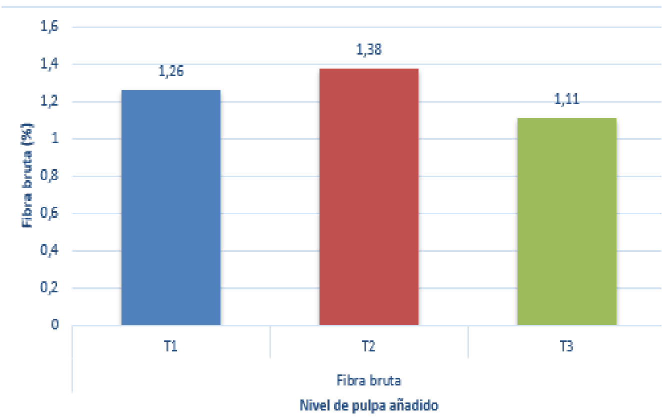

Figure 8. Behavior of crude fiber between the three treatments.

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Although the treatment with 40% pulp had the highest crude fiber content, a strong linear relationship was not observed between the percentage of pulp and the fiber content, due to the low coefficient of determination (R^2=0.3074). This indicates that other factors, such as thermal processing or experimental variability, could have influenced the results.

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Agosto 2026

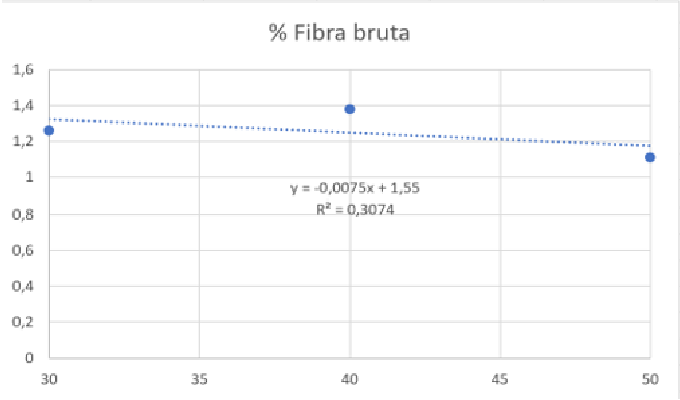

Figure 9. Linear correlation of crude fiber between the three treatments.

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Soluble solids (˚Brix)

Soluble solids presented significant statistical differences between treatments, with the highest value recorded in T1 (65.1 °Brix) and the lowest in T3 (62.4 °Brix). Behavior was influenced by the increase in the content of copoazú pulp and the relative decrease in soluble solids available in the formulation, and as the proportion of fruit increased, greater quantities of intrinsic water and insoluble compounds were incorporated, generating a dilution effect on the final concentration of sugars. and dissolved solids.

From a regulatory point of view, T1 was the only treatment that met the minimum established for jams, which indicate minimum values close to 65 °Brix to guarantee stability, consistency and conservation of the product. In T2 and T3, lower values could affect the conservation capacity due to lower osmotic pressure and greater availability of water for microbial development, but at the pH level used in all treatments this situation can be faced and counteracted.

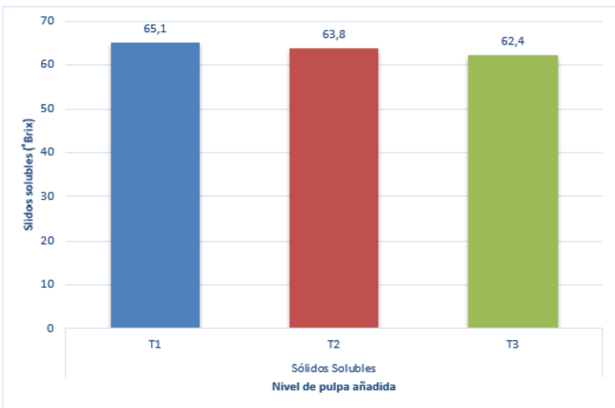

Figure 10. Behavior of soluble solids between the three treatments.

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The progressive decrease in soluble solids by increasing the concentration of copoazú pulp. The behavior presented a very strong negative linear correlation (R^2=0.9995),

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Vol. 4 No. 10 PP. 172-189

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Agosto 2026

indicating that the increase in pulp reduces the concentration of soluble sugars in the formulation.

(16) points out that insufficient concentrations of solids can reduce the firmness and stability of jam-type products.

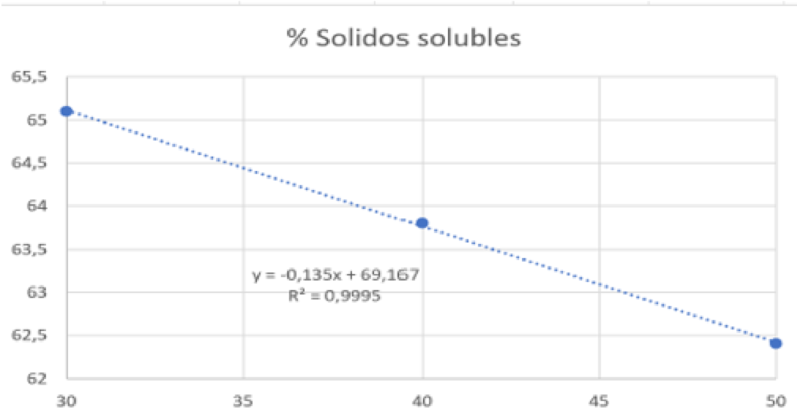

Figure 11. Behavior of soluble solids between the three treatments.

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Sensory evaluation

An acceptability test was performed on 50 untrained panelists where they were presented with the attributes odor, flavor, texture, color and general appearance. A 5-point hedonic scale was imposed on them, where they were asked to give a value based on this range to describe the sensory qualities of the product in question. Each sample was coded with three random numbers without repeating any. The rules were not to communicate with each other, avoid turning and being very honest in their perception of the importance of the study. Table 3 shows the average results obtained for each experimental treatment

Table 3. Average results of the Sensory evaluation of jam made with different levels of copoazú pulp.

Tratamiento	Color	Olor	Sabor	Textura	Apariencia	Promedio general
T1 (30%)	4.18	4.04	4.06	3.8	3.98	4.01
T2 (40%)	4.28	3.98	3.98	4.1	3.94	4.06
T3 (50%)	4.02	4.02	3.9	4.08	3.86	3.98

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The sensory analysis of the prebiotic copoazú jam, evaluated using a five-point hedonic scale and analyzed with the non-parametric Kruskal-Wallis test ($p > 0.05$), showed that there were no significant differences between the treatments for the attributes of color, smell, flavor, texture and appearance. The averages obtained ranged between 3.80 and 4.28, which indicates favorable acceptance by the panelists. Although the treatment with 40% pulp presented the highest overall average of acceptability (4.06), followed by the treatment with 30% (4.01) and 50% (3.98), these differences were not statistically significant. These results suggest that the increase in the content of copoazú pulp did not perceptibly modify the sensory characteristics of the product, maintaining an adequate organoleptic quality and demonstrating that it is possible to increase the pulp content without affecting consumer acceptance, as mentioned (17), the thermal treatment given to the jam favors a certain loss of compounds, partially homogenizing the characteristics between the treatments, likewise its smell was quite characteristic, according to (18) the fruit of the copoazú has a high content of compounds. aromatics.

Economic Analysis

The economic analysis was carried out with the purpose of determining the economic viability of making jam using different levels of cupoazú pulp. For this, the costs of raw materials, inputs, packaging, labor, energy, cleaning and depreciation were considered; all these aspects are described in table 4.

Table 4. Production costs of jam with different levels of cupoazú pulp.

Elemento	Costo total	Costo/frasco (500 g)
Materia prima	30.00	2.5
Insumos	8.7	0.7
Envase	10	0.8
Mano de obra	10	0.8
Energía	3	0.2
Limpieza	1.5	0.13
Depreciación de equipos	2	0.17
Total	$ 65.2	$ 5.3

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The costs incurred for the production of copoazú jam allowed us to determine a total production cost of 65.20 USD, equivalent to an approximate cost of 5.30 USD per 500 g jar and with a cost-benefit index of $1.49.

The raw material represented the highest percentage of the total production cost, mainly due to the price of cupoazú and the low yield of pulp obtained during processing; This fruit has a high proportion of peel and seeds, which increases shrinkage and reduces industrial yield. According to (19), products made from non-traditional tropical fruits usually have higher costs due to the limited availability of raw materials and the difficulty of standardizing production processes, which was explained previously.

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Labor also presented a significant value, which is related to the artisanal nature of production and the value of the basic salary, according to (20) mentions that in developing countries the availability of this is affected by the lack of industry that demands and sees viability.

The benefit/cost ratio was favorable for all the treatments evaluated since an established market sale price of $6.50 and the production price of $65.25 were taken, the total benefit was $97.5 and giving us a final profitable value of $1.49.

DISCUSSION

The results obtained showed that the percentage of cupoazú pulp mainly influenced the pH, titratable acidity, ash, water activity, crude fiber and soluble solids, while humidity did not present significant differences. Treatment T2 (40% pulp) presented the best general performance, standing out for its highest crude fiber content (1.38%), ash (0.24%) and lower water activity (0.863). This behavior demonstrates that the formulation and processing conditions influence the final characteristics of the jam, as also pointed out by (4) for products made from fruits.

The pH presented significant differences, with the lowest value in T2 (3.69), while T1 and T3 registered 3.87 and 3.82, respectively. The values obtained correspond to an acidic food and favor the stability of the product. (5) point out that pH is an important parameter in the physicochemical stability of fruit products. On the other hand, the titratable acidity increased as the amount of pulp increased, presenting a strong linear relationship (R^2 = 0.98). This difference between pH and acidity can be explained because pH represents free hydrogen ions, while titratable acidity reflects the total amount of acids present in the food.

The ash content was higher in T2 (0.24%) and lower in T3 (0.19%), which demonstrates that a higher percentage of pulp does not necessarily proportionally increase the mineral content. (10) mentions that thermal processes can modify the distribution of minerals in foods. Regarding water activity, T2 presented the lowest value (0.863), while T3 reached 0.900. This behavior can be related to the concentration of sugar, pectin and soluble solids. (11) point out that the reduction of water activity contributes to improving the stability of foods, while (13) indicate that a higher concentration of soluble solids favors the decrease in available water.

Crude fiber presented its highest value in T2 (1.38%), followed by T1 (1.26%) and T3 (1.11%). Although a progressive increase was expected with a greater amount of pulp, treatment T3 presented a decrease, possibly related to the effect of thermal processing. (14) points out the importance of the structural components of plant cell walls, while (15) indicates that processing can modify the stability of the fiber. Soluble solids, for their part, decreased from 65.1 °Brix in T1 to 62.4 °Brix in T3, presenting a very strong negative linear relationship (R^2 = 0.9995). This can be attributed to the greater contribution of water and insoluble components of the pulp as their proportion increases.

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Agosto 2026

In the sensory evaluation, no significant differences were found between treatments for color, smell, flavor, texture and appearance, with favorable averages between 3.80 and 4.28 points. T2 obtained the highest general acceptance (4.06), although the differences were not significant. These results indicate that the increase in pulp did not negatively affect the acceptance of the product. (17) relate heat treatment to the homogenization of certain characteristics of fruit products, while (18) highlight the characteristic aromatic compounds of copoazú.

Finally, the economic analysis showed a total production cost of 65.20 USD, an approximate cost of 5.30 USD per 500 g jar and a benefit/cost ratio of 1.49, indicating economic viability under the experimental conditions. (19) points out that products made with non-traditional tropical fruits may have high costs due to the availability and performance of the raw material. Overall, T2 was the treatment with the best physicochemical and sensory balance. Although the product contains dietary fiber, the content obtained does not allow it to be considered strictly as a prebiotic. However, the use of copoazú represents a value-added alternative for the development of innovative agroindustrial products.

CONCLUSIONS

Among the treatments evaluated, treatment T2, corresponding to 40% of cupoazú pulp, presented the best balance, standing out for registering the highest crude fiber content (1.38%), highest ash content (0.24%), and lowest water activity (0.863%). These results allow it to be considered the most suitable formulation for making jam. Furthermore, although the jam obtained cannot be strictly considered a prebiotic product because it has a moderate fiber content, it can be classified as a product with a significant contribution of dietary fiber, which gives it nutritional value and functional potential for the consumer.

Regarding the sensory evaluation, it was carried out using the same hedonic scale that did not show significant differences ($p>0.05$) between treatments, in any of the attributes evaluated, which indicates that the variation in pulp content does not generate perceptible changes in consumer acceptance, maintaining a homogeneous and pleasant sensory profile for the consumer, since on average the results were favorable.

The economic analysis determined a total production cost of 65.20 USD and a unit cost of 5.30 USD per 500 g jar, evidencing that the cost structure is mainly determined by the raw material, packaging and labor, the high cost responds to structural factors such as the limited availability of copoazú in the study area since it was worked in the mountains of Ecuador and the product is grown in the Amazon area, therefore, the product was brought to order, therefore the logistical supply costs and the experimental scale of production increased the cost, which prevents the application of economies of scale, but the results demonstrate the technical viability of the product and its potential for agro-industrial scaling, especially in market niches of natural and value-added products, or as

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an exclusive product due to its great sensory profile. Likewise, the product was profitable by achieving a 1.49 in the benefit-cost index.

REFERENCES

1. Ballesteros, Gonzales. Role of prebiotics and probiotics in the functionality of the microbiota in the patients receiving enteral nutrition. 2020. DOI: https://dx.doi.org/10.20960/nh.1956.
2. Montecel N. Plan de negocio para la producción y comercialización de mermelada y té de cacao con stevia en la ciudad de Guayaquil [tesis]. Universidad Agraria del Ecuador; 2021. Disponible en: https://cia.uagraria.edu.ec/Archivos/MONTECEL%20GOMEZ%20MELISSA%20NAYBI.pdf.
3. Salazar J. Agroindustrial Residues as Sources of Nutrients and Phenolic Compounds. Epistemus. 2023;17(34). DOI: https://doi.org/10.36790/epistemus.v17i34.265.
4. Guevara-García M, et al. Energetic value and sensorial characteristics of jam formulated with Cucurbita ficifolia B. - Citrus sinensis L. and pectin sweetened with stevia. Revista de Invest. Agropecuaria Science and Biotechnology. 2025;5(4):1-11. DOI: http://doi.org/10.25127/riagrop.20254.1127.
5. Castillo K, et al. Bromatological and physicochemical characterization of an acai jam (Euterpe Oleracea Mart.) sweetened with cocoa mucilage. Reincisol. 2024;3(6):929-952. DOI: https://doi.org/10.59282/reincisol.V3(6)929-952.
6. FAO. Bases técnicas para el aprovechamiento agroindustrial de especies nativas de la amazonia. 2025. Disponible en: https://www.fao.org/fileadmin/templates/inpho/documents/ad418s00.pdf.
7. Shahida A, et al. An overview of fermentation in the food industry - looking back from a new perspective. Bioresour Bioprocess. 2023;10. DOI:10.1186/s40643-023-00702-y.
8. Geraldine M. Acidez Titulable y pH en Alimentos. 2025. Disponible en: https://es.scribd.com/document/526676883/ACIDEZ-TITUABLE-Y-PH.
9. García E. Desarrollo y Caracterización de Mermelada producida a partir del fruto de mate Crescentia cujete L. [tesis]. Universidad Técnica de Ambato; 2019. Disponible en: https://repositorio.uta.edu.ec/server/api/core/bitstreams/e2c6160a-76d6-40ea-a53e-18724b6effd9/content.
10. Jacqueline B. Mineral in Food. 2020. En: ScienceDirect Topics. Disponible en: https://www.sciencedirect.com/topics/food-science/mineral-in-food.
11. Campo R, et al. Degradación de los componentes químicos presentes en los alimentos por influencia de la temperatura. Pol. Con. 2023;8(85). DOI:10.23857/pc.v8i8.
12. Febles J, et al. Análisis preliminar del efecto de la actividad de agua sobre la viabilidad y estabilidad en formulaciones de probióticos. 2016. Disponible en: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2223-48612016000100009.
13. Yadav A, et al. Deshidratación osmótica de frutas y verduras. 2012. DOI:10.1007/s13197-012-0659-2.

14. Fujimori S. Humans have intestinal bacteria that degrade the plant cell walls in herbivores. World J Gastroenterol. 2021;27(45):7784. DOI:10.3748/wjg.v27.i45.7784.
15. Pak N. Fibra dietética en frutas cultivadas en Chile. Arch Latinoam Nutr. 2013;53(4). Disponible en: https://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0004-06222003000400013.
16. López C, et al. Fourier transform infrared spectroscopy (FTIR) application chemical characterization of enamel, dentin and bone. 2025. DOI:10.1080/05704928.2018.1431923.
17. Zelanda C, et al. Efecto de la temperatura de pasteurización y proporción de mezclas binarias de pulpa de carambola y mango sobre su capacidad antioxidante lipofílica. 2013. Disponible en: https://www.redalyc.org/pdf/3374/337430545009.pdf.
18. Quispe R, et al. Análisis de la actividad antioxidante durante el proceso de producción del néctar de copoazú. Revista Alfa. 2025;9(26). DOI: https://doi.org/10.33996/revistaalfa.v9i26.357.
19. Monar A. Relación entre la manufactura de frutas tropicales y la cadena de valor de bebidas no alcohólicas en Manabí-Ecuador. ECA Sinergia. 2019;10(3). DOI: https://doi.org/10.33936/eca_sinergia.v10i3.1815.
20. Revilla, Guerrero. Desarrollo de mermelada de flor de jamaica (Hibiscus sabdariffa) en diferentes estados (natural y deshidratada). Pontificia Universidad Católica del Ecuador; 2025. Disponible en: https://repositorio.puce.edu.ec/items/fa790407-15e1-4907-952c-63c1e262e37d.