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Physicochemical and sensory evaluation of artisanal blackberry wines produced and marketed in Mérida state, Venezuela

Evaluación fisicoquímica y sensorial de vinos artesanales de mora producidos y comercializados en el estado Mérida, Venezuela

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Abstract

This study aimed to conduct a comparative analysis of the physicochemical and sensory characteristics of three artisanal blackberry wines produced in the towns of Caño Zancudo (Wine 1), El Valle (Wine 2), and La Azulita (Wine 3), in the state of Mérida, Venezuela. The evaluation focused on determining their quality and compliance with Venezuelan national regulations. Key parameters such as alcohol content, total and volatile acidity, dry extract, tannin content, reducing and total sugars, and methanol concentration were measured. In addition, a panel of 41 semi-trained tasters performed a sensory evaluation of the samples. The results showed significant differences among the wines. Although all complied with the alcohol content range stipulated by COVENIN Standard 3042, all three wines presented dry extract levels far exceeding those permitted by COVENIN Standard 3287, indicating deficiencies in the standardization of production processes. Wine 2 presented a serious defect due to its high volatile acidity (3.03 g/L), exceeding the limit permitted by COVENIN Standard 3286 and resulting in rejection during the sensory evaluation. Wine 3 received the highest score, with 67.04 points and a preference of 75.61% of the panel, standing out for its sensory balance. The study highlights the need to improve and standardize artisanal production methods to ensure the quality and safety of these wines.

Keywords: *blackberry wine, alcoholic fermentation, panelists, sensory analysis, standardization.*

Resumen

El presente estudio tuvo como objetivo realizar un análisis comparativo de las características fisicoquímicas y sensoriales de tres vinos artesanales de mora elaborados en las localidades de Caño Zancudo (Vino 1), El Valle (Vino 2) y La Azulita (Vino 3), del estado Mérida, Venezuela. La evaluación se centró en determinar su calidad y conformidad con la normativa nacional venezolana. Se midieron parámetros clave como grado alcohólico, acidez total y volátil, extracto seco, contenido de taninos, azúcares reductores y totales, y concentración de metanol. Además, un panel de 41 catadores semientrenados realizó una evaluación sensorial de las muestras. Los resultados mostraron diferencias significativas entre los vinos. Aunque todos cumplieron con el rango de grado alcohólico estipulado por la Norma COVENIN 3042, los tres vinos presentaron niveles de extracto seco muy superiores a los permitidos por la Norma COVENIN 3287, lo que evidencia deficiencias en la estandarización de los procesos de producción. El Vino 2 presentó un defecto grave debido a su alta acidez volátil (3,03 g/L), superando el límite permitido por la Norma COVENIN 3286 y generando rechazo en la evaluación sensorial. El Vino 3 obtuvo la mejor aceptación, con 67,04 puntos y preferencia del 75,61% del panel, destacando por su equilibrio sensorial. El estudio resalta la necesidad de mejorar y uniformar los métodos de producción artesanal para asegurar la calidad y seguridad de estos vinos.

Palabras clave*: vino de mora, fermentación alcohólica, panelistas, análisis sensorial, estandarización.*

1. Introduction

Since ancient times, the discovery of fermentation has allowed humans to produce alcoholic beverages, the consumption of which was associated with feelings of pleasure and relaxation (García Zapateiro et al., 2016). Currently, wine production from fruit has gained relevance in various countries, especially those whose climatic conditions limit grape cultivation. This situation has driven the search for viable alternatives through the use of local fruits. To achieve proper alcoholic fermentation, it is necessary to adapt the environment to the available resources and establish technical parameters that guarantee the quality of the final product (Córdova et al., 2018).

Due to the abundant cultivation of blackberries in tropical countries, this fruit has been used as a viable alternative to grapes for the production of fermented wines, demonstrating remarkable oenological potential. The wine is produced from blackberry juice, which imparts distinctive organoleptic and sensory properties attributable to its chemical profile, characterized by the presence of compounds such as anthocyanins and carotenoids (Beltrán et al., 2023). These parameters were evaluated through physicochemical analyses and are reflected in the characteristic color of wines made with this fruit.

Despite the wide variety of artisanal blackberry wines in the region, a gap persists in their physicochemical and sensory characterization from a scientific perspective. This deficiency limits objective comparison between products, hinders the identification of factors that influence their quality, and impedes the design of effective strategies to improve production processes. Although some studies have addressed aspects such as fermentation and stabilization, significant variations in physicochemical parameters have been reported, influenced by both the properties of the fruit and the specific conditions of the process. These factors are crucial for ensuring the final product quality and its safety for the consumer.

The production of artisanal wines from fruits other than grapes has gained particular interest in various regions of Latin America as a way to diversify local production, add value to agricultural products, and preserve traditional knowledge. In the case of Mérida State, Venezuela, the use of blackberries (Rubus glaucus) as a raw material for wine production represents a sustainable alternative, given their widespread cultivation in Andean areas, their favorable organoleptic properties, and their richness in natural antioxidant compounds. Furthermore, it fosters the generation of direct and indirect employment and opens opportunities for the innovation of new products and expansion into new markets. (Torres Mejía & Torres Mejía, 2022).

The Rubus species cultivated in the Andean region of Venezuela is Rubus glaucus Benth., which is likely a hybrid of Rubus subgroup “Idaeobatus” (raspberry) and Rubus subgroup “Eubatus” (blackberry). (Cedeño, L. and Carrero, C., 2000). The Andean blackberry (Rubus glaucus) is a fruit widely enjoyed for its exquisite flavor, aroma, and attractive color, both for fresh consumption and for its ease of processing as a raw material for preparing sweets, jams, juices, ice cream, syrups, and even wine. (Coronel, 2011).

Blackberries have demonstrated excellent adaptability to clay soils and tropical climates, which favors their use in the production of artisanal wines with a high antioxidant content. (Núñez, 2022). The production of artisanal blackberry wine has generated interest due to its economic and cultural value, as well as the potential health benefits it may offer. Research indicates that moderate wine consumption may reduce the incidence of certain age-related chronic diseases, such as heart disease, hypertension, metabolic diseases, and neurodegenerative diseases. (Johnson & De Mejia, 2011). Unlike grape wine, blackberry wine requires specific standardization in its production process, as the concentration of sugars, acidity, and phenolic compounds can vary significantly depending on the blackberry variety, the degree of ripeness at harvest, and the agroclimatic conditions of the region (Torres Mejía & Torres Mejía, 2022).

According to the Venezuelan Standard COVENIN 3342, the alcoholic strength of a wine should be between 7 and 14% ABV. This refers to the milliliters of ethanol and its homologues, such as methanol, higher alcohols, and 2,3-butanediol, present in a wine, which originate from the fruit or are formed during fermentation (Fernández et al., 2009). At a commercial level, this parameter is of great importance since wines and other alcoholic beverages are marketed and priced according to their alcohol content.

Among the compounds that make up wines are carbohydrates in the form of sugars. The best known are sucrose, glucose, and fructose, but there are others that, although found in lower concentrations in the products we consume daily, are very important due to their physical, chemical, and nutritional properties (Badui Dergal, 2006). Total sugars consider the overall concentration of all sugars, calculated after an acid hydrolysis process. To determine the sugar content in different samples of blackberry wine, the Fehling's and Lane-Eynon methods were combined. These methods are based on the reducing power of the carbonyl group of aldehydes. The Fehling's method is a qualitative method that indicates the reduction of copper by the sugar with the appearance of a red precipitate. While the Lane-Eynon method is a titration that allows quantifying the sugar present using tabulated values (Universidad Nacional de San Juan, 2018).

Wines must exhibit qualities such as color, fruity aroma, and distinctive flavor when evaluating their quality and consumer acceptance. These attributes are due to the presence of anthocyanins, tannins, and other phenolic compounds. Total acidity refers to the acids that make up wine, primarily tartaric and malic acids; other acids are

present in smaller amounts (lactic and acetic). The combined action of all these acids contributes to the development of aromas through the esterification of alcohols (Beltrán et al., 2023).

The food industry uses sensory evaluation as a tool to assess consumer perception of a product as a whole or of a specific aspect of it. In this type of testing, the information provided by a panel is perceived through the sensory organs of sight, smell, hearing, taste, and touch (Ávila de Hernández & González Torrivilla, 2011).

Furthermore, according to Ratti (2011), sensory analysis of wines allows for the evaluation of different attributes individually and/or globally, as well as the appreciation of their positive or negative characteristics. Among these, tannins stand out; these plant compounds give structure and body to the wine, as well as astringency. They influence the flavor and promote the aging process, as they tend to soften over time (Peña Neira, 2006).

In this context, the present study aims to conduct a comparative analysis of the physicochemical and sensory characteristics of three types of artisanal blackberry wines produced and marketed in Mérida, Venezuela. Various parameters were evaluated to identify the factors that influence the quality and safety of the product and to verify its compliance with the requirements established in the Venezuelan Standard COVENIN 3342 for wines and their derivatives. This research seeks to contribute scientific knowledge that will help in the development of high-quality functional beverages that are safe for consumers and have potential for increased value in the local market.

2. Experimental Procedure

To achieve the stated objectives, a sampling procedure was carried out, which included the acquisition of three samples of artisanal wine from the state of Mérida. This approach allows for the evaluation of the quality and characteristics of the products available to the consumer. The methodology was structured in two fundamental areas: physicochemical analysis and sensory evaluation. For the physicochemical analysis, the procedures and methodologies established in Venezuelan regulations were followed, primarily using COVENIN 3342 as the reference standard. Within this framework, the following key parameters were determined: alcoholic strength, volatile acidity and total acidity, dry extract, tannin content, sugar concentration, and the presence of methanol, the latter determined by a spectrophotometric colorimetric method.

Additionally, a sensory evaluation was conducted with a panel of semi-trained tasters to assess the organoleptic properties of the wines. This analysis focused on attributes such as color, aroma, flavor, and texture, in order to obtain a complete profile of the quality and acceptance of the products studied.

2.1 Alcohol Content

The method is based on the distillation of an aliquot of the wine sample, separating the ethanol from the non-volatile components, following the COVENIN 3042-1993 standard, with some variations. The ethanol content in the distillate is determined using a hydrometer alcoholmeter and expressed in degrees Gay-Lussac (GL) using a scale calibrated directly in units of alcohol concentration.

2.2 Volatile Acidity

The method is based on the separation of volatile acids (mainly acetic acid) from the wine by steam distillation. The distilled volatile acids are collected in a container and titrated with a standardized sodium hydroxide (NaOH) solution until an endpoint is reached, indicated by a visual indicator (phenolphthalein) or by potentiometric detection at a specific pH according to COVENIN 3286:1997. Volatile acidity is conventionally expressed as grams of acetic acid per liter (g/L).

2.3 Total Acidity

The method is based on the volumetric titration of the acids present in the wine with a standardized sodium hydroxide solution, until an endpoint is reached, indicated by a visual indicator (phenolphthalein) or by potentiometric detection (SPER SCIENTIFIC 860033 digital potentiometer) at a specific pH according to COVENIN 3286:1997. Total acidity is conventionally expressed as grams of tartaric acid per liter (g/L).

2.4 Dry Extract

The determination of tartaric acid, malic acid, sugars, and other crystals is carried out by evaporating volatile substances at atmospheric pressure and the boiling point of water, following the methodology of COVENIN standard 3287:1997.

2.5 Tannins

The method consists of the hot acid hydrolysis of tannins in the presence of butanol and an iron salt as a catalyst. This process transforms proanthocyanidins into anthocyanidins (cyanidin and delphinidin), which are quantified by visible light spectrophotometry at 550 nm. The final concentration is obtained by subtracting the pre-existing anthocyanidins in the sample and is calculated in mg/L of wine using a cyanidin calibration curve. This method is based on the manual of analytical techniques for musts and wines (Nazrala et al., 2009).

2.6 Sugars

The methodology employed was based on the procedures established in COVENIN Standard 3285:1987. Initially, Fehling's solution (A and B) was prepared and standardized with a 5% glucose solution. The blackberry wine was diluted in two steps to reach a final concentration of 10% for analysis. In the determination of reducing sugars, the diluted blackberry wine sample was used to titrate Fehling's solution under hot conditions. The amount of blackberry wine required for the color change allows for the quantification of reducing sugars. To measure total sugars (including non-reducing sugars such as sucrose), a portion of the diluted wine sample was subjected to acid hydrolysis (with hydrochloric acid and heat) to convert non-reducing sugars (such as sucrose) into reducing sugars. After neutralization, it was titrated in the same way as in the previous step. The concentration of total and reducing sugars is expressed in grams of sugar per liter (g/L). Total sugars were also determined using a digital refractometer that measures Brix degrees (°Brix).

2.7 Methanol

A colorimetric method, based on standard NTC 5159, was used to quantify methanol. The methanol in the sample was oxidized to formaldehyde using potassium permanganate. The formaldehyde then reacted with chromotropic acid to form a colored compound. The intensity of this color, which is directly proportional to the original amount of methanol, was measured with a spectrophotometer at 575 nm (Instituto Colombiano de Normas Técnicas y Certificación, 2003).

2.8 Sensory Analysis

For the sensory analysis of the blackberry wines, a total of 41 semi-trained panelists were used to evaluate the following variables: color, aroma, flavor, texture, and overall experience. This experiment consisted of three phases. In the visual phase, color intensity and turbidity were evaluated; in the olfactory phase, odor intensity and fruity character were assessed; and in the gustatory phase, flavor intensity, sweetness, acidity, persistence in the mouth, and the drying effect of the retronasal passage were evaluated. These variables were assessed according to a modified Robert and Parker scale, totaling 100 points (Torres Mejía & Torres Mejía, 2022).

2.9 Statistical Analysis

For the statistical treatment of the experimental data, an analysis of variance (ANOVA) was applied to determine if there were significant differences between the treatments evaluated. This method allows for the comparison of the means of several groups and establishes whether the variations observed in the response variable are attributable to the factors studied or to chance. The assumptions of normality and homogeneity of variances were verified beforehand. When significant differences were detected ($\alpha < 0.05$), multiple comparison tests were performed to identify the treatments that differed from each other.

3. Results and discussion

3.1 Physicochemical Characterization

Table 1 presents a comparative analysis of three samples of artisanal blackberry wine produced in the state of Mérida, identified as Wine 1, Wine 2, and Wine 3, based on their main physicochemical parameters. The interpretation is based on the values obtained and the statistical significance analysis (α is less than or equal to 0.05), indicated by the superscripts (a, b, c), where different letters imply statistically significant differences.

Regarding alcohol content, all three wines have an alcohol content within the typical range for table wines and corresponds to the value shown on the commercial label. Wine 1 (14 °GL) is the most alcoholic, followed by Wine 2 (13 °GL) and Wine 3 (12 °GL). This variation is due to the different fermentation methods and the sugar content of the blackberry must. It is important to note that the alcohol content of the three wines complies with the range established by COVENIN Standard 3342, between 7 and 14% ABV, and with the MERCOSUR Wine Regulations, which establish a minimum limit of 7% ABV for wines.

Regarding volatile acidity, the Venezuelan Standard COVENIN 3342 establishes a limit of 1.20 g/L for this variable. The volatile acidity analyses applied to blackberry wines 1, 2, and 3 recorded values of 0.22 g/L, 3.03 g/L, and 2.17 g/L, respectively. According to these results, blackberry wine 1 is below the established limit, suggesting acceptable sensory quality in this respect. However, the results obtained indicate that blackberry wines 2 and 3 have volatile acidity levels significantly higher than the limit established by Venezuelan regulations (1.20 g/L), suggesting excessive exposure to oxygen during winemaking or storage. According to Causes Of Wine Spoilage And How To Prevent Them - Grapeworks - Tanium Machinery (2023), high acidity can inhibit bacterial growth, negatively affecting the taste and quality of the wine.

Total acidity is a key parameter for evaluating wine quality, as it affects both microbiological stability and sensory characteristics. In this regard, Beltran et al. (2023) indicate that maintaining adequate total acidity in blackberry wine is necessary to balance its natural sweetness, providing a freshness that prevents the wine from being too heavy or cloying.

Table 1. *Physicochemical analysis of blackberry wine.*

Parameter	Wine_1	Wine_2	Wine_3	Method
Alcohol content (ºGL)	14	13	12	COVENIN 3042-1993
Volatile acidity (g/L)	0,22[a]	3,03[b]	2,17[c]	COVENIN 3286:1997
Total acidity (g/L)	8,75[a]	11,95[b]	7,20[b]	COVENIN 3286:1997
Dry extract (g/L)	262,49[a]	245,53[a]	173,53[b]	COVENIN 3287:1997
Tannins (g/L)	198,45[a]	77,18[a]	132,30[a]	(Nazrala et al., 2009)
Reducing sugars (g/L)	13,82[a]	13,05[b]	11,16[c]	COVENIN 3285:1987
Total sugars (g/L)	14,01[a]	13,91[a]	11,24[b]	COVENIN 3285:1987
ºBrix	14,4	14,2	11,7	Refractómetro digital
Methanol (mg/L)	39,6	39,6	39,6	NTC 5159

[a,b,c]: The mean values of the parameters for each sample with different superscripts are significantly different ($\alpha \leq 0,05$)

The results summarized in Table 1 show that blackberry wine 1 had an average acidity of 8.75 g/L, considered suitable for artisanal fruit wines. Blackberry wine 2 registered a higher acidity of 11.95 g/L, while wine 3 had an acidity of 7.20 g/L. It is worth noting that all three wine samples exhibited tartaric acid values between 5 and 12 g/L, which comply with the range established by the MERCOSUR Wine Regulations. However, blackberry wine 2 stands out as the most acidic in the group, and according to the study by González Hernández (2016), this high acidity could be due to a higher concentration of natural organic acids in the fruit or specific conditions during fermentation, which could result in a more pronounced acidic taste. The variations observed in total acidity among the wines could be explained by the characteristic acidity of blackberries. According to CataTú (2022), factors such as temperature, fermentation duration, or inoculum characteristics could favor an increase in acid production in the fermented must.

In the dry extract measurements of the blackberry wines, wine 1 had a value of 262.5 g/L, the highest in the group, followed by blackberry wine 2, which had a concentration of 245.5 g/L, and finally wine 3 with a result of 173.5 g/L, which is notably the lightest. In all cases, the results obtained exceed the limits established in the COVENIN 3342 standard, whose maximum value is 28 g/L of dry extract. According to the study by Vega et al. (1971), high dry extract values suggest non-standardized production, which hinders the proper conversion of sugars into alcohol.

A drastic difference is observed in the tannin results obtained in this trial. Blackberry wine 1 has a very high tannin content of 198.45 mg/L, predicting a strong sensation of astringency and structure in the mouth. Blackberry wine 3, with a value of 132.3 mg/L, has a moderate level, while blackberry wine 2 presented the lowest tannin value at 77.18 mg/L. According to the study by Peña Neira (2006), a low tannin value can make blackberry wine appear softer in texture.

The values obtained in the determination of reducing sugars in the blackberry wines show a hierarchy. First, blackberry wine 1 has a value of 13.82 g/L, followed by blackberry wine 2 with 13.04 g/L, and finally blackberry wine 3, the driest of the group with 11.16 g/L. The differences, especially between blackberry wines 1 and 2 and blackberry wine 3 (a difference of 2.69 g/L), suggest variations in the winemaking process or the raw materials used, ranging from fruit ripeness and the fermentation process to the yeast strain employed. These results allow us to classify all three wines as semi-dry. According to Vidaurre Rojas (2004), in a dry wine, the reducing sugar content is less than 5 g/L. A semi-dry or off-dry wine contains between 5 and 60 grams per liter of reducing sugars, while sweet wines have a reducing sugar content greater than 60 g/L.

The values for reducing and total sugars are very similar in each blackberry wine, indicating a predominance of simple sugars (glucose and fructose). Blackberry wine 1 and blackberry wine 2 are the sweetest, with total sugar values of 14 and 13.89 g/L and Brix values of 14.4 and 14.2 °Brix, respectively, while blackberry wine 3 is slightly drier with a total sugar concentration of 11.2 g/L and Brix value of 11.7 °Brix. According to Vidaurre Rojas (2004), the alcohol content of wines is proportional to their tannin content, since a higher sugar content implies a higher alcohol content.

Methanol in wines is a natural byproduct formed during fermentation from the enzymatic demethylation of pectins present in the raw material. The methanol concentration in each of the wine samples was 39.6 mg/L. This quantification was performed following the standardized procedure described in Colombian Technical Standard NTC 5159. Blackberries (Rubus glaucus), like other berries and fruits, are characterized by a high pectin content in their cell walls and skin, which are rich in methyl esters. According to the study by Hodson et al. (2017), the result obtained indicates that there was normal extraction of compounds from the blackberry skin during maceration, releasing pectins into the must.

3.2 Sensory Evaluation

The true quality of a wine is revealed by connecting chemical data with consumer perception. According to the study by Torres Mejía & Torres Mejía (2022), these attributes are the pillars of oenological quality. Tables 2 and 3 report the sensory evaluation performed on three blackberry wine samples, which reveal significant differences in their organoleptic profiles and in the overall acceptance by the tasting panel. The results obtained by the panel of semi-trained tasters allow us to establish a clear hierarchy of preference, where blackberry wine 3 stands out as having the

highest perceived quality, followed by blackberry wine 1, and finally blackberry wine 2 as having the lowest acceptance, as shown in Figure 1.

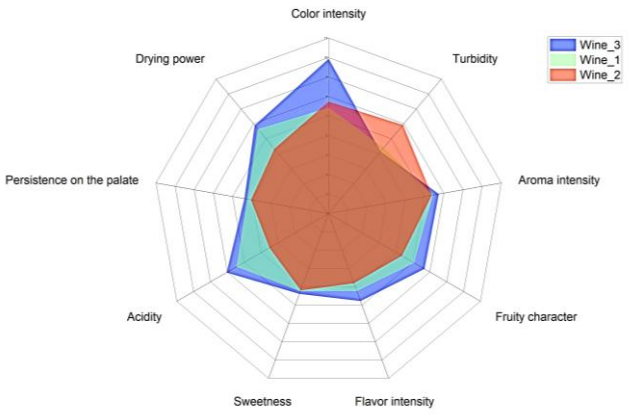

Figure 1. Sensory Characterization.

According to the results shown in Tables 2 and 3, Blackberry Wine 3 obtained the highest total score (67.04 points), which directly correlates with the most favorable overall experience: 75.61% of the tasters rated it positively (31.71% "I liked it very much" and 43.9% "I liked it"), while only 9.76% expressed a neutral opinion ("I neither liked it nor disliked it"). Based on the values obtained in the physicochemical analysis and sensory evaluation, Blackberry Wine 3 presents several key attributes that, together, create a balanced and appealing wine.

Table 2. Sensory Analysis Score.

Characteristic	Wine_1	Wine_2	Wine_3
Color intensity	7,80	7,62	9,94
Turbidity	6,40	7,93	6,16
Aroma intensity	7,44	7,38	7,74
Fruity character	7,07	6,34	7,68
Flavor intensity	6,24	5,80	6,78
Sweetness	6,24	6,20	6,39
Acidity	7,46	5,51	8,05
Persistence on the palate	6,24	6,05	6,39
Drying power	7,66	6,34	7,90
Total	**62,57**	**59,17**	**67,04**

Wine 3 stands out notably for its color intensity (9.94), although with a slight turbidity (6.16). Its aroma intensity (7.74) is subtly superior to the others, and its fruit character (7.68) is the highest. According to CataTú (2024), fruit character is one of the main drivers of consumer preference. Furthermore, the most defining aspect of Blackberry Wine 3 is its flavor balance. It presents the highest flavor intensity (6.78) and, crucially, the highest acidity (8.05). High acidity in a wine, along with a drying effect (7.90), creates a complex, structured mouthfeel with good persistence (6.39). According to Fernández et al. (2009), acidity enhances the characteristic aromas of blackberries, contributing to a more complex and appealing sensory profile, with a clean and refreshing finish.

Table 3. Overall wine experience.

Overall Experience	Wine_1(%)	Wine_2(%)	Wine_3(%)
I liked it a lot	24,39	7,32	31,71
I liked it	39,02	29,27	43,90
I didn't like it	24,39	12,20	9,76
I liked it a little	9,76	26,83	12,20
I didn't like it	2,44	24,39	2,44

Wine 1 is positioned as an intermediate option, with a total score of 62.47 points. Its reception was mostly positive (63.41% combining "I liked it a lot" and "I liked it"), but a significant 24.39% of the tasters were indifferent, suggesting that it is a decent wine but not as exciting as Wine 3. Furthermore, Blackberry Wine 1 has a balanced sensory profile; its acidity (7.46) and drying power (7.66) are good, giving it a correct and pleasant structure on the palate. Its aroma intensity (7.44) and fruity character (7.07) are adequate, surpassing Blackberry Wine 2 but without reaching the expressiveness of Blackberry Wine 3. However, Blackberry Wine 1 obtained a lower flavor intensity (6.24) and fruity character (7.07) compared to Blackberry Wine 3, according to the tasting panel. Therefore, it is a well-made wine, without obvious defects, but lacking the complexity and intensity that characterize a superior quality wine. This aligns with «Vino de Calidad: Factores y Características» (2020).

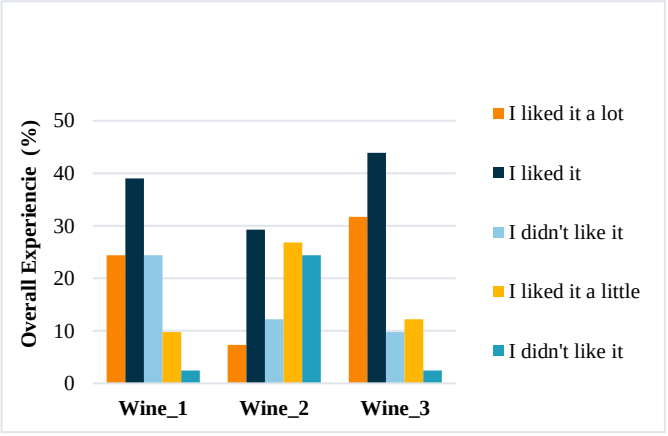

Figure 2. Overall sensory analysis experience.

Regarding Blackberry Wine 2, it received the lowest rating (59.17 points) and the lowest overall acceptance from the tasting panel, with 53.66% of panelists expressing a

negative opinion ("I didn't like it much") or indifference ("I neither like it nor dislike it"). The most notable deficiency of Blackberry Wine 2 was its acidity, which resulted in a low score for this attribute, making it seem lacking in freshness and unbalanced. This may have contributed to the low scores for flavor intensity (5.80) and persistence on the palate (6.05), since acidity is a flavor enhancer. Similarly, it also obtained the lowest scores for fruit character (6.34) and aroma intensity (7.38). The lack of a clear fruit expression and limited aromatic intensity make the wine less appealing and memorable to the taster. Although its color intensity was not as badly rated (7.62), its turbidity score (7.93) was the highest of the three wines, suggesting a potential lack of clarity that may be penalized by consumers. Furthermore, its low drying power (6.34) indicates a weak tannic structure, which, combined with low acidity, results in a wine with little body and character, according to «Vino de Calidad: Factores y Características» (2020). Therefore, Blackberry Wine 2 was perceived as an unbalanced wine, negatively impacting its intensity, persistence, and overall freshness, making it the least preferred by the panel.

4. Conclusions and recommendations

The three blackberry wines analyzed meet the alcohol content requirement (between 7 and 14 °GL) stipulated by Venezuelan Standard COVENIN 3342. However, all significantly exceed the maximum dry extract limit (28 g/L), suggesting a lack of control in the concentration and clarification processes during their artisanal production.

The quality of artisanal blackberry wines is heterogeneous. It was identified that the balance between total acidity, sweetness, and a pronounced fruity character are the determining factors for high sensory acceptance, as demonstrated in wine 3. On the other hand, high volatile acidity is a critical indicator of deterioration that directly impacts the product's low quality and rejection, as occurred with wine 2.

All three wines are safe for consumption, as their methanol levels (39.6 mg/L) are well below the maximum limit of 300 mg/L permitted by the COVENIN 3042 standard, ruling out any risk of toxicity from this compound.

This study highlights the need to implement standardized protocols in the production of artisanal blackberry wines in the region. Greater control over fermentation variables and physicochemical parameters is essential to avoid serious defects, improve consistency, and develop high-quality products that meet consumer preferences.

References

Ávila de Hernández, Rita M, & González-Torrivilla, César C. (2011). La evaluación sensorial de bebidas a base de fruta: Una aproximación difusa. Universidad, Ciencia y Tecnología, 15(60), 171-182. Recuperado en 07 de junio de 2025, de http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S1316-48212011000300007&lng=es&tlng=es.

Badui Dergal, S. (2006). Qímica de los Alimentos (Cuarta ed.). (E. Quintanar Duarte, Ed.) México, México: PEARSON.

Beltrán Balarezo, C., Yánez Romero, M. E., Flores Acosta, A. R., Carchi Tandazo, T. A., & Lam, A. M. (2023). Influencia de las propiedades fisicoquímicas del vino de mora, determinadas mediante análisis sensorial. *Ciencia Latina Revista Científica Multidisciplinar*, *7*(4). https://doi.org/10.37811/cl_rcm.v7i4.7125

CataTú. (2021, 16 julio). *El Color del Vino según distintos Tipos de Vinos. Factores que influyen*. Blog. https://catatu.es/blog/color-vino/

CataTú. (2024, 8 mayo). *Los aromas del vino. Primarios, secundarios y terciarios.* Blog. https://catatu.es/blog/aromas-vino/

Causes of Wine Spoilage and How to Prevent Them - Grapeworks - Tanium Machinery. (2023, 20 abril). Grapeworks - Tanium Machinery. https://grapeworks.com.au/news/winemaking/causes-of-wine-spoilage-and-how-to-prevent-them/#:~:text=Deterioro%20bacteriano%20del%20vino,minimizar%20la%20presencia%20de%20bacterias.

Cedeño, L., & Carrero, C. (2000). Coniothyrium fuckelii causando quema en cañas de mora de Castilla. Revista Científica de la Facultad de Ciencias Agropecuarias, 13(2), 38.

Córdova Guambo, I. V., Tituaña Pulluquitin, G. I., Tobar Jácome, M. C., & Lascano Sumbana, A. V. (2018). Comparación del comportamiento fermentativo de levadura de panificación y levaduras vínicas (uvaferm cm, lalvin ec1118, lalvin qa23) y sus efectos sobre la calidad de vinos de mora (rubus glaucus benth). *Revista Caribeña de Ciencias Sociales*. https://www.eumed.net/rev/caribe/2018/05/calidad-vinos-mora.html

Cómo apreciar el sabor del vino. (2023, 14 diciembre). El Blog de Vinoselección. https://www.vinoseleccion.com/blog/vinos/apreciar-sabor-vino/?srsltid=AfmBOoq91BlftZH0V7JUFg7JDmbbIB_ouAZgbpyimif7doE01i58VutK

Coronel Feijó, M. A. (2011). Estandarización y optimización de procesos de vino de mora de Castilla (Rubus glaucus Benth). Tsafiqui - Revista de Investigación Científica UTE, (2), 20.

Cruz de Aquino, Mario A. de la, Martínez-Peniche, Ramón A., Becerril-Román, A. Enrique, & Chávaro-Ortiz, Ma. del Socorro. (2012). Caracterización física y química de vinos tintos producidos en Querétaro. Revista fitotecnia mexicana, 35(spe5), 61-67. Recuperado en 07 de junio

de 2025, de http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0187-73802012000500013&lng=es&tlng=es.

Fernández, V., Berradre, M., Sulbarán, B., Ojeda de Rodríguez, G., & Peña, J. (2009). Caracterización química y contenido mineral en vinos comerciales venezolanos. *Revista de La Facultad de Agronomía*, *26*(3), 382–397. http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S0378-78182009000300005&lng=es&nrm=iso&tlng=es

García Zapateiro, Luis Alberto, Florez Mendoza, Cielo Inés, & Marrugo Ligardo, Yesid. (2016). Elaboración y caracterización fisicoquímica de un vino joven de fruta de borojó (B patinoi Cuatrec). Ciencia, docencia y tecnología, (52), 507-519. Recuperado en 06 de junio de 2025, de https://www.scielo.org.ar/scielo.php?script=sci_arttext&pid=S1851-17162016000100020&lng=es&tlng=es.

González Hernández, M. (2016). Características sensoriales y composición no volátil de vinos tintos: avances en la exploración de la calidad. Dialnet. https://dialnet.unirioja.es/servlet/tesis?codigo=46984

González Seguí, H. o. G., Hernández López, J., & Hendrik Giersiepen, J. H. (2019). *Metanol: tolerancias y exigencias en las normas para mezcal y bebidas de agave*. *Revista RIVAR*, 7(19), 1-21. https://doi.org/10.35588/rivar.v7i19.4246

Hodson, G., Wilkes, E., Azevedo, S., & Battaglene, T. (2017). Methanol in wine. *BIO Web Of Conferences*, *9*, 02028. https://doi.org/10.1051/bioconf/20170902028

Instituto Colombiano de Normas Técnicas y Certificación. (2003, 26 febrero). NTC 5159 DETERMINACION CONTENIDO DE METANOL.pdf. Scribd. https://es.scribd.com/document/144965156/NTC-5159-DETERMINACION-CONTENIDO-DE-METANOL-pdf

Johnson, M. H., & Gonzalez de Mejia, E. (2011). Comparison of chemical composition and antioxidant capacity of commercially available blueberry and blackberry wines in Illinois. Journal of Food Science, 77(1), C141–C148. https://doi.org/10.1111/j.1750-3841.2011.02505.x

Los taninos del vino | Tannins.org. (2022, 30 diciembre). Tannins.org. https://www.tannins.org/es/los-taninos-del-vino/

Nazrala, J. J. B., Paladino, S. C., Vila, H. F., & Lucero, C. C. (2009). Manual de técnicas analíticas para mostos y vinos. Instituto Nacional de Tecnología Agropecuaria. https://repositorio.inta.gob.ar/handle/20.500.12123/6664

Norma Venezolana COVENIN: 3042 (1997). Bebidas alcohólicas. Determinación del grado alchólico.

Norma Venezolana COVENIN: 3285 (1997). Vinos y sus Derivados. Determinación de azúcares.

Norma Venezolana COVENIN: 3286 (1997). Vinos y sus Derivados. Determinación de acidez total y acidez volátil.

Norma Venezolana COVENIN: 3287 (1997). Vinos y sus Derivados. Determinación de extracto seco libre.

Norma Venezolana COVENIN: 3342 (1997). Vinos y sus Derivados.

Núñez Cárdenas, L. (2022). Identificación y caracterización de los productos bioactivos presentes en los vinos cubanos de alta gama (Tesis doctoral, Universidad de Córdoba, UCOPress). http://hdl.handle.net/10396/23354

Peña Neira, A. (2006). En la calidad de uvas y vino Los taninos y su importancia. VENDIMIA. http://www.gie.uchile.cl/pdf/Alvaro%20Pe%F1a/taninos.pdf

Ratti, R. (2011). Cómo degustar los vinos. Manual del catador. Ed. Mundi-Prensa, Madrid (España).

Reglamento Vitivinícola del MERCOSUR. (1997). WIPO. https://www.wipo.int/wipolex/en/legislation/details/10477

Rua Joao, L. f. (s.f.). TECNAL. doi:13.413-102

Shen, J., Huang, W., You, Y., & Zhan, J. (2024). Controlling strategies of methanol generation in fermented fruit wine: Pathways, advances, and applications. Comprehensive Reviews In Food Science And Food Safety, 23(6). https://doi.org/10.1111/1541-4337.70048

Torres Mejía, J. A., & Torres Mejía, F. (2022). Evaluación fisicoquímica del vino de mora (Rubus glaucus), elaborado en Santa Rosa de Copán, Honduras. Nexo Revista Científica, 35(01), 60–71. https://doi.org/10.5377/nexo.v35i01.13916

Universidad Nacional De San Juan. (2018). *Glúcidos.* Recuperado el 13 de Marzo de 2022, de http://dea.unsj.edu.ar/quimica2/LABORATORIO%202%20GLUCIDOS.pdf

Vega, R., Flores, E., & Ofrías, H. (1971). Determinación rapida del extracto seco en vinos por densimetría. Facultad de Ciencias Agrarias. https://bdigital.uncu.edu.ar/objetos_digitales/19602/2-roberto-vega-eduardo-o.-flores-y-humberto-v.-ofria-p.-7-18

Vidaurre Rojas, P. (2004). Evaluacion De La Temperatura Y La Concentración De Azucar Durante La Elaboracion De Vino Utilizando Levaduras Seleccionadas (Saccharomyces cerevisi~ae R.f. cerevisiae). [UNIVERSIDAD NACIONAL DE SAN MARTIN]. https://core.ac.uk/download/pdf/287328309.pdf

Vino de calidad: factores y características. (2020, 29 octubre). Bodegas Bianchi. https://www.bodegasbianchi.com.ar/blogs/blog/que-factores-inciden-en-la-calidad-de-un-vino?srsltid=AfmBOoqtwt1nW-NLlQv760JKMyYUJ6wufMUDmbvDT1QEmaxsUbV2xCUy

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