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Alcoholic Beverages Obtained from Black Mulberry

Jacinto Darias-Martín^{1*}, Gloria Lobo-Rodrigo², José Hernández-Cordero¹,
Eugenio Díaz-Díaz² and Carlos Díaz-Romero³

¹Centro Superior de Ciencias Agrarias, Departamento de Ingeniería Química,
Area de Tecnología de Alimentos, Universidad de La Laguna, Carretera de Geneto 2,
E-38200 La Laguna, Tenerife, Canary Island, Spain

²Instituto Canario de Investigaciones Agrarias

³Departamento de Química Analítica, Nutrición y Bromatología, Universidad de La Laguna,
Carretera de Geneto 2, E-38200 La Laguna, Tenerife, Canary Island, Spain

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Summary

Black mulberry (*Morus nigra*) is a fruit not known only for its nutritional qualities and its flavour, but also for its traditional use in natural medicine as it has a high content of active therapeutic compounds. However, this fruit is not widely produced in Spain but some trees are still found growing in the Canary Islands, particularly on the edges of the ravine. The inhabitants of these islands (Tenerife, La Gomera, La Palma, El Hierro and Lanzarote) collect the fruit and prepare homemade beverages for medicinal purposes. Numerous authors have reported that type II diabetes mellitus can be controlled by taking a mixture containing black mulberry and water. Apart from that, this fruit has been used for the treatment of mouth, tongue and throat inflammations. In this study we present some characteristics of black mulberry juice (TSS, pH, titratable acidity, citric acid, lactic acid, polyphenols, anthocyanins, the potassium *etc.*) and alcoholic beverages (alcoholic grade, pH, total acidity, volatile acidity, tannins, phenols *etc.*) obtained from black mulberry. Moreover, we have studied the quality of liquors obtained from black mulberry in Canary Islands.

Key words: *Morus nigra*, juice, fermentation, alcoholic beverage

Introduction

The black mulberry (*Morus nigra*) belongs to Moraceae family. This nonclimacteric fruit is picked during the months of July and August. The black mulberry fruit is usually 1 to 4 mm long, oval in shape with bright red colour before full ripeness and it is purply-black when fully ripe. It is fairly common for the inhabitants on the Canary Islands to use this fruit to elaborate juices and alcoholic beverages because of its natural therapeutic qualities for the control of type II diabetes mellitus (1) and inflammations of the throat, tongue and mouth (2).

Recently, authors have recommended the ingestion of black mulberry for strengthening the solid tissues of teeth (3). Gerasopoulos and Stavroulakis (4) presented a study carried out on four mulberry cultivars (*Morus* sp.) grown in Greece. They found differences in the behaviour of the cultivars analysed in terms of shelf-life, firmness, titratable acidity and anthocyanin compounds. There is not much information available about the quality of the black mulberry juice used in the elaboration of alcoholic beverages. The juice analysis performed between

* Corresponding author; Fax: ++34 922 318 523; E-mail: jdarias@ull.es

the years 1996 and 1999 is presented here, as well as the description of the elaboration of the alcoholic beverage from black mulberry juice. Parameters of this alcoholic beverage such as: pH, titratable acidity, volatile acidity, TSS, specific gravity, potential alcohol, potassium, sodium, tannins, and total phenol index are also shown.

The quality of liquors obtained from black mulberry juice in Canary Islands are studied by sensory determination.

Materials and Methods

Plant material

As the black mulberry is a fruit that is not easily found in the market, we picked it from trees on the island of La Gomera when fully ripe. To characterise black mulberry juice, samples were analysed in the months of July and August over a period of four years (from 1996 until 1999). The fruit was homogeneously and carefully selected in terms of shape and ripeness, and then mixed with a blender. A sieve was used to eliminate the seeds and the extract was then pressed softly in order to increase the yield. Samples were frozen and stored at -36°C to be analysed. Next, the black mulberry juice was pasteurized by boiling for 10 min to inactivate microorganisms and later on used to obtain alcoholic beverages.

Black mulberry juice quality

All the parameters explained here were analysed in triplicate using the frozen black mulberry juice obtained every year during the months of July and August from 1996 until 1999. Standard methods of analysis for general wine composition were used.

pH and titratable acidity expressed as g/L citric acid were determined by CEE Wine Regulations 2676/1990, using a solution of 0.1 N NaOH up to pH=7.0. Total soluble solids (TSS) were determined by refractometry (5) using an Atago Refractometer. Malic, lactic and citric acid were analysed by using Boehringer enzymatic methods and ECHO automatic analyser as described by Zoeklein *et al.* (6). Total phenol index, as absorbance units (AU) at 280 nm, was measured using a spectrophotometer Perkin Elmer 550-SE, and tannins were determined as described by Ribereau-Gayon *et al.* (7). Free anthocyanins were analysed by bleaching with bisulphite as explained by Ribereau-Gayon and Stonestreet (8), using a Perkin Elmer 550-SE spectrophotometer at λ_{520} nm. Sodium and potassium contents were determined by flame emission spectrometry as described by Zoeklein *et al.* (6), while glycerol was determined by enzymatic spectrometric analysis (5).

Alcoholic beverages obtained from the fermentation of black mulberry juice

Black mulberry juice was divided into three batches in 10-L fermentation tanks where the temperature was maintained at 20°C , with a stable and almost completely dark atmosphere. Two fermentation methods were assayed in order to determine the best alcoholic beverage obtained. Method 1 consisted of a free fermentation produced by the native yeast present in the black mul-

berry juice. In method 2, the native flora of the juice was firstly inactivated by heat and when the juice temperature was around 20°C it was inoculated with *Saccharomyces cerevisiae* (commercial yeast), then fermented at 20°C . In all cases, 40 mg/L of sulphur dioxide was added as metabisulphite before the fermentation.

Alcoholic beverages obtained from the fermentation of black mulberry syrup

The syrup was obtained by mixing black mulberry juice with sugar in the proportion of 200 g/L and boiling the resulting solution until reduction of 25 % of the volume was obtained.

Two fermentation procedures were used to obtain alcoholic beverages. The first one consisted of fermenting a solution of black mulberry syrup and water in a proportion of 1:1, while in the second method the proportion was 1:2.

Evaluation of the homemade black mulberry beverages produced in Canary Islands

Different homemade black mulberry liquor samples obtained from Tenerife, La Gomera, La Palma, El Hierro and Lanzarote were organoleptically evaluated in terms of colour, odour and flavour by a panel of 10 judges. In initial sessions, the panelists gave descriptive terms to describe the liquors of the study. Later, the intensity of those descriptors was evaluated for all samples.

Statistics

Statistical analysis was performed by means of the SPSS version 10.0 software for Windows. The mean values obtained in the different groups were compared by One-Way ANOVA, assuming that there were significant differences between mean values when statistical comparison was $p < 0.05$.

Results and Discussion

The purpose of this study was to produce black mulberry alcoholic beverage either from black mulberry juice or black mulberry syrup. Nevertheless, we cannot talk about black mulberry wine because the alcoholic level obtained from the juice or syrup is below the ones described in wine legislation.

Using the methodology described above, 0.84 L of juice was obtained per kg of *Morus nigra* harvested, so the yield was higher than that of grape juice, 0.70–0.75 L. The black mulberry juice was of a reddish-black colour and the characteristics measured after the 4-year study are presented in Table 1. There were no significant differences in titratable acidity, TSS, malic acid and phenols measured during the assay, while in the other parameters such as pH and lactic acid the differences were very small within these years. It is also remarkable that the content in $^{\circ}\text{Brix}$ fluctuated between 15 and 16, which is low compared with 20 to 23 for unfermented grapes (9). The values of pH and total acidity were similar to those found by Elmaci and Altug (10) for black mulberry (*Morus nigra*) cultivars from Turkey and differed from those obtained by Gerasopoulos and Stav-

Table 1. Mean value of the quality parameters measured in black mulberry juice obtained between 1996 and 1999

Parameters measured	Mean value	Range values	Standard deviation
	1996–1999		1996–1999
pH	3.28	3.10–3.36	0.08
Titrateable acidity (g/L citric acid)	21.07	16.21–28.16	3.20
TSS (°Brix)	15.63	13.00–17.50	1.68
Malic acid (g/L)	1.44	0.90–2.30	0.34
Lactic acid (g/L)	0.19	0.17–0.26	0.05
Citric acid (g/L)	25.20	20.00–34.00	5.93
AU 280 nm	35.30	30.00–45.00	5.10
Anthocyanins (mg/L)	2120.00	2000–2600	268.33
Potassium (ppm)	3361.36	3075–4000	307.07
Sodium (ppm)	98.37	72.45–114.32	22.64
Volumic mass (g/cm ³)	1.067	1.06–1.07	0.004
Probable alcoholic grade (%)	9.18	8.41–9.73	0.69

Table 2. Mean value of the quality parameters measured in the beverage obtained from Black mulberry juice fermentation with *Saccharomyces cerevisiae* between 1996 and 1999

Parameters measured	Mean value	Range values	DS
	1996–1999		1996–1999
Alcoholic grade	7.40	5.4–9.4	1.63
pH	3.47	3.46–3.50	0.02
Total acidity (g/L citric acid)	19.62	15.58–23.17	3.11
Volatile acidity (g/L acetic acid)	0.58	0.56–0.59	0.02
Tannins (g/L)	3.70	3.12–4.27	0.58
AU 280 nm	52.80	44.6–61.0	8.20
Potassium	3326.32	3040–3825	325.30
Sodium	114.32	94.78–133.96	18.34

roulakis (4) for three cultivars of *Morus alba* in Greece. In this case, °Brix was between 23 and 17 and pH was between 5 and 7.

Malic acid content was similar to that of grape juice from warm areas, while citric acid content was higher than that of the grape and other fruits (11), which is very interesting from the nutritional point of view. Moreover, high potassium and low sodium content present in the juice make the consumption of this juice highly recommendable for people with cardiovascular problems. The sodium content in black mulberry juice is very similar to that in grape juice, and the potassium content is approximately 4 times higher (11).

The results in Table 1 demonstrate that black mulberry (*Morus nigra*) is a good source of phenolic compounds and anthocyanins. The content of anthocyanins is four times higher than in grapes.

Due to the poor quality of alcoholic beverages obtained using the native yeast of black mulberry juice (fermentation method 1, described in Materials and Methods), only the parameters measured for the beverage obtained from the fermentation of black mulberry juice with *Saccharomyces cerevisiae* (method 2) were discussed. This beverage was produced every year during

the study and the parameters measured are presented in Table 2.

As the alcohol level was low when black mulberry juice was fermented, black mulberry syrup was used to increase the sugar concentration and therefore the alcohol level. From the first fermentation, in which the syrup was mixed with the same proportion of distilled water, the alcohol level after 21 days of fermentation was around 11.5 %. As was to be expected, the second fermentation method led to a beverage with lower alcohol level (7.9 %) due to the dilution of the syrup (1:2). The alcohol level obtained was not enough to prevent its degradation by lactic acid bacteria and the generation of acidic flavours made the beverage undrinkable.

An experiment to obtain a beverage with 15 % of alcohol was done by mixing black mulberry syrup and alcohol. The resulting liquor was of a good quality and its characteristics were very similar to the homemade ones from the Canary Islands.

Table 3 shows how the panel found organoleptic differences among the liquors made on different islands. As shown in Table 3, the panel was able to detect differences among the samples analysed.

Table 3. Sensory assessment of different homemade liquors produced in the Canary Islands

Island	Organoleptic description		
	Colour	Odour	Flavour
La Gomera	Reddish-brown, showing orange shades	Caramel aroma, fig aroma with herbaceous character	Similar to over-ripened figs, dates Very sweet
Tenerife	Reddish-brown, showing orange shades	Fruit aroma with a superficial acetic odour	Caramel flavour with sweet fruits
La Palma	Reddish-brown	Burnt caramel with over-ripe fruits	Very sweet and acidic flavor with a high alcoholic persistence
El Hierro	Reddish-orange	Fruity aroma with an intense acetic odour	Fruit flavour masking the alcoholic flavour
Lanzarote	Brilliant maroon	Herbaceous	Oily sensation

Conclusions

Short shelf-life of mulberries, as well as the difficulties in harvesting large amounts of this fruit due to the location of the trees, lead us to the conclusion that its commercialisation on a large scale as a fresh fruit is unviable. Nevertheless, its nutritional and therapeutic characteristics and attractive taste of the beverages obtained in this study lead us to believe that this product could be popular with the consumer.

Black mulberry juice and syrup could be considered as a rich source of anthocyanins and phenols, with a high potassium and citric acid content and low sodium level, and recommended for young children and elderly people. The characterisation of black mulberry juice showed that the quality of the fruit was very similar in all the years of the study.

It was not possible to make wine from fresh black mulberry juice due to the low alcohol level that the beverage showed after fermentation not only with native yeast but also with commercial *Saccharomyces cerevisiae*. This product is highly perishable and its shelf life can be prolonged when it is stabilised with SO₂ or more alcohol. This is why most homemade black mulberry beverages are liquors. Moreover, from the organoleptic description one can observe that artisans use syrup, which is why sweet or caramel flavour is common in all the beverages.

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Alkoholna pića pripravljena od crnoga duda

Sažetak

Crni dud (*Morus nigra*) poznat je ne samo po svojoj prehrambenoj vrijednosti i okusu već i po tradicionalnom korištenju u pučkoj medicini zbog velikoga udjela aktivnih terapeutskih spojeva. U Španjolskoj nije raširen uzgoj duda, za razliku od Kanarskih otoka gdje najčešće raste uz klisure. Stanovnici tih otoka (Tenerife, La Gomera, La Palma, El Hierro i Lanzarote) skupljaju voće i pripremaju domaće ljekovite napitke. Mnogi su autori utvrdili da se tip II šećerne bolesti može kontrolirati razrijeđenim sokom od crnoga duda s vodom. Osim toga, dud se koristio za liječenje upale usta, jezika i grla. U radu autori prikazuju neka svojstva soka od duda (količina otopljenih tvari, pH, kiselost dobivena titriranjem, limunska i mliječna kiselina, polifenoli, antocijanini, kalij i natrij) i alkoholnih pića od duda (postotak alkohola, pH, ukupna kiselost, hlapljivost, tanini i fenoli). Osim toga, ispitana je kakvoća pića dobivenih od crnoga duda s Kanarskih otoka.