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Revaluation of "jerjo" (*Vasconcellea Candicans* [A. Gray] A. D C.) through the formulation and physicochemical and sensory characterization of a macerated liqueur

Revalorización del "jerjo" (*Vasconcellea Candicans* [A. Gray] A. DC.) mediante la formulación y caracterización fisicoquímica y sensorial de un licor macerado

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Abstract

The present study aimed to revalue the Andean fruit "jerjo" (*Vasconcellea candicans*), a native resource from the Marán sector, Tomepampa district (La Unión province, Arequipa, Perú), through the elaboration and characterization of a macerated liqueur. Nine formulations were prepared by combining different fruit/liquor ratios and maceration times (15, 30, and 45 days). Sensory evaluation was conducted with 15 judges using a 5-point hedonic scale. Formulation T3t2 (60 % fruit, 28 % pisco, 12 % syrup, and 30 days of maceration) was identified as the most accepted. Physicochemical, proximate, and bioactive parameters of the fresh fruit and the selected macerate were analyzed in duplicate and interpreted descriptively. Compared with fresh fruit, the macerate showed reductions in moisture (91.14 % to 82.72 %), ash (0.70 % to 0.53 %), fiber (0.55 % to 0.004 %), and vitamin C (17.12 mg/100 g to 0.44 mg/100 mL). In contrast, carbohydrates (6.72 % to 16.51 %) and energy value (32.29 kcal/100 g to 67.06 kcal/100 mL) increased, likely due to syrup addition. Total polyphenols (0.10 mg/100 g to 5.70 mg/100 mL) and antioxidant capacity (63 mmol T.E./L to 120 mmol T.E./L) also increased descriptively, and 85 % anthocyanin retention was observed, attributed to its transfer into the hydroalcoholic matrix. Overall, jerjo maceration yielded a product with favorable sensory attributes and an enriched functional profile (within the descriptive scope of the study), providing an initial contribution to the technological valorization of *Vasconcellea candicans*.

Keywords: Alcoholic beverage, andean fruits, antioxidants, bioactive compounds, polyphenols.

Resumen

La presente investigación tuvo como objetivo revalorizar el fruto andino "jerjo" (*Vasconcellea candicans*), un recurso nativo procedente del sector Marán, distrito de Tomepampa (provincia de La Unión, Arequipa, Perú), mediante la elaboración y caracterización de un licor macerado. Se prepararon nueve formulaciones que combinaron distintas proporciones fruta/licor y tiempos de maceración (15, 30 y 45 días). En la evaluación sensorial, realizada con 15 jueces utilizando una escala hedónica de 5 puntos, se identificó la formulación T3t2 (60 % fruta, 28 % pisco, 12 % almíbar y 30 días de maceración) como la más aceptada. La caracterización fisicoquímica, proximal y bioactiva del fruto fresco y del macerado seleccionado se realizó en duplicado y se interpretó de forma descriptiva. Se detectaron reducciones en humedad (91.14 % a 82.72 %), cenizas (0.70 % a 0.53 %), fibra (0.55 % a 0.004 %) y vitamina C (17.12 mg/100 mL a 0.44 mg/100 mL) en el macerado. En contraste, se observaron incrementos en carbohidratos (6.72 % a 16.51 %) y valor energético (32.29 kcal/100 mL a 67.06 kcal/100 mL), probablemente debido al almíbar. También se registró un aumento descriptivo en polifenoles totales (0.10 mg/100 mL a 5.70 mg/100 mL) y capacidad antioxidante (0.063 mmol T.E./L a 0.120 mmol T.E./L), junto con una retención de antocianinas del 85 %, atribuible a su transferencia hacia la matriz hidroalcohólica. En conjunto, los resultados indican que es posible obtener de la maceración del jerjo un producto con atributos sensoriales favorables y un perfil funcional enriquecido (dentro del carácter descriptivo del estudio), lo cual constituye un primer aporte para la valorización tecnológica de *Vasconcellea candicans*.

Palabras clave: Antioxidantes, bebida alcohólica, compuestos bioactivos, frutos andinos, polifenoles.

Introduction

Peruvian Andean fruits represent a cultural and nutritional resource of high value. However, their use remains limited due to their restricted geographical distribution and the limited knowledge of their properties (Obregón-La Rosa *et al*., 2021). Among the diversity of Andean species, *Vasconcellea candicans* ("jerjo") stands out as a fruit that thrives in arid ecosystems and exhibits relevant nutritional and functional attributes. Nevertheless, scientific evidence regarding its composition, bioactive potential, and technological applications remains scarce, which has constrained its valorization and sustainable use.

Recent studies emphasize the importance of developing innovative products that help reserve the bioactive compounds of Andean fruits (Gallón-Bedoya *et al*., 2024). In this context, maceration emerges as a viable technological approach that may retain sensitive components such as vitamin C, polyphenols, and natural antioxidants, which are key to determining both the functional quality and the sensory profile of the final product (Gutiérrez-Román *et al*., 2023).

The global interest in functional foods, artisan beverages, and fruit products with high added value has notably increased in recent years, after the COVID-19 pandemic (Gong *et* al., 2025). Despite this trend, no studies have been identified describing the formulation or characterization of a macerate or liqueur prepared from jerjo. This gap represents an opportunity for research, as jerjo combines ecological resilience, a potentially high content of bioactive compounds, and a distinctive sensory profile. These qualities make it a promising raw material for the development of innovative beverages with added value.

Therefore, this research aimed to formulate and characterize a jerjo macerated liqueur by evaluating its nutritional, physicochemical, and sensory properties. It was hypothesized that the fruit/liqueur ratio and maceration time influence sensory acceptability and the transfer of phenolic compounds into the macerate. The findings may provide scientific evidence to support the revalorization of Andean fruits and may serve as a starting point for future technological and commercial initiatives.

Materials and methods

Materials

A total of 75 *Vasconcellea candicans* ("jerjo") fruits were collected, and their taxonomic identification was confirmed at the Herbarium Areqvipense (HUSA). Of these, 52 fruits meeting quality criteria were selected. The pulp was cut into 2 × 2 cm cubes. The base liqueur was prepared using Quebranta pisco (70 % v/v; 40 °GL) and syrup (30 % v/v). Nine treatments of 1.5 L were prepared by varying the fruit/liqueur ratio and maceration time (15, 30, and 45 days). Analyses were carried out using standard laboratory equipment (oven, muffle furnace, Soxhlet, Kjeldahl unit, centrifuge, potentiometer, alcohol distillation unit, and spectrophotometer), as well as Folin-Ciocalteu reagent, CUPRAC reagents, iodometric reagents, and extraction solvents.

Methods

Jerjo collection

Vasconcellea candicans ("jerjo") fruits were collected in April 2023 in the Marán sector, Tomepampa district, La Unión province, Arequipa, Perú, located at 2590 m a.s.l. (15°10'23"S, 72°49'47"W) (Figure 1). In this area, harvesting occurs seasonally between December and the first days of April.

Taxonomic classification

Taxonomic classification of the plant material was conducted at the Botanical Laboratory of the Herbarium Areqvipense (HUSA) at the National University of San Agustín of Arequipa, through the evaluation of the fresh sample using a qualitative approach and a non-experimental design. The diagnostic characteristics of the species were systematically assessed, including shape, size, and arrangement of leaves, flowers, stems, and fruits.

Taxonomic and phylogenetic contextualization

Taxonomic identification of *Vasconcellea candicans* was corroborated using herbarium records from the Herbarium Areqvipense (HUSA). In addition, phylogenetic contextualization was performed using previously published molecular sequence data retrieved from the GenBank database. Representative nucleotide sequences of *Vasconcellea* species reported in the literature were selected, aligned, and used to generate a phylogenetic tree in MEGA, version 12, following standard procedures. This analysis was performed exclusively to provide taxonomic and evolutionary context for the studied species and was not intended to produce novel phylogenetic inferences.

Preparation of the jerjo-pisco-based macerate

The nine experimental units (T1, T2, and T3 combined with maceration times t1, t2, and t3) were prepared according to the fruit and base liqueur proportions established in Table 1. Each macerate, with a final volume of 1.5 L, was stored in amber glass jars at a

Figure 1. Geospatial location of the *Vasconcellea candicans* sampling site in Tomepampa (La Unión, Arequipa, Perú), with a regional view and enlargements of the collection area.

Table 1. Experimental formulations of jerjo macerated liqueur, using different proportions of base liqueur and fruit maceration times

Formulation	Base liqueur		Fruit
	Syrup (%) vol./vol.	Pisco (%) vol./vol.	Fruit (%) weight/vol.
T1.t1	9	21	70
T1.t2	9	21	70
T1.t3	9	21	70
T2.t1	15	35	50
T2.t2	15	35	50
T2.t3	15	35	50
T3.t1	12	28	60
T3.t2	12	28	60
T3.t3	12	28	60

*T1: 70/30 %Fruit/%Base Liqueur (F/BL%); T2: 50/50 F/BL%; T3: 60/40 F/BL%; t1: 15 days; t2: 30 days; t3: 45 days.

controlled temperature of 18 °C - 22 °C. At the end of each maceration period, samples were filtered and bottled in previously sterilized glass containers. The formulation with the highest sensory acceptance was selected for subsequent physicochemical characterization, bioactive compound determination, and proximal composition analysis.

Table 1 summarizes the nine specific combinations used in macerate preparation, expressed as Tn/tn (e.g., T1.t1 indicates 70 % fruit and 30 % base liqueur with a maceration time of 15 days).

Organoleptic analysis

Sensory evaluation was conducted with 15 semi-trained judges, who rated aroma, color, flavor, and overall acceptance using a 5-point hedonic scale (1 = "dislike very much" to 5 = "like very much"). The most accepted formulation was then analyzed for physicochemical properties, bioactive compounds, and proximate composition.

Proximate composition

The proximate composition of jerjo pulp and the macerate with the highest sensory acceptance was determined using standardized methods. Moisture and total solids were measured according to NTP 209.085 (National Institute for Quality [INACAL], 2017), by drying the sample in an oven at 102 °C until constant weight was reached. Ash was obtained by incineration at 600 °C in a muffle furnace following AOAC method 2.173 (2000). Total fat was quantified according to NTP 208.016 (INACAL,2021) using Soxhlet extraction and subsequent solvent evaporation. Protein content was determined by the Kjeldahl method (AOAC 2.057, 13th ed.), using a nitrogen-to-protein conversion factor of 6.25. Crude fiber was quantified according to NTP 209.047 (INACAL, 2015, through successive acid and alkaline digestions, followed by filtration, washing, and drying. Total carbohydrates were determined following AOAC method 31.04 by acid hydrolysis with HCl, neutralization, and titrimetric quantification of reducing sugars.

Physicochemical analysis

pH was measured according to NTP 213.036 (INACAL, 2022) using a calibrated potentiometer at 20 °C, and readings were recorded after stabilization. Soluble solids were determined by digital refractometry and expressed as degrees Brix (°Brix). Alcoholic strength of the macerate was determined by distillation followed by reading with an alcoholmeter, applying the appropriate temperature corrections according to the official OIV-MA-AS312-01A method.

Determination of bioactive compounds

Determination of vitamin C: Vitamin C content was quantified following method 31.61 of the Adolfo Lutz Institute (2008). Ascorbic acid was extracted using a 3 % (w/v) stabilizing solution of metaphosphoric or oxalic acid, followed by filtration, and the filtrate was titrated iodometrically with standardized iodine solution using starch as the indicator. Vitamin C content was calculated from the titrant volume and expressed as mg of ascorbic acid per 100 g of sample.

Determination of antioxidant capacity: Antioxidant capacity was determined using the CUPRAC (Cupric Reducing Antioxidant Capacity) spectrophotometric method (Apak *et al.*, 2004). To obtain the extract, 100 mg of homogenized sample were extracted with 10 mL of ethanol:water (1:1, v/v), and the resulting extract was filtered through a 0.45 µm membrane. Then, 0.5 mL of the filtrate was reacted with $CuCl_2$ (10 mM), neocuproin (7.5 mM), and acetate buffer (pH 7.0). The mixture was incubated for 30 minutes at room temperature, and absorbance was measured at 450 nm using a UV-Vis spectrophotometer. Results were expressed as millimoles of Trolox equivalents per 100 g of sample (mmol TE/100 g).

Determination of total phenolic compounds: Total phenolic content was determined using the Folin-Ciocalteu method, according to the procedure described by Singleton *et al.* (1999). For this purpose, 200 µL of the extract were mixed with 1 mL of 0.2 N Folin-Ciocalteu reagent. Then, 800 µL of 7.5 % (w/v) Na_2CO_3 were added, and the mixture was allowed to react for 2 h in the dark at room temperature. After this period, absorbance was measured at 760 nm using a UV-Vis spectrophotometer. Total phenolic concentration was calculated from a gallic acid calibration curve and expressed as mg of gallic acid equivalents per gram of sample on a dry basis.

Determination of anthocyanins: Total anthocyanins were determined using the pH differential method. Absorbance was measured at 520 nm of the sample adjusted to pH 1.0 and pH 4.5, taking advantage of the reversible structural change of anthocyanins with pH. The concentration was calculated from this absorbance difference and expressed as mg/L of cyanidin-3-glucoside, using its molecular weight and molar absorption coefficient, according to standardized procedures.

Experimental design and statistical analysis

A 3 × 3 factorial design was applied, with three fruit/liqueur ratios (T1, T2, T3) and three maceration times (15, 30, and 45 days), yielding nine treatments. Sensory evaluation was conducted with 15 semi-trained judges, and data were analyzed using multifactorial ANOVA, checking for normality and homogeneity of variances. Mean comparison was performed using Tukey's test ($p < 0.05$). For proximate composition, physicochemical parameters, and bioactive compounds of the fresh fruit and the optimal formulation (T3t2), two replicates (n = 2) were performed, and results are presented as mean ± standard deviation. The statistical analysis was performed using Statgraphics Centurion 19.

Principal component analysis (PCA) was applied as an exploratory multivariate tool to summarize the variability of the sensory attributes (color, flavor, aroma, and overall appearance) and to identify patterns among formulations. The analysis was performed using the mean sensory scores obtained for each formulation, with variables standardized to prevent attributes with higher variance from dominating the solution. Components were extracted based on eigen decomposition and supported by inspection of the scree plot. PCA was used exclusively as a complementary descriptive approach to integrate sensory information and support interpretation of the factorial ANOVA results. Therefore, PCA outputs were interpreted cautiously and were not used for inferential purposes.

Results

Taxonomic classification of jerjo

Taxonomic identification of jerjo was performed by evaluating its morphological and anatomical characteristics. The resulting features are shown in Table 2. The species was identified as *Vasconcellea candicans* (A. Gray) A. DC., belonging to the *Caricaceae* family.

Table 2. Taxonomic classification of *Vasconcellea Candicans* ("jerjo")

Division	Magnoliophyta
Class	Magnoliopsida
Order	Brassicales
Family	Caricaceae
Genus	Vasconcellea
Species	*Vasconcellea Candicans* (A. Gray) A. DC.

Source: Herbarium Areqvipense (HUSA) (2023).

Figure 2 shows a circular cladogram of the *Vasconcellea* genus, with bootstrap values supporting phylogenetic relationships. Strong support is observed for the clade comprising *V. cundinamarcensis*, *V. candicans*, and *V. carvalhoae*, suggesting a recent common ancestor among these taxa. In contrast, the grouping of *V. badilloi*, *V. cauliflora*, *V. chiachapoyensis*, and *V. pentalobis* shows less resolution. This tree may serve as a basis for future evolution, biogeography, and conservation studies.

Organoleptic analysis

Before comparing treatments, the statistical assumptions of the model were assessed. Although the Shapiro–Wilk test confirmed some deviations from normality, Levene's test confirmed homogeneity of variances ($p > 0.05$). Sensory evaluation was conducted with 15 semi-trained judges under a balanced design; the judge factor was included as a block in the ANOVA and showed no significant effect ($p > 0.05$), indicating consistency across rates. Given the verified assumptions and considering the robustness of ANOVA for these data, a factorial model was applied to evaluate the joint effect of the fruit/liqueur ratio and the maceration time. The treatments showed significant effects on color, flavor, aroma, and overall appearance ($p < 0.001$). Tukey's test identified T3t2 and T2t2 as the best-rated formulations, while T1t3, T2t3, and T3t3 presented the lowest scores. In general, higher fruit proportions combined with intermediate maceration times were associated with better acceptance, while formulations with lower fruit content or with insufficient or excessive maceration were less accepted. Means, standard deviations, and homogeneous groups are presented in Table 3, confirming T3t2 and T2t2 as the most sensorially balanced alternatives.

Superscript letters indicate that treatments with the same letter are not significantly different, whereas different letters denote significant differences among treatments ($p < 0.05$). Formulations T3t2 and T2t2 showed the highest values, indicating greater acceptance, while the intermediate treatments are grouped in the middle, and T1t3, T2t3, and T3t3 exhibited the lowest values.

Figure 3 presents the sensory profile of the nine formulations using a radar chart integrating color, flavor, aroma, and overall appearance. Treatments with higher fruit proportions and intermediate maceration times show wider curves, highlighting T3t2 as the formulation with the most favorable overall performance. In contrast, T1t3 and T3t3 presented smaller areas in the polygon, reflecting lower acceptance, while T2t2 and T3t1 present intermediate results. This chart provides a visual synthesis consistent with the statistical differences reported in Table 3.

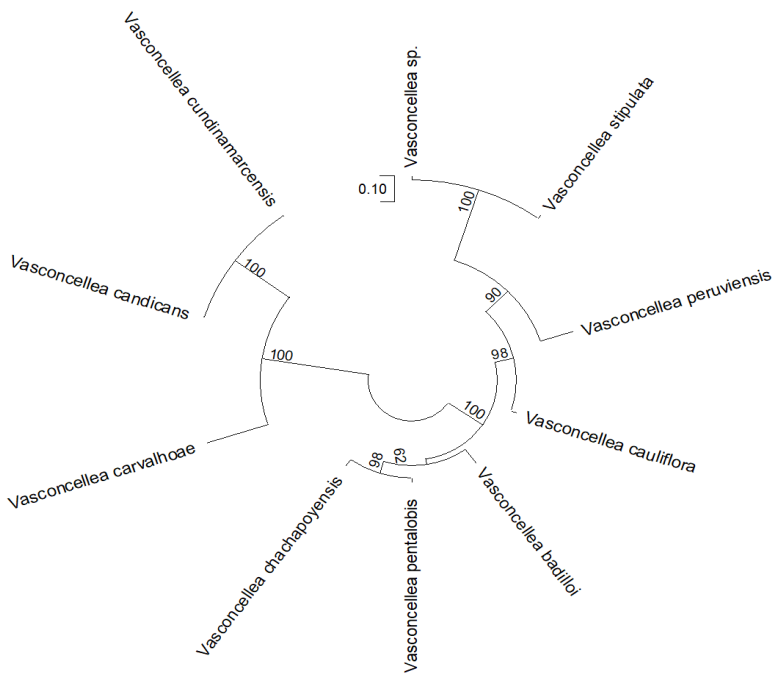

Figure 2. Phylogenetic cladogram of *Vasconcellea* species.
Source: Developed by the authors with MEGA 12.

Table 3. Results of the organoleptic analysis of the nine formulations (mean ± standard deviation)

Samples	Attributes			
	Color	Flavor	Aroma	General appearance
T1t1	2.8 ± 0.41 ^{bc}	2.53 ± 0.52 ^{bcd}	2.73 ± 0.46 ^{c}	2.67 ± 0.49 ^{cd}
T1t2	2.87 ± 0.35 ^{bc}	2.73 ± 0.46 ^{cd}	2.60 ± 0.51 ^{bc}	2.87 ± 0.35 ^{d}
T1t3	2.4 ± 0.51 ^{b}	2.2 ± 0.41 ^{ab}	2.13 ± 0.35 ^{b}	2.13 ± 0.35 ^{ab}
T2t1	3.13 ± 0.35 ^{c}	3.27 ± 0.46 ^{e}	3.4 ± 0.51 ^{d}	3.07 ± 0.26 ^{d}
T2t2	4.13 ± 0.35 ^{d}	4.13 ± 0.35 ^{f}	4.2 ± 0.41 ^{e}	4.13 ± 0.35 ^{e}
T2t3	2.73 ± 0.46 ^{bc}	2.27 ± 0.46 ^{abc}	2.13 ± 0.35 ^{b}	2.27 ± 0.46 ^{bc}
T3t1	2.8 ± 0.41 ^{bc}	2.87 ± 0.35 ^{de}	2.8 ± 0.41 ^{c}	2.67 ± 0.49 ^{cd}
T3t2	4.4 ± 0.51 ^{d}	4.4 ± 0.51 ^{f}	4.53 ± 0.52 ^{e}	4.87 ± 0.35 ^{f}
T3t3	1.73 ± 0.59 ^{a}	1.8 ± 0.41 ^{a}	1.47 ± 0.52 ^{a}	1.8 ± 0.41 ^{a}

*n = 15 evaluators. T1–T3 correspond to the fruit/base liqueur proportions, and t1–t3 to the maceration times. Different letters within each column indicate significant differences among treatments according to Tukey's test ($p < 0.05$).

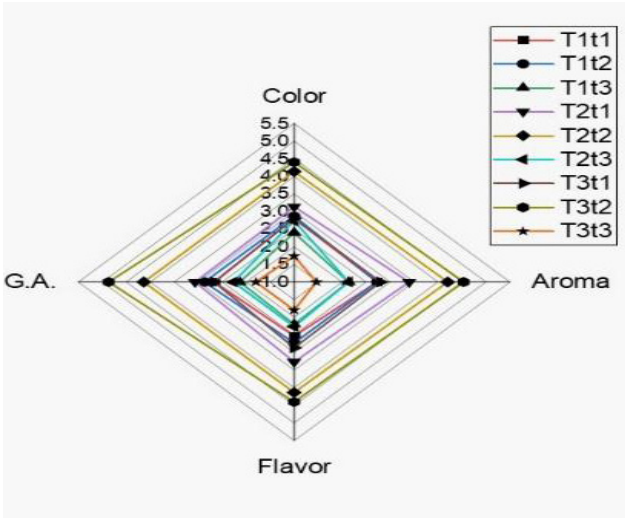

Figure 3. Radial graph of sensory attribute acceptance scores. G.A.: general appearance.

A principal component analysis (PCA) was performed to summarize the variability in sensory attributes and to explore patterns among treatments using the mean scores of color, flavor, aroma, and overall appearance. The scree plot (Figure 4) showed that only the first principal component (PC1) met the Kaiser criterion (eigenvalue ≥ 1), suggesting that most of the sensory variability is captured by a single dominant component.

PCA indicated that a single principal component concentrated most of the variability among treatment mean scores, suggesting a correlation between the evaluated sensory attributes. This pattern is consistent with an overall acceptance gradient distinguishing best-scored formulations from those with lower values. However, these results should be interpreted cautiously because the analysis was based on a limited number of aggregated observations.

PCA provided an integrated visualization of sensory trends among formulations, supporting the patterns previously identified by ANOVA.

Proximal, physicochemical, and bioactive composition of the fresh fruit and optimized macerate (T3t2)

Bioactive compounds, proximate composition, and physicochemical properties of the fresh fruit and the optimized macerate T3t2 were analyzed. Given the limited number of analytical replicates (n = 2), nutritional composition, bioactive compounds, and physicochemical parameters were analyzed only descriptively (mean ± standard deviation), and no inferential tests were applied. Consequently, differences between fresh fruit and the macerate should be interpreted as indicative trends rather than statistically demonstrated effects.

Proximal composition

The proximate composition results indicate differences between fresh fruit and the T3t2 macerate; however, these variations should be interpreted as descriptive trends, given that the determinations were performed in duplicate. The fruit showed high moisture content (91.14 ± 2.73 %), which decreased in the macerate (82.72 ± 2.48 %), a behavior consistent with the compositional changes associated with maceration and the incorporation of non-aqueous ingredients. Conversely, carbohydrate content increased, rising from 6.72 ± 0.06 % in the fruit to 16.51 ± 0.50 % in the macerate, an effect mainly attributable to the syrup included in the formulation. This increase was reflected in the energy value, which nearly doubled in the macerate (67.06 ± 2.01 kcal/100 mL) compared with the fresh fruit (32.29 ± 0.97 kcal/100 g). In contrast, protein, fat, and fiber decreased in the final product, as expected due to dilution of the fruit solid material within the hydroalcoholic matrix. Overall, these results describe a macerate with higher caloric density and carbohydrate content, accompanied by lower levels of structural components typically present in fresh fruit (Table 4).

Physicochemical analysis

pH values were similar in both matrices (5.00 ± 0.15 and 5.06 ± 0.15), suggesting that the overall acidity did not vary significantly in the macerate. Degrees Brix were higher in the macerate (21.60 ± 0.65 %) compared to the fruit (5.00 ± 0.15 %), which is consistent with syrup addition. The macerate showed an alcohol value of 17.20 ± 0.51 GL, reflecting the incorporation of pisco, whereas fresh fruit contained no ethanol. These parameters reflect the physicochemical changes associated with the

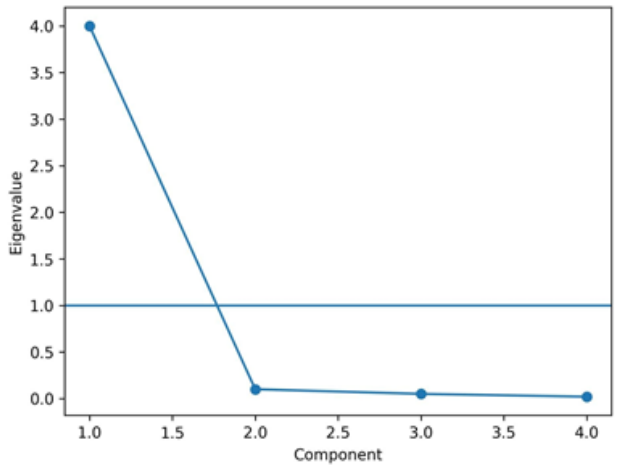

Figure 4. Principal component analysis (PCA) screen plot.

maceration process, which lead to a product with higher sugar content and the presence of alcohol, while simultaneously maintaining a level of acidity similar to that of fresh fruit.

Bioactive compound analysis

Although the vitamin C content decreased markedly in the macerate (0.44 ± 0.01 mg/100 mL) compared with the fresh fruit (17.12 ± 0.51 mg/100 g), consistent with the high susceptibility of this compound to oxidation and degradation during processing, descriptive values indicated notable increases in total polyphenols (5.70 ± 0.17 mg/100 mL) and antioxidant capacity (120 ± 4 mmol T.E./L), compared with fresh fruit (0.10 ± 0.003 mg/100 g and 63 ± 2 mmol T.E./L, respectively). This behavior suggests the efficient extraction of phenolic compounds into the hydroalcoholic matrix, as ethanol can enhance the solubilization of antioxidant constituents in maceration systems. Total anthocyanins were slightly lower in the macerate (0.200 ± 0.006 mg/100 mL) than in fresh fruit (0.240 ± 0.057 mg/100 g), possibly reflecting partial degradation or reduced pigment stability in the presence of ethanol and oxygen. These results indicate that, although maceration is associated with substantial vitamin C loss, it may promote the concentration and transfer of phenolic and antioxidant compounds, increasing the overall antioxidant capacity of the final product.

Discussion

The phylogenetic of *Vasconcellea candicans*, based on previously reported molecular data retrieved from GenBank and visualized using MEGA 12, exhibits clearly defined evolutionary affinities within the Caricaceae family, particularly with *V. cundinamarcensis* and *V. carvalhoae* (Tineo *et al.*, 2020). Recent studies combining morphological and molecular evidence highlight the taxonomic complexity of the genus

Table 4. Nutritional composition, physicochemical parameters, and bioactive characteristics of fresh fruit and the macerate (T3t2)

Analysis	Fruit (per 100 g)	Macerate T3t2 (per 100 mL)
Nutritional composition		
Moisture (%)	91.140 ± 2.734	82.720 ± 2.482
Ash (%)	0.700 ± 0.021	0.530 ± 0.016
Fat (%)	0.150 ± 0.005	0.010 ± 0.000
Protein (X 6.65) (%)	0.740 ± 0.022	0.230 ± 0.007
Fiber (%)	0.550 ± 0.017	0.004 ± 0.000
Carbohydrate (%)	6.720 ± 0.060	16.510 ± 0.495
Energy (kcal/100 g or mL)	32.290 ± 0.969	67.060 ± 2.012
Physicochemical properties		
pH	5.000 ± 0.150	5.060 ± 0.152
Brix degrees (%)	5.000 ± 0.150	21.600 ± 0.648
Alcoholic strength (GL 20 °C)	N.D.	17.200 ± 0.516
Bioactive compounds		
Vitamin C (mg/100 g or mL)	17.120 ± 0.514	0.440 ± 0.013
Antioxidant capacity (mmol T.E./L)	63.00 ± 2.00	120.00 ± 4.00
Total polyphenols (mg/100 g or mL) (*)	0.100 ± 0.003	5.700 ± 0.171
Anthocyanin (mg/100 g or mL)	0.240 ± 0.057	0.200 ± 0.006

*N.D.: Not detected. T3t2 corresponds to the formulation made with 12 % syrup, 28 % pisco, and 60 % fruit, macerated for 30 days. TE: Trolox equivalent, (*) expressed in tannic acid.

(Iraola-Linares *et al.*, 2025), underscoring the value of wild species for understanding the diversity and biogeography of the group, as well as the need for maintaining phylogenetic hypotheses up to date.

Fruit/liqueur ratio and maceration time influenced sensory acceptability. ANOVA showed significant effects of the treatments across the four attributes evaluated, with T2t2 and T3t2 receiving the highest scores, associated with intermediate maceration times and higher fruit proportions. In contrast, T1t3, T2t3, and T3t3 recorded the lowest scores. PCA summarized these differences into a sensory gradient that clustered the best-rated formulations, confirming the pattern observed in ANOVA.

Moisture decreased from 91.14 % to 82.72 %, consistent with reports for other fruit macerates. In these cases, water loss during the process can occur due to the osmotic effect generated by the hydroalcoholic and sugar-rich medium (Guler, 2023). Similar behavior has also been recorded in processed beverages, where water transfer to the medium contributes to higher soluble solid content and bioactive compounds.

On the other hand, a marked reduction in total fiber was observed, decreasing from 0.55% to 0.004%. This decrease may be explained by the decomposition of insoluble fractions, such as cellulose and lignin, which have low solubility in hydroalcoholic media. In contrast, soluble fibers, particularly pectins, can partially solubilize or remain dispersed in the liquid phase (Pereira-Coelho *et al.*, 2023). This behavior align with studies indicating that extraction and contact with liquids favor degradation of insoluble fibers and the release of soluble polysaccharides into the extract.

Although vitamin C in the jerjo macerate decreased considerably (from 17.12 mg/100 g to 0.44 mg/100 mL), this loss is largely compensated by the notable increase in the total polyphenol and anthocyanin content, which is reflected in an increase in antioxidant capacity (from 63 mmol T.E./L to 120 mmol T.E./L). This behavior is consistent with the fact that, while Andean fruits like *Physalis peruviana* exhibit higher vitamin C content in the fresh state compared to jerjo, this compound is highly susceptible to oxidative degradation during maceration processes, with losses that may exceed 80 % in beverages made from fruits like blueberries (Varo *et al.*, 2022). However, jerjo stands out compared with other Andean fruits such as tumbo, for which vitamin C values around 7.7 mg/100 mL have been reported (Chañi-Paucar *et al.*, 2024).

This result is consistent with hydroalcoholic maceration systems, where ethanol enhances the solubilization of phenolic compounds and promotes their transfer into the liquid phase (Guler, 2023). Similar extraction trends have been described in jabuticaba fermentations, where maceration time influences the release of antioxidant and volatile compounds that enrich the sensory profile (Paula *et al.*, 2022). This indicates that, although vitamin C decreases sharply, a residual fraction remains in the macerate.

Pisco-based maceration has also been reported to enhance antioxidant capacity and increase polyphenol content, reflecting the efficiency of hydroalcoholic (ethanol–water) media for extracting and stabilizing phenolic compounds (Jiménez-Moreno *et* al., 2019). In this context, ethanolic extracts of yew tree exhibit higher antioxidant activity, which is consisted with observations reported for this type of matrix (Gutiérrez-Román *et al.*, 2023). Moreover, the presence of flavonoids such as catechin, epicatechin, and quercetin in pisco/based matrices, together with the effect of maceration time, may contribute to the observed increases in antioxidant-related measures (Poblete *et al.*, 2025). Thus, although vitamin C decreases during maceration, polyphenols, which are more stable in ethanolic media, become the main source of antioxidant activity, based on their phenolic profile.

Jerjo presented an initial anthocyanin concentration of 0.240 mg/100 g, whereas the macerate showed 0.200 mg/100 mL, suggesting appreciable retention within the descriptive scope of the study. Research in wines reports that anthocyanins may be partially preserved during maceration and can also undergo transformations into more stable forms, with these processes influenced by factors such as pH, temperature, and oxygen exposure (Delić *et al.*, 2024). The observed retention is also consistent with the relatively low natural concentration of these pigments in fresh fruit.

Conclusion

The T3t2 formulation, composed of 60 % fruit, 28 % pisco, and 12 % syrup, and macerated for 30 days, achieved the highest sensory acceptance, highlighting the combined influence of the fruit/liqueur ratio and maceration time on the evaluators' preferences. Differences observed between fresh fruit and the macerate reflect the changes inherent to the process, including reductions in moisture, ash, fiber, and vitamin C, along with descriptive increases in carbohydrates, energy value, and phenolic compounds. Likewise, the macerate showed a partial anthocyanin retention of approximately 85 %. Overall, these results suggest that jerjo maceration is a promising approach for the valorization of poorly studied Andean fruits and provides a baseline for future research to delve deeper into its characterization.

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