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Postharvest conditions of *Capsicum annuum* and their effect on hot sauce added *Ananas comosus*

Condiciones postcosecha de *Capsicum annuum* y su efecto en la salsa picante añadida con *Ananas comosus*

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ABSTRACT

Postharvest handling of ingredients directly influences the sensory quality and stability of derived food products. This study aimed to evaluate the effect of the postharvest condition of chili pepper (*Capsicum annuum* L.) (fresh or dehydrated) and its proportion with pineapple (*Ananas comosus* (L.) Merr.) on the physicochemical and sensory properties of a hot sauce. A completely randomized design with a factorial A×B arrangement (chili condition × pineapple percentage) was used, generating six treatments with three replications. Physicochemical variables were analyzed using ANOVA and Tukey's test ($P \leq 0.05$), while sensory attributes were evaluated using the Kruskal-Wallis test. Treatments with dehydrated chili (T4–T6) showed higher pH, soluble solids content, and favorable sensory attributes such as color and flavor, with T4 (40% pineapple) standing out due to its high acceptability and lower pungency perception. In contrast, treatments with fresh chili (T1–T3) exhibited higher acidity, moisture, and pungency threshold, negatively affecting texture and overall perception. T6 reached the highest °Brix content (22.87), while T1 had the highest moisture (78.42%) and pungency (3.90). It is concluded that the use of dehydrated chili, especially in combination with 40–50% pineapple, significantly improves physicochemical and sensory parameters, enhancing product stability and consumer acceptance. These findings highlight the importance of postharvest handling in optimizing the formulation of value-added food products by balancing flavor, texture, and stability.

Keywords:
Acceptability
Added value
Physicochemical properties
Pungency threshold
Sensory profile

RESUMEN

El manejo postcosecha de ingredientes influye directamente en la calidad sensorial y estabilidad de productos derivados. Este estudio tuvo como objetivo evaluar el efecto del estado postcosecha del ají (*Capsicum annuum* (L.)) (fresco o deshidratado) y su proporción con piña (*Ananas comosus* (L.) Merr.) sobre las propiedades fisicoquímicas y sensoriales de una salsa picante. Se empleó un diseño completamente al azar con arreglo factorial A×B (estado del ají × porcentaje de piña), generando seis tratamientos con tres repeticiones. Las variables fisicoquímicas se analizaron mediante ANOVA y prueba de Tukey ($P \leq 0,05$), y los atributos sensoriales con Kruskal-Wallis. Los tratamientos con ají deshidratado (T4–T6) presentaron mayor pH, contenido de sólidos solubles y atributos sensoriales favorables como color y sabor, destacando T4 (40% piña), con alta aceptabilidad y menor percepción de pungencia. En contraste, los tratamientos con ají fresco (T1–T3) exhibieron mayor acidez, humedad y umbral de pungencia, lo que afectó negativamente la textura y percepción global. T6 alcanzó el mayor contenido de °Brix (22,87), mientras que T1 mostró la mayor humedad (78,42%) y pungencia (3,90). Se concluye que el uso de ají deshidratado, especialmente combinado con 40–50% de piña, mejora significativamente los parámetros fisicoquímicos y sensoriales, favoreciendo la estabilidad y aceptación del producto. Esta evidencia resalta la importancia del manejo postcosecha para optimizar la formulación de alimentos con valor agregado, equilibrando sabor, textura y estabilidad.

Palabras clave:
Aceptabilidad
Valor agregado
Propiedades fisicoquímicas
Umbral de picor
Perfil sensorial

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The chili pepper (*Capsicum annuum* (L.)) has been the subject of numerous studies in the food industry due to its capsaicin content (Gonçalves et al. 2024; Rezazadeh et al. 2021), an alkaloid responsible for its characteristic spiciness, a parameter that influences consumer acceptance of the product (Sunarmani et al. 2024). This compound has been crucial for the creation of various food products, such as sauces, stews, and dehydrated foods, which stand out for their unique sensory profiles (Hameed et al. 2022). In addition to providing spiciness, capsaicin has facilitated the incorporation of chili peppers into various culinary traditions, particularly in the preparation of hot sauces, an essential ingredient in many cuisines worldwide (Marikos 2024).

In Ecuador, the hot sauce industry represents a significant economic sector, with a production of 224 million kilograms in 2022, of which 6% was allocated to exports. These exports generated revenues of $669 million, marking a 10% increase compared to the previous year (Chong and Parra 2019). Although it is not a staple food, hot sauce has become an essential complement to many traditional dishes, in addition to being a distinctive cultural element in various regions, driven by global trends (Pazos 2021).

One of the key factors in hot sauce production is the choice of the chili pepper's postharvest state, which is generally used fresh (Yin et al. 2021). However, studies have shown positive results when using dehydrated chili peppers, highlighting their enhanced sensory characteristics (Li et al. 2022).

The local hot sauce market is limited in terms of ingredients and formulations, which reduces the options available to consumers. To innovate and diversify production, it is essential to explore new alternatives that enrich flavor and expand the variety of products. The incorporation of tropical fruits, such as pineapple (*Ananas comosus* (L) Merr.), represents a promising option. This fruit, widely cultivated in Ecuador (Abad and Pérez 2024), is rich in vitamin C, bromelain, and antioxidants, compounds that not only enhance the sensory qualities of hot sauce but also provide additional nutritional benefits (Ortega et al. 2021; Santos et al. 2021).

Considering the above and the fact that the sauce market in Ecuador is growing, where hot sauces play an important role, it is pertinent to carry out studies aimed at increasing the added value of chili bell pepper harvests and improving the competitiveness of the sector. Therefore, the aim of this research was to evaluate the effect of the post-harvest state of chili bell pepper (*Capsicum annuum* (L.)) (fresh or dehydrated) and its proportion with pineapple (*Ananas comosus* (L.) Merr.) on the physicochemical and sensory properties of a hot sauce.

MATERIALS AND METHODS

Location of the experimental site

The preparation of the treatments was carried out in the Unit Operations Laboratory. The physicochemical analysis was conducted in the Bromatology Laboratory, and the sensory analysis was performed with a group of students from the Faculty of Industry and Production Sciences (FCIP). These locations are within the La María campus of the Universidad Técnica Estatal de Quevedo (UTEQ), located at kilometer 7.5 of the Quevedo-El Empalme highway, in the San Felipe precinct, Mocache canton, Los Ríos province, at the geographic coordinates 01°04'56" S, 79°30'08" W.

Data analysis

The data on physicochemical characteristics were subjected to analysis of variance. A Completely Randomized Design with a bifactorial AxB arrangement was applied, which involved the interaction between levels of factor A (Postharvest state of the chili pepper) and factor B (Pineapple inclusion percentage), as described in Table 1.

Table 1. Experimental factors and levels for chili sauce production.

Factors	Code	Levels
Postharvest state	A	a0: Fresh chili pepper a1: Dehydrated chili pepper
Pineapple inclusion percentage	b	b0: 40% pineapple b1: 45% pineapple b2: 50% pineapple

The interaction between factors resulted in six treatments (Table 2), each with three replications, forming a total of 18 experimental units. To determine statistical differences between treatments, Tukey's test ($P \leq 0.05$) was applied using the InfoStat statistical software.

On the other hand, the sensory analysis data did not follow a normal distribution; therefore, the non-parametric Kruskal-Wallis test was used.

Experiment management

Pineapple juice processing

The selection of pineapples (MD2 variety) followed the criteria of Ganoza-Yupanqui et al. (2021), ensuring a soluble solids content between 12° and 15° Brix for an optimal balance of sweetness and acidity. The fruits were then washed with potable water to ensure product hygiene. After washing, the pineapples were peeled, cored, and chopped to facilitate processing. To enhance their sensory profile, the pieces were roasted, caramelizing their natural sugars and intensifying their flavor. Finally, the roasted pieces were blended until a homogeneous mixture was obtained, which was then filtered to separate the juice from the sediments. This process ensured a clean and high-quality base for the preparation of the treatments.

Table 2. Factorial arrangement with the proposed treatment combinations for the experimental design.

No.	Symbol	Description
T1	a0b0	Fresh chili + 40% pineapple
T2	a0b1	Fresh chili + 45% pineapple
T3	a0b2	Fresh chili + 50% pineapple
T4	a1b0	Dehydrated chili + 40% pineapple
T5	a1b1	Dehydrated chili + 45% pineapple
T6	a1b2	Dehydrated chili + 50% pineapple

Processing of spicy sauce with fresh and dried chili pepper

The chili peppers (Ratón variety) were thoroughly washed with potable water to remove impurities. The seeds and peduncles were then removed, ensuring the exclusive use of the pericarp and avoiding bitter flavors. For the treatments using fresh chili, the pericarps were blanched in hot water at 90 °C for 5 minutes, softening their texture while preserving their color and flavor. They were then blended until a homogeneous paste was obtained and filtered to remove sediments and seed residues. In contrast, the chili intended for dry treatments was dehydrated at 80 °C for 5 hours, resulting in a fine powder. Finally, both the chili paste and powder were mixed with the filtered pineapple juice, along with spices and other ingredients, in the proportions established in Table 3.

Table 3. Formulation of chili sauce treatments with pineapple addition.

Ingredients	T1 (%)	T2 (%)	T3 (%)	T4 (%)	T5 (%)	T6 (%)
Pineapple	40	45	50	40	45	50
Fresh Chili	10	10	10	-	-	-
Dried Chili	-	-	-	1.6	1.6	1.6
Water	20	15	10	28.4	23.4	18.4
Vinegar	7	7	7	7	7	7
Salt	3	3	3	3	3	3
Sugar	6	6	6	6	6	6
Bell Pepper	2	2	2	2	2	2
Onion	7	7	7	7	7	7
Garlic	5	5	5	5	5	5

The mixtures obtained in the different formulations (treatments) were subjected to cooking at 90 °C for 15 minutes, allowing for complete flavor integration and achieving the desired consistency. Subsequently, the hot sauces were packaged in labeled glass jars, previously sterilized at 100 °C, ensuring their preservation. The jars were gradually cooled to 36 °C to stabilize the product before final storage at 4 °C, guaranteeing quality and extending shelf life.

Evaluated variables

Physicochemical characteristics

pH determination

Ten grams of the sample were weighed into a beaker, and 100 mL of distilled water was added. The mixture was homogenized using a stirring rod, and the pH was measured by immersing the electrode of a previously calibrated pH-meter.

Volatile acidity (%)

Ten grams of the sample were weighed into an Erlenmeyer flask, followed by the addition of 50 mL of distilled water. The mixture was homogenized, and a burette was filled with 0.1 N NaOH. The electrode of the pH-meter was inserted into the diluted sample, and titration with NaOH was performed until a sudden change in the reading indicated the equivalence point. The calculation was performed using Equation 1.

$$\text{Volatile acidity}(\%) = \frac{vNaOH * NNaOH * Meq}{m} * 100 \quad (1)$$

Where v is the volume of NaOH consumed (mL), N is the normality of the NaOH solution, Meq is the molar mass expressed in g mol^{-1} (98.079 for sulfuric acid), and m is the sample weight (g).

Soluble solids measurement (°Brix)

A sample was collected using a metal spoon and placed directly onto the measuring surface of the refractometer. By pressing the start button, the device automatically provided the reading, displaying the result as a percentage.

Moisture determination (%)

Crucibles were dried in an oven at 100 °C for 30 minutes and cooled in a desiccator for 15 minutes. They were then weighed along with 1 g of the sample and placed in an oven at 100 °C for 24 hours. After an additional 15-minute cooling period, the final weight was recorded for moisture content calculation using Equation 2.

$$\text{Moisture determination}(\%) = \frac{m - (a - b)}{m} * 100 \quad (2)$$

Where m is the initial sample weight (g), a is the weight of the sample plus the crucible after drying, and b is the weight of the empty crucible.

Ash content determination (%)

The dried sample from the moisture analysis was placed in a muffle furnace at 500 °C for 4 hours. The samples were then cooled for 30 minutes and transferred to a desiccator for complete cooling over 15 minutes. The samples were weighed along with the crucible, and the data were recorded for calculation using Equation 3.

$$\text{Ash content determination}(\%) = \frac{W2 - W1}{W0} * 100 \quad (3)$$

Where W0 is the sample weight (g), W1 is the weight of the empty crucible, and W2 is the weight of the crucible plus the ashed sample.

Viscosity determination (cP)

The sample was placed in a beaker positioned beneath the viscometer rotor. The rotor needle was adjusted, and after pressing the start button, the equipment provided the result after 3 minutes.

Fat content analysis (%)

Three (3 g) of the sauce were weighed onto filter paper, which was then placed inside a thimble holder and covered with a thimble cover. This assembly was inserted into a Goldfish extractor, and 40 mL of petroleum ether was added to the beaker before securing it to the tube. The system was operated at 55 °C for 4 hours, after which the samples were transferred to solvent recovery beakers. Finally, they were placed in an oven at 100 °C for 2 hours, cooled in a desiccator, and weighed to record the data using Equation 4.

$$\text{Fat content}(\%) = \frac{W2 - W1}{W} * 100 \quad (4)$$

Where W is the sample weight (g), W1 is the weight of the empty beaker, and W2 is the weight of the beaker plus the extracted fat.

Sensory analysis

A sensory evaluation was conducted with a panel of 20 students from the Food Science program at FCIP-UTEQ. Due to their academic background, they were semi-trained, ensuring an accurate evaluation. The samples were randomly coded and presented at room temperature. Each panelist received a standardized amount of each sample along with a spoon and a tasting sheet, which included different levels for color, aroma, flavor, texture, spiciness threshold, and overall acceptability. In a controlled environment, panelists assessed the spiciness level of the samples using a predefined scale and then submitted their individual evaluation sheets.

For the evaluation of color, aroma, flavor, and texture, a five-point hedonic scale was used. The color scale ranged from 1 = Orange, 2 = Intense Orange, 3 = Brick, 4 = Tile, to 5 = Butane. For aroma, the scale included 1 = Fruity (ripe fruits), 2 = Sweet, 3 = Slightly sweet, 4 = Not sweet, and 5 = Complex. The flavor descriptors were 1 = Pineapple, 2 = Chili, 3 = Garlic, 4 = Onion, and 5 = Vinegar. Texture was assessed using the following scale: 1 = Very viscous, 2 = Viscous, 3 = Neither viscous nor fluid, 4 = Very dense, and 5 = Dense.

Similarly, for spiciness threshold determination, a five-point hedonic scale was used to assess the panelists' perception of spiciness: 1 = Not spicy, 2 = Slightly spicy, 3 = Moderately spicy, 4 = Spicy, and 5 = Very spicy.

It is important to note that the selected panelists had no chili allergies and expressed a preference for consuming spicy foods. To evaluate acceptability, participants were asked to indicate which treatment they liked the most.

RESULTS AND DISCUSSION

Physicochemical characteristics

pH

Regarding the ANOVA analysis of the pH in the chili sauce, statistical differences were observed between treatments ($P<0.05$). The highest values were recorded in T4 (4.18) and T1 (4.17), with no significant differences between them, but both were statistically different from T3 (4.06), which had the lowest pH. T5 (4.14) did not show significant differences with T4, while T6 (4.08) differed from both but not from T2 (4.11), which presented an intermediate value (Figure 1).

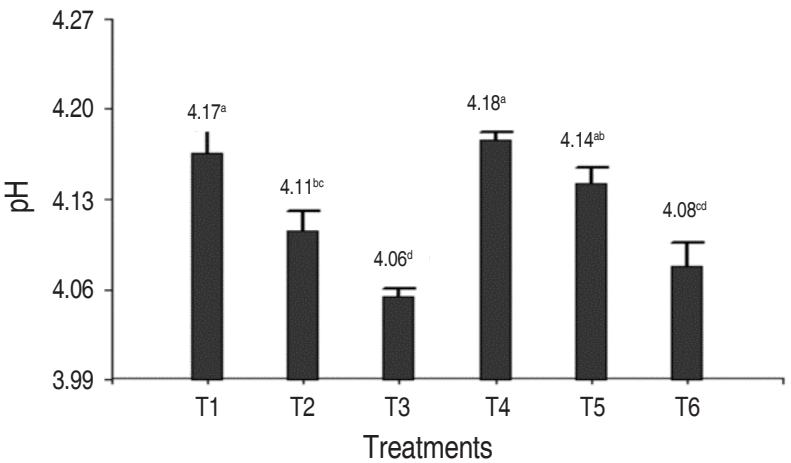

Figure 1. Effect of the postharvest condition of chili on the pH of a spicy sauce with added pineapple. T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

The pH values obtained in this study are higher than those reported by Kammar-García et al. (2022), who found a pH of 3.60 in a chili sauce with tamarind, due to the high acidity of tamarind. In comparison, pineapple juice has a less pronounced effect on pH (Trujillo 2021). On the other hand, the results of this research are similar to those of

Custodio and Fabian (2023), who reported a pH range of 4.07 to 4.43 in chili sauce with lima bean purée, indicating that the values found are within an acceptable range for this type of product.

Volatile acidity (%)

Regarding the volatile acidity in chili sauce, statistical differences were observed between treatments (P<0.05). The highest values were recorded in T3 (1.18%), T2 (1.18%), and T6 (1.17%), with no significant differences among them. In contrast, T4 showed the lowest volatile acidity (1.09%), differing significantly from the rest. Treatments T1 (1.12%) and T5 (1.12%) presented intermediate values, with no significant differences between them but differing from the other treatments (Figure 2).

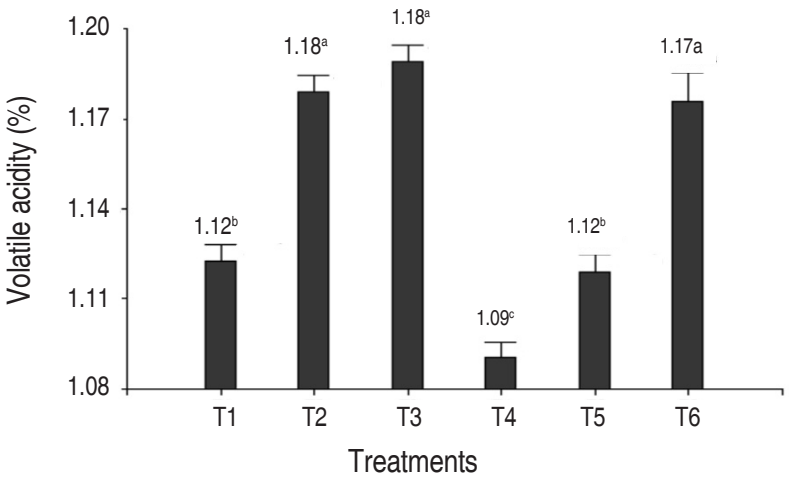

Figure 2. Effect of the postharvest state of chili in a spicy sauce with pineapple addition on volatile acidity**.** T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

The volatile acidity values in this study were lower than those reported by Conforme (2019), who states that higher acidity contributes to the preservation of spicy sauces. Vílchez (2020) explains that dehydrated chili loses volatile compounds during thermal processing, which may reduce volatile acidity, while the addition of pineapple increases it due to its natural acids, aligning with the results obtained.

Soluble solids (°Brix)

Regarding the soluble solids content (°Brix), statistical differences were observed between treatments (P<0.05). Treatment T6 presented the highest value (22.87 °Brix), significantly differing from the rest, followed by T3 (22.63 °Brix) and T5 (22.13 °Brix), which also showed significant differences between them. In contrast, treatments T1 (20.77 °Brix) and T4 (20.87 °Brix) recorded the lowest values, with no significant differences between them. Treatment T2 (21.87 °Brix) presented an intermediate value, differing from the other treatments (Figure 3).

Regarding soluble solids, Custodio and Fabian (2023) reported lower values (12 °Brix) compared to this study (20.77–22.87 °Brix), a difference attributed to the high solid content in pineapple juice. Additionally, Oña (2022) suggests that a maximum of 30 °Brix is optimal for consumer acceptance, confirming that the developed sauces meet this parameter.

Ash content (%)

Regarding ash content, significant differences were observed between treatments (P<0.05). Treatments T3 (0.75%) and T6 (0.74%) showed the highest values, with no significant differences between them. Treatment T2 (0.67%) and T5 (0.66%) presented intermediate values and did not show significant differences between them, although they differed from the treatments with lower ash content. In contrast, treatments T1 (0.60%) and T4 (0.57%) recorded the lowest values, with no significant differences between them (Figure 4).

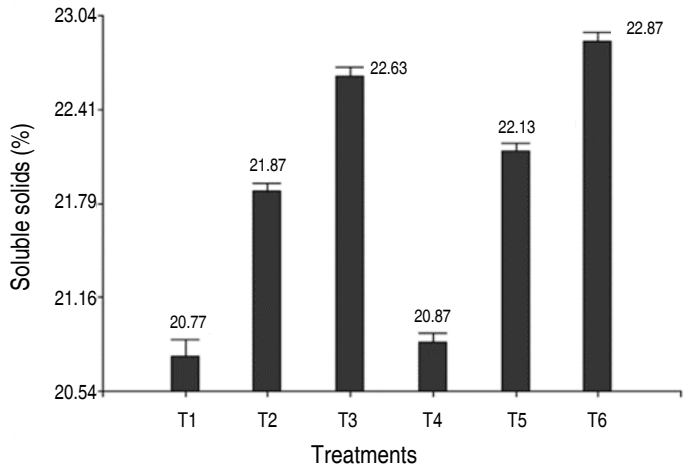

Figure 3. Effect of the Postharvest State of Chili in a Spicy Sauce with Pineapple Addition on Soluble Solids. T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

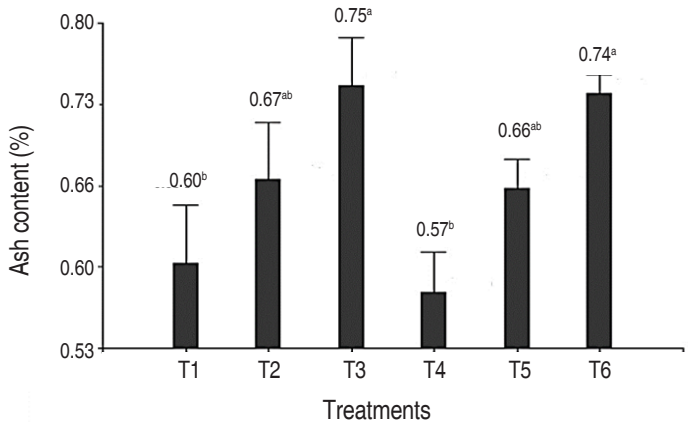

Figure 4. Effect of the Postharvest State of Chili in a Spicy Sauce with Pineapple Addition on Ash Content (%). T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

The ash values obtained in this study were lower than those reported by Vílchez (2020), who recorded an average of 1.25% in sauces with pineapple pulp, indicating a lower mineral content in the evaluated formulations. More notably, Terry and Casusol (2018) found an ash content of 3.30%, significantly higher than the maximum of 0.75% obtained in this study, highlighting the variability in mineral composition depending on the ingredients and processes used.

Moisture content (%)

Regarding moisture content, statistical differences were observed between treatments (P<0.05). Treatment T1 presented the highest value (78.42%), significantly differing from the treatments that included dehydrated chili. It was followed by T2 (77.68%) and T3 (77.15%), which showed no significant differences between them but differed from the treatments with lower moisture content. On the other hand, treatments T4 (75.35%), T5 (74.87%), and T6 (74.42%) recorded the lowest values, with T6 showing the lowest moisture content and significantly differing from the rest (Figure 5).

The moisture results in this study were lower than those reported by Terry and Casusol (2018), who recorded 90.4%, indicating that the formulation evaluated here has

a lower water content, likely due to the incorporation of ingredients with lower moisture levels. In contrast, another study reported a value of 73%, slightly lower than the lowest average obtained in this study (74.42%), though the difference is minimal.

Viscosity (Cp)

Regarding viscosity (Cp), statistical differences were observed between treatments ($P<0.05$). Treatments T3 (5929.33 Cp) and T6 (5899.33 Cp) showed the highest values, with no significant differences between them,

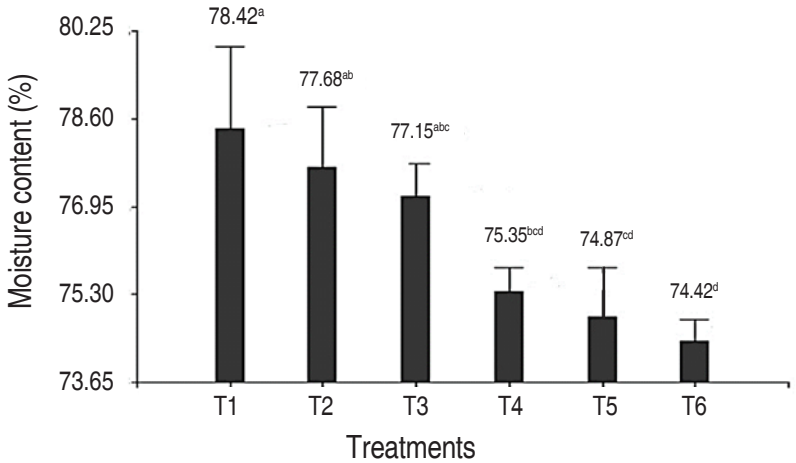

Figure 5. Effect of the postharvest state of chili in a spicy sauce with pineapple addition on moisture content **(%).** T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

but differing from the other treatments. Meanwhile, treatments T2 (5286.00 Cp) and T5 (5277.67 Cp) presented intermediate values, with no significant differences between them, though they differed from the treatments with lower viscosity. Finally, treatments T1 (4688.00 Cp) and T4 (4630.67 Cp) recorded the lowest values, with no significant differences between them (Figure 6).

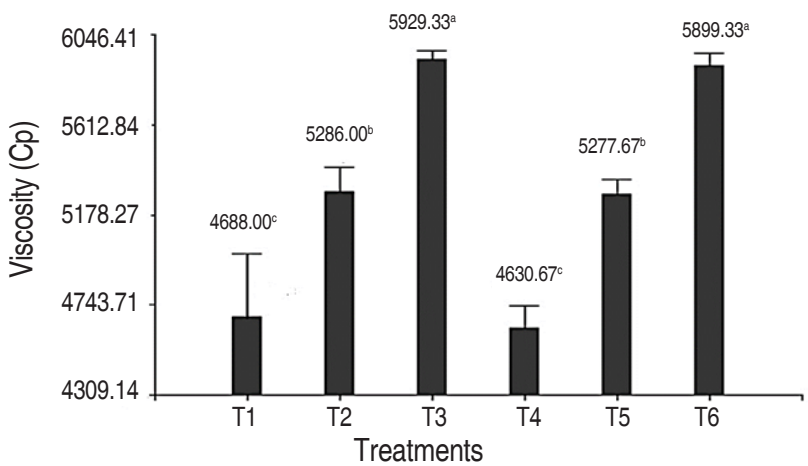

Figure 6. Effect of the postharvest state of chili in a spicy sauce with pineapple addition on viscosity (Cp). T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

The viscosity results in this study indicate that the amount of pineapple significantly influences the texture of the sauce, as treatments with a higher pineapple content (T3 and T6) showed the highest viscosities. This aligns with the findings of Custodio and Fabian (2023), who reported an increase in viscosity when adding tamarind pulp, likely due to the presence of pectins and polysaccharides that form a denser and more cohesive structure in the mixture. According to Ganoza-Yupanqui et al. (2021), pectins act as gelling agents, which explains why a higher proportion of pineapple results in a thicker and less liquid sauce texture.

Fat content (%)

Regarding fat content (%), statistical differences were observed between treatments (P<0.05). Treatment T3 (3.33%) presented the highest value. Treatments T2 (3.20%) and T6 (3.09%) showed intermediate values and did not present significant differences between them, although they differed from the others. Meanwhile, treatment T1 (2.80%) had a lower value than T2, T3, and T6 but was higher than T5 (2.61%) and T4 (2.40%). Notably, T4 recorded the lowest fat content and significantly differed from all other treatments (Figure 7).

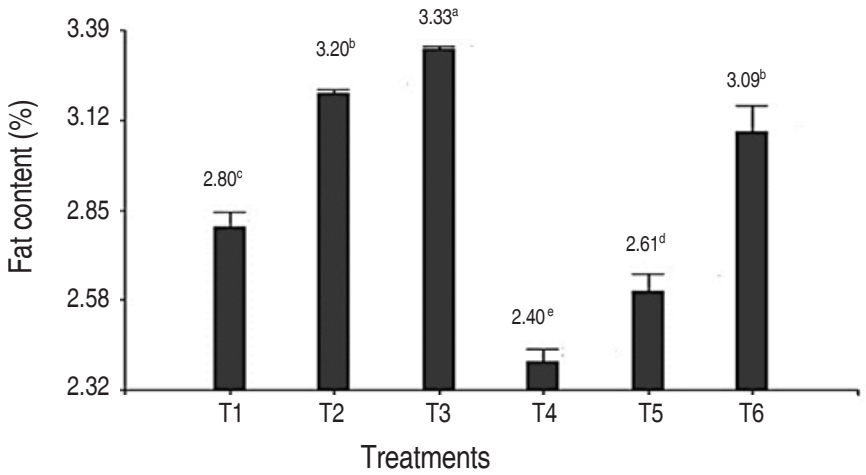

Figure 7. Effect of the postharvest state of chili in a spicy sauce with pineapple addition on fat content (%). T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

The fat content results in this study align with the findings of Baldeón-Apaestegui and Hernández-Gorritti (2017), who explain that the dehydration process can reduce the fat percentage in chili composition.

Sensory analysis

Color, aroma, flavor, and texture

Figure 8 shows that, in terms of color, treatment T4 stood out with the highest score (3.47), corresponding to a shade between "Tile" and "Butane." T5 and T6 also exhibited high color values, associated with "Brick." On the other hand, treatments with fresh chili, T1 (2.00), T2 (1.45), and T3 (1.20), showed lower shades, corresponding to "Intense Orange" and "Orange."

Regarding aroma, T1 (2.20) and T4 (2.18) stood out with a "Sweet" scent, while T2 (1.53), T3 (1.33), and T6 (1.48) had a "Fruity (ripe fruits)" aroma. T5 (1.77) was in an intermediate range, described as "Fruity" to "Sweet" (Figure 8). In terms of flavor, T4 led with a score of 2.65, described as "Garlic," while the other treatments, including T1 (1.93), T2 (1.53), T3 (1.07), T5 (1.90), and T6 (1.83), remained within the "Chili" flavor range (Figure 8). For texture, T3 (3.10) and T2 (2.93) were preferred, categorized as "Neither viscous nor fluid," while T4 received the lowest score (1.75), indicating a "Viscous" texture. T1 (2.32), T5 (2.07), and T6 (2.27) were described as "Very viscous" (Figure 8).

The results showed that the percentage of pineapple in the sauce directly influences the aroma, color, flavor, and texture perceived by the tasters. Regarding aroma, its increase was associated with a sweeter perception due to the presence of pineapple's aromatic compounds, which mask the spicy aroma of chili (Contreras et al. 2015). In

terms of color, treatments with a higher pineapple content tended toward orange tones, explained by the natural carotenoids in the fruit combined with chili pigments (Ulloa-Gómez et al. 2021).

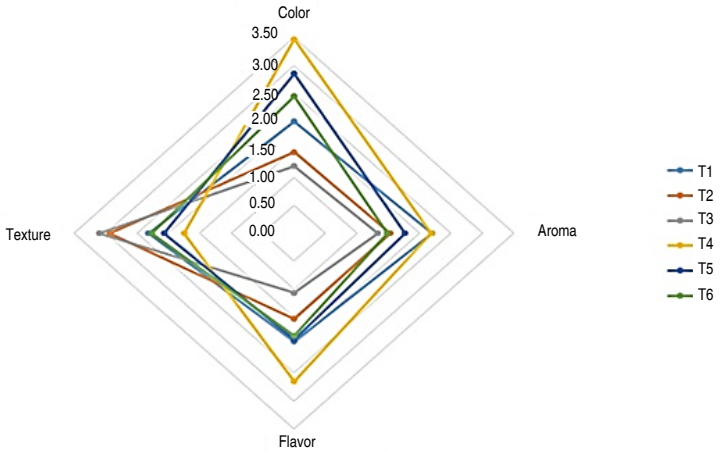

Figure 8. Sensory profile of each evaluated treatment. T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

For flavor, pineapple contributed sweet and acidic notes that softened the intensity of the chili, a phenomenon also reported by Contreras et al. (2015). Regarding texture, a higher proportion of pineapple resulted in a denser perception, attributed to insoluble fiber that contributes to a firmer texture (Shiau et al. 2015). Finally, the type of chili used also influenced the sensory characteristics, as fresh chili was associated with a more intense flavor and a more viscous texture compared to dehydrated chili. This could be explained by the volatilization of compounds during dehydration and the loss of moisture, which reduces its ability to retain water in the sauce (Núñez et al. 2023).

Spiciness threshold

Treatment T1 received the highest score for spiciness intensity, with a value of 3.90, categorized as "Spicy," making it the sauce with the highest perceived heat. On the opposite end, treatment T6 had the lowest value, at 1.58, classified as "Mildly Spicy," making it the least spicy sauce. The remaining treatments showed intermediate levels of spiciness, distributed as follows: T2 reached a value of 3.18 ("Moderately Spicy"); T3 obtained 2.88 ("Mildly Spicy"); T4 recorded 2.37 ("Mildly Spicy"); and T5 presented a value of 1.98 ("Mildly Spicy") (Figure 9).

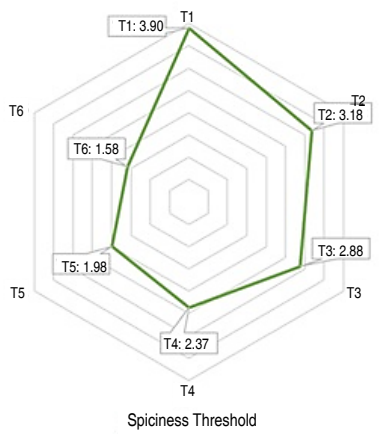

Figure 9. Spiciness threshold of each evaluated treatment. T1: Fresh chili + 40% pineapple, T2: Fresh chili + 45% pineapple, T3: Fresh chili + 50% pineapple, T4: Dehydrated chili + 40% pineapple, T5: Dehydrated chili + 45% pineapple, and T6: Dehydrated chili + 50% pineapple.

It was observed that a higher pineapple content in the sauce reduced the perception of spiciness, as its sweet and acidic compounds counteract the effect of capsaicin (Contreras et al. 2015). Additionally, dehydrated chili exhibited lower spiciness intensity compared to fresh chili, possibly due to the loss of volatile compounds during the dehydration process (Núñez et al. 2023).

Acceptability

Treatment T4, composed of dehydrated chili and 40% pineapple, achieved the highest acceptance, with a preference of 8.00 panelists out of 20.00, reflecting a notable preference for this formulation. In contrast, the other treatments (T1, T2, T3, T5, and T6) recorded significantly lower acceptability levels.

CONCLUSION

The formulation of hot sauces based on pineapple and different types of chili peppers, fresh and dried, showed that the combination of ingredients has a significant impact on the physicochemical and sensory properties of the product. In particular, formulation T4 (dehydrated chili + 40% pineapple) presented an optimum profile by reaching a pH of 4.18, soluble solids of 20.87 °Brix, and adequate levels of volatile acidity and fat content, parameters that favor both the preservation and the sensory perception of the product. This same formulation obtained the highest score in the sensory tests, standing out in attributes such as color, aroma, and flavor, which positioned it as the most accepted by the panelists. These results confirm the technological and sensory feasibility of the T4 formulation, which stands out for its organoleptic balance and functional potential. In this context, it is recommended to develop complementary research focused on evaluating its shelf life, microbiological stability, and sensory behavior during storage, as well as its industrial feasibility for scaling and commercialization.

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CONFLICT OF INTERESTS

The authors declare no conflicts of interest.

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