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Original Article

Use of amazon fruits in the preparation of alcoholic beverages

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Abstract
The objective of this research was to evaluate the use of Amazonian fruits in two fermented beverages: fermentation of a dilute solution of honey known commercially as mead for between 10 and 25 days with an ethanol concentration greater than 7%, and a lager-type beer with an alcoholic concentration over 4%, fermented between 4 and 6 days. The Amazonian fruits were Asai (*Euterpe precatoria* Mart), which has a high content of anthocyanins, flavonoids and carotenoids of interest in the food industry, and copoazu, a fruit with intermediate acidity, a high content of vitamin C and soluble solids, and a possible antioxidant activity. The fermentation took place during the reported, standard periods, without r adding nutrients and/or stabilizing the initial musts. Stability over time was observed for the studied quality variables in the case of the fermented mead drink.
Keywords: Amazonian fruits, Mead, Beer, Fermentation, Asai, Copoazu

Background

In Colombia, the Amazon region has a high variety of fruits of interest for gastronomy and the food industry that contribute greatly to local economic development. One of the Amazonian fruits used in this study was asai (*Euterpe precatoria* Mart), which has a lot of potential and is recognized for its high content of anthocyanins (1110 mg/kg), flavonoids and total carotenoids.[1,2] These compounds are studied in relation to benefits for human health,[3] and maintain a low pH, a favorable characteristic in the studied beverage type.

Copoazu (*Theobroma grandiflorum)* is a fruit with intermediate acidity and a high content of vitamin C and soluble solids, facilitating the elaboration of various food products with a possible antioxidant activity. The chemical composition of the pulp imparts a very favorable sensory characteristic because of its creamy texture, resulting from high molecular weight carbohydrates such as starch and pectins, and its exotic flavor, resulting from the balance between sugars and organic acids. These fruits have a high level of carbohydrates in the pulp and in the seeds, providing an important source of energy.[4]

There is a lot of potential for the use of this fruit type in the development of beverages, which is a growing and highly competitive market worldwide with an evident, current trend for consumers seeking products with new flavors that are locally produced and environmentally friendly, e.g. no plastic bottles and economic contribution to local communities.

Mead is an ancient alcoholic beverage that is obtained by fermenting diluted honey with yeast and some kinds of bacteria. Fermentation and maturation require a prolonged period, and the characteristics of final products are variable.[5-8] Depending on the solution type used to dilute the honey, the resulting product can have different names: pyments, cysers, myelomas, and metheglin, which incorporate grapes, apples, other fruits and spices, respectively.[7]

Small-scale beer production, traditionally known as craft beer, allows the inclusion of new flavors, achieving unique characteristics that provide a new sensory experience for consumers. Today, the ingredient market for these small companies is highly developed, offering high quality raw materials, machinery and supplies for obtaining highly competitive products.

Studies on products that use amazonian fruit pulp as the raw material are scarce, and there is a lot of potential in discovering the physicochemical and sensory characteristics of these fruits.

Methods

Must(honey/ asai-copoazu fruit juice) was prepared for the mead at a concentration of 28 °Brix for the soluble solids, which was sanitized with pasteurization at 65°C for 20 minutes, with subsequent rapid cooling and

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inoculation with *Saccharomyces cerevisiae* yeast in an anaerobic fermenter. Completion of the fermentation process was estimated with stability over time in the value of the must soluble solids.[9]

Brewing: the brewing process consisted of preparing must from German Pilsen-best malt with a malt/water ratio of 2/10 and adding fruits and hops at different concentrations, and inoculation with *Saccharomyces cerevisiae* lager yeast with fermentation for 5 days to constant temperature (15°C).

The control parameters were evaluated as follows:

Soluble solids: the concentration of soluble solids was measured using an ATAGO refractometer (model PAL-1, Japon), with a precision of 0.1°Brix

pH: determined according to the AOAC 960.19 method.[10]

Total acidity: 10 mL of sample dissolved in distilled water at 20°C and titrated with 0.1 NaOH to pH 8.2 using the AOAC 945.08 method.[10]

Ethanol: made following the procedures described in NTC5113[11] and NTC3952[12] for wine and beer, respectively.

Statistical analysis

A one-way analysis of variance (ANOVA) was carried out to study the differences between storage times. The analysis was conducted with the aid of the software MATLAB R2020b (© 1994-2021 The MathWorks, Inc.). Mean difference analysis was performed using Tukey's test at $P \leq 0.05$.

Results

Asai Mead

This product was a wine-type fermented drink, with a pleasant taste and a color imparted by the fruit (asai). The fermentation lasted 10 days, similar to the times reported in other investigations with mead (8 and 11 days) and fruit wines without requiring the addition of additional nutrients.[13-15] The physicochemical characteristics of the initial must and the processed product are described in Table 1.

The final product met the health requirements for a fermented wine-type drink, achieving an alcoholic concentration higher than 7%. The decrease in the pH value and the increase in total acidity in the first days of fermentation is characteristic of these processes.[14,16] Similar values for pH (2.95 to 4.05) and total acidity (3.1 and 7.76) are reported for similar studies.[17-19]

For the stability tests in the final product, the parameters, pH, acidity and soluble solids were monitored for 6 months (Table 2). Instability was not observed in the evaluated parameters (pH and soluble solids) under the refrigerated conditions or the environmental conditions, with an average temperature of 24°C. significant difference ($P<0.05$) in titratable acidity, were observed in the first record for the refrigerated samples However it is important to store mead in dark places and low temperatures.[20] The non-variation of the pH value and the concentration of soluble solids is an indicator of the stability of the mead over time.[16]

Asai Beer

The fermentation process for the beer with asai pulp developed satisfactorily over 5 days, providing a product with high sensory quality typical in beers with fruit[21] and complying with the physicochemical parameters required by the relevant standards.

The physicochemical characteristics of the fermentation must and the final product can be seen in Table 3. The decrease in pH values and the content of total soluble solids, as well as an increase in the titratable acidity in the first short days of fermentation are similar for this type of process.[22,23]

Table 2. Time Tracking of Asai Mead Quality Parameters

	pH	Acidity (g Tartaric Acid/L)	Soluble Solids
Behavior Under Refrigerated Conditions			
Month 0	3.55 ± 0.06 ^{a}	6.34 ± 0.3 ^{a}	19.15 ± 0.15 ^{a}
Month 1	3.53 ± 0.02 ^{a}	7.29 ± 0.02 ^{b}	20.3 ± 0.1 ^{a}
Month 2	3.63 ± 0.06 ^{a}	7.16 ± 0.04 ^{b}	20.25 ± 0.45 ^{a}
Month 3	3.53 ± 0.02 ^{a}	6.9 ± 0.15 ^{ab}	20.25 ± 0.15 ^{a}
Month 4	3.48 ± 0.02 ^{a}	6.83 ± 0.08 ^{ab}	19.75 ± 0.05 ^{a}
Month 5	3.46 ± 0.03 ^{a}	7.09 ± 0.04 ^{b}	19.85 ± 0.25 ^{a}
Month 6	2.73 ± 0.73 ^{a}	7.09 ± 0.04 ^{b}	19.55 ± 0.05 ^{a}
P value	0.3963	0.0205	0.05
Behavior Under Ambient Conditions			
Month 0	3.46 ± 0.03 ^{a}	6.26 ± 0.04 ^{a}	19.35 ± 0.05 ^{a}
Month 1	3.69 ± 0.09 ^{a}	7.95 ± 0.75 ^{a}	19.9 ± 0.3 ^{a}
Month 2	3.51 ± 0.04 ^{a}	7.22 ± 0.17 ^{a}	21.15 ± 0.65 ^{a}
Month 3	3.49 ± 0.03 ^{a}	6.6 ± 0.3 ^{a}	19.75 ± 0.25 ^{a}
Month 4	3.45 ± 0.05 ^{a}	6.56 ± 0.11 ^{a}	20.85 ± 0.35 ^{a}
Month 5	3.34 ± 0.06 ^{a}	6.53 ± 0.08 ^{a}	20.45 ± 0.85 ^{a}
Month 6	3.53 ± 0.05 ^{a}	6.64 ± 0.26 ^{a}	20.65 ± 0.85 ^{a}
P value	0.5434	0.0878	0.3394

Different letters in the same column indicate significant difference between different samples ($P \leq 0.05$), determined by Tukey´s test

Table 1. Physicochemical Characteristics Determined in the Asai Mead

	pH	Acidity (g Tartaric Acid/L)	Soluble Solids
Must	4,2 ± 0,06	4.4 ± 0.3	29.2 ± 1.2
Mead	3.55 ± 0.06	6.34 ± 0.3	19.15 ± 0.15

Table 3. Physicochemical Characteristics in the Brewing Process

	pH	Acidity (g Tartaric Acid/L)	Soluble solids
Must	5.2 ± 0.2	0.3 ± 0.1	17.2± 0.4
Beer	4.5± 0.3	O.9 ± 0.2	4.4± 0.6

The final product had an alcohol concentration of 4%, within the parameters allowed by the sanitary regulations. The physicochemical characteristics are similar to those reported for craft beer.[24] A characterization of the bioactive compounds and the antioxidant activity of this beer was not reported in this research, however other studies report its high contribution.[25,26]

Conclusions

The fermentation processes developed satisfactorily, complying with the required sanitary parameters found in Colombian regulations. The mead beverage had an alcohol percentage over 7% and a stability period longer 6 months for the parameters pH, acidity and soluble solids under refrigerated conditions and at room temperature. The beer with Amazonian fruits had an alcohol percentage over 4%, with excellent sensory characteristics for color and flavor. Including Amazonian flavors in alcoholic beverages is possible, providing an alternative for local development.

Competing Interests

None.

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