Sensorial Analysis of Wines from *Malpighia glabra* L. Pulp

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Abstract
This work aimed to make the sensorial analysis of Barbados cherry (*Malpighia glabra* L.) wines. A standardized questionnaire was used to evaluate the effect of soluble solids (°Brix) and the concentration of fruit pulp on sensorial quality attributes (color, flavor and aroma) of wines; which were measured on hedonic scale, to obtain the best condition for manufacturing wine from Barbados cherry. *Saccharomyces cerevisiae* yeast was used for fermentation. Results showed that Barbados cherry wines were suave, sweet and with 11°GL of alcohol concentration. Flavor and color of wines were characteristic of *acerola* fresh fruit. The t Student test showed that did not present any significant difference among the wines in both these sensorial attributes. Increasing the initial °Brix of must, the wine obtained had better acceptance and there was no effect of pulp mass on sensorial attributes studied. Sensorial analysis revealed that the best Barbados cherry wine was obtained for a must with composition of 22 g/L of sugar and 1 kg of Barbados cherry pulp for each 6 liter of wine. This work supports the usage of *acerola* for obtaining high quality wines which possess pleasing aroma and shiny red color.

Keywords: sensorial analysis, quality control, barbados cherry, wine, color, flavor, aroma

Introduction

The Barbados cherry (*Malpighia glabra* L.) fruit, as any other minor non-conventional fruit plants, leaves doubt on its origin. It was introduced in Brazil about 50 years back, in the state of São Paulo, brought from Puerto Rico (Dinizi et al., 2003). The fruit is known for its very high ascorbic acid (vitamin C) content. About 100 g of juice possesses 50 to 100 times more of this vitamin than that of an equal quantity of lemon or orange juice (Gomes et al., 2002). Other vitamins of relevant importance for health and human food purposes such as A, B1 and B2 also favor the consumption of this fruit. The daily consumption of 2 to 4 fruits is sufficient to meet the normal necessities of human being. The Barbados cherry is also important from social and economic aspects as it offers to the poor population as an easy and accessible source of vitamins and mineral salts at low cost.

The wine commercialization undergoes long and traditional trajectories until it arrives at the table for consumption. However, the product undergoes stabilization treatments and packaging that transforms it into a quality product although at many times, turns it to be quite original and personalized. Thus being, the wines should constant improvements in its characteristics and these must be perfectly stabilized and submitted to severe rules which assure product protection against frauds, whereby guarantee the consumer (Delanoe et al., 1989).

Although the wines better appreciated are made from grapes yet other fruits could be utilized as raw material for the manufacture of wines. These fruits could be orange, pineapple, strawberry, Barbados cherry, cashew apple, *cajá* and other exotic fruits such as *cupuaçu* (Costa et al., 2003 and 2006; Freitas et al., 2001; Garrutti, 2001; Santos et al., 2005a and 2005b; Severo Júnior et al., 2007). Generally, the wines made from these fruits result in flavor and aroma characteristics of the original fruit utilized and if proper care is taken, could last for long time storage.

An alcohol drink ("*Aguardente*" or spirit) obtained of starch from root manioc was compared to two sugar-cane alcohol drink by sensorial analysis. Results showed that color, aroma and flavor from manioc spirit these were not significantly differences to the commercial sugarcane spirits (Ferreira et al., 2005).

The *Saccharomyces cerevisae* yeast was reused in human feeding as beer yeast drags. They were obtained of wines from cashew (*Anacardium occidentales* L.), Malay apple (*Eugenia malaccensis*) and mangaba (*Hancornia speciosa* Gomes) pulps, the musts dregs were separated of the wines, placed into capsule former and they were dried at 55 °C into dryer with air circulation. The beer yeast capsules obtained were compared sensorial to the beer yeast drags commercialized in Brazil. The beer yeast drags had aroma, color and flavor characteristics of these fruits sources. The sensorial analysis showed that all beer yeast drags from tropical fruits wines had good acceptance of tasters and its values were more than beer yeast drags commercialized (Almeida et al., 2005).

The sensorial analysis was used to choose the best *Saccharomicys cerevisiae* yeast between FLASHMAN® and FERMIX® to manufacturing the maize beer (Severo Júnior et al.,

2005). The sensorial acceptances of 30 consumers on beer sensorial qualities were evaluated by use of a hedonic scale, in a standardized questioner. The sensorial analysis showed that the beer obtained by FLASHMAN yeast was the best in all sensorial quality and its acceptance was very good, introducing that this beer may be commercialized.

A sensorial analysis with 30 consumers had done, to compare the wine from cashew apple (*Anacardium occidentale* L.) with the peach and grape wines. Results showed that cashew wine was a good accepted quality and it was the best wine than others fruit wines (Costa et al., 2003 and 2006).

Severo Júnior et al. (2007) produced a wine from *cajá* (*Spondias mombin L.*) pulp. Of this wine, three new wines were obtained, a non-clarified one and two clarifieds, one by sedimentation and other by membrane separation process. After sensorial analysis with 50 consumers, authors perceived that clarified wines showed a good acceptance by the consumers and that anyone of clarification process did not change the quality of the wine.

Santos et al. (2005a and 2005b) to manufacture a wine from Barbados cherry fruit, but the process had been not starting. Composition of must was of 240 g/L of sugar and 1 kg of pulp from 8 liter of wine. The significant data had shown that the Barbados cherry wine was well accepted for consumers and not had difference with relation to the commercialized wine, being able to be a new source of investments for small producers or new option of market.

Recently, the use of neural network based on Kohonen algorithms was applied in the sensorial analysis of Barbados wine samples. Kohonen network results were similar or better than statistical classification, this shows that the use of Kohonen algorithm in the sensorial analysis of wines is valid. Kohonen algorithm is very good in clustering of wine samples and it uses in sensorial analyses of beverages is promises (Curvelo-Santana et al., 2008; Dias et al., 2008).

With this objective in mind, this work was undertaken to obtain a wine of good and acceptable quality prepared from the usage of Barbados cherry fruit, which may consequently aggregate further values to this fruit culture.

Materials and Methods

The Barbados cherry fruits at stage of maturity were selected, cleaned with chlorine (2 ppm of active Cl_2) water and triturated in a blender, thus obtaining the pulp which was stored in a refrigerator. For the preparation of must, the pulp quantity of Barbados cherry fruits and total soluble solids (°Brix) content were varied according to the experimental planning design of 2^2, presented in Table 1. The inorganic nutrients were added in the concentrations of 1 g/L of $NH_4H_2PO_4$ and 0.1 g/L of $MgSO_4$. The pH of the medium was later corrected in the range of 4 to 5 with Na_2CO_3. Fractions of total volume of these were separated in different flasks, from the principal vat as being to approximately 4 L, 500 ml and 10 ml, which were denominated as vessels. These were pasteurized by heating in an

Table 1 - Experimental conditions of manufacture of *acerola* wines.

Wine samples	Factors	
	°Brix (g sugar/100 mL)	% Mass (kg Barbados cherry pulp/liter of must)
A	22	1/6
B	26	1/6
C	22	1/3
D	26	1/3
E	24	¼
F	24	¼
G	24	¼

autoclave and cooling rapidly in running water having the sole objective of sterilization of medium (Delanoe et al., 1989; Garruti, 2001; Lima et al., 2001).

In order to better evaluate the effect of total solids (°Brix, g sugar/l00 mL of must) and fruit pulp mass (*%Mass*, kg Barbados cherry pulp/ liter of must) on the wines acceptability in relation to flavor, color and aroma.

Preparation of wines

Fermentation: the *Saccharomyces cerevisiae* was inoculated in the lowest volume of vessel at a concentration of 70 to 80 g/L, where it remained between 20 - 24 hours for adaptation of the medium. It was later transferred to the next vessel and maintained for 48 hours, after which it was transferred to the principal vat, in which it remained for the final days of its fermentation. After fermentation, the wines were clarified by added of bentonit clay at 1% solution. Later filtration for complete separation of the two phases (liquid and solid) was achieved, resulting in a clear wine (Delanoe et al., 1989; Garruti, 2001; Lima et al., 2001). The wines were packed in amber-colored bottles of 1.0 Liter capacity which were sealed with cork. The closed wine bottles were sterilized by heating in an autoclave at 115 °C and 1.5 kg/cm^2 for 15 minutes, cooled later in running water and stored in refrigerator at 5 °C for a period of 6 months for posterior evaluation of its quality (Gava, 1986).

Physical-chemical analysis of wines

The characteristics determined were: total acidity by titrating with NaOH solution 0.1 M and volatile acidity according to the method of Casenave-Ferré, reducing sugars by Fehling method, percent alcohol by distillation and later measurement of density with alcoholmeter, density measurement by weighing the mass in analytical balance of a determined volume, dry matter by drying at 100-105 °C and pH by potentiometer method (Ascar, 1985; Delanoe et al., 1989; Garruti, 2001).

Sensorial analyses

The acceptability of samples of fermented musts was evaluated using sensorial affective tests, comparing with the aroma of sparkling wine. The samples were served to the 50 consumers in codified tulip-shaped glasses covered with watch glasses, using

a monadic presentation and a 9-cm non-structured hedonic scale. The consumers also registered their purchasing intentions for each sample on the same score sheet, using a five-point attitude scale (Mamede et al., 2005; Teixeira et al., 1987). Sensorial characteristics such as flavor, color and aroma of wines were evaluated. The experimental research on quantitative basis was undertaken wherein a standard form for sensorial analysis was used and random sampling was applied for each of the above attributes using a hedonic scale (1-9), as is shown in Table 2. Based on frequency of responses, the sensorial data were compared by T Student test of significance and plotted in Figure 1 (Almeida et al., 2005; Ferreira et al., 2005; Teixeira et al., 1987). The Appendix 1 shows the model of questionnaire used to obtain the sensorial data.

Table 2 - Form of translation of the sensorial responses of consumer to numerical valor in hedonic scale, for anyone sensorial qualities.

Sensorial response of consumer (Portuguese)	Sensorial response of consumer	Similar valor in hedonic scale
"Não gostei muitíssimo"	I liked not very extremely	1
"Não gostei muito"	I liked not extremely	2
"Não gostei regularmente"	I liked not regularly	3
"Não gostei ligeiramente"	I liked not	4
"Indiferente"	I perceived not diference	5
"Gostei ligeiramente"	I liked slightly	6
"Gostei regularmente"	I liked regularly	7
"Gostei muito"	I liked extremely	8
"Gostei muitíssimo"	I liked very extremely	9

Results and Discussion

Sensorial qualities from wines

The wines obtained possessed clean appearance having the color and aroma characteristics pertaining Barbados cherry fruit, light and sweet flavor, showing that these characteristics of the fruit were retained to a great extent. According to Freitas et al. (2001) and Garrutti (2001), the wines made from fresh fruit pulps had color, flavor and aroma characteristics of these sources and if due care is taken, could last for long time storage.

The detailed observation for the data in Table 3 shows that majority of wines presented satisfactory results in their sensorial analysis, being close to six, it introduces that Barbados cherry wines had been well appreciated for consumers. Figure 1 presents in the visual form the presentation of mean values of analysis sensorial of wines. This shows that in color practically there was no difference between the diluted or more concentrated wines leading to conclude that the weight of fruit mass did not alter significantly the wine color. It was also observed that there was a little visual difference among the samples in relation to wine aroma and to a little higher extent to flavor.

However, according to Teixeira et al. (1987) to exist significant differences between wines, the valor calculated to t Student must be higher than tabled t Student. Tables 4, 5 and 6

Table 3 - Experimental conditions of manufacture of Barbados cherry wines and yours responses to the sensorial qualities.

Wine samples	Responses*		
	Color	**Aroma**	**Flavor**
A	5.740	5.428	4.860
B	6.460	6.340	7.261
C	5.653	5.160	4.027
D	6.380	6.220	6.913
E	6.200	5.907	6.324
F	6.189	5.950	6.176
G	6.020	5.660	5.759

*Average of the sensorial analysis of 50 consumers.

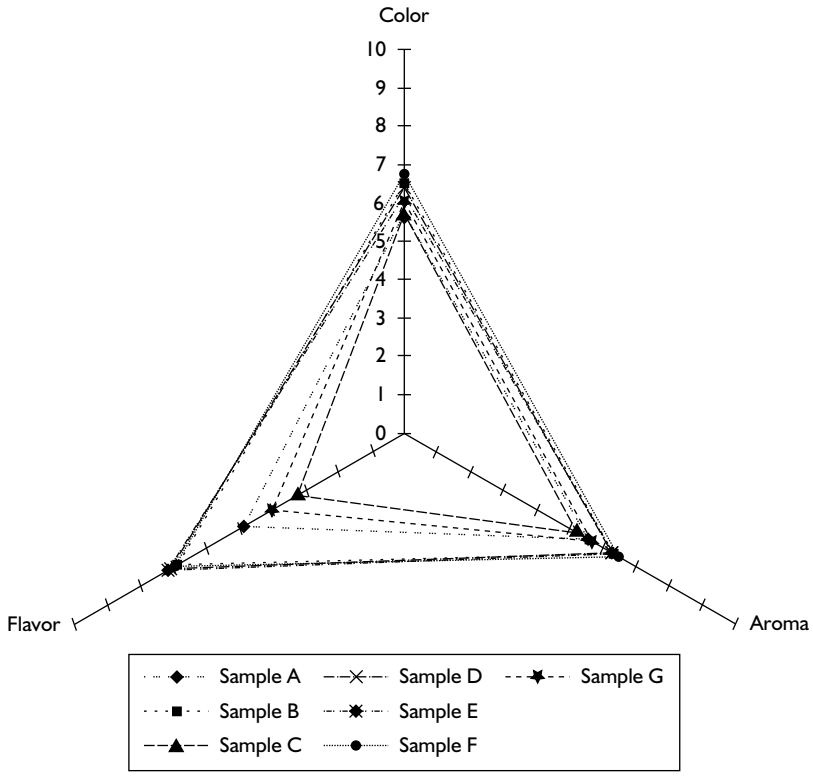

Figure 1 - Sensorial attributes for Barbados cherry wine.

show the t Student test for the sensorial attributes from Barbados cherry wines. From tables, it notes that the valor calculated to t Student varied from 0.005 to 0.36, which is much lower than tabled t Student (2.86), of this way, the value of calculated t Student were be at least four times lower than tabled t Student. Thus, the t Student test showed that did not present any significant difference among the wines in both these sensorial attributes.

Table 4 - Statistic comparison based in t Student analysis at 95% of level confidence, for the wine appearance.

Wines	Calculated t Student					
	B	C	D	E	F	G
A	0.089	0.005	0.079	0.057	0.119	0.032
B	-	0.094	0.010	0.032	0.030	0.057
C	-	-	0.084	0.062	0.124	0.037
D	-	-	-	0.022	0.040	0.047
E	-	-	-	-	0.062	0.025
F	-	-	-	-	-	0.087

Tabled t Student for 50 analyses = 2.864, source: Teixeira et al. (1997).

Table 5 - Statistic comparison based in t Student analysis at 95% of level confidence, for the wine aroma.

Wines	Calculated t Student					
	B	C	D	E	F	G
A	0.108	0.044	0.093	0.103	0.126	0.020
B	-	0.152	0.015	0.005	0.018	0.088
C	-	-	0.136	0.147	0.170	0.064
D	-	-	-	0.010	0.033	0.072
E	-	-	-	-	0.023	0.082
F	-	-	-	-	-	0.106

Tabled t Student for 50 analyses = 2.864, source: Teixeira et al. (1997).

Table 6 - Statistic comparison based in t Student analysis at 95% of level confidence, for the wine flavor.

Amostras	Calculated t Student					
	B	C	D	E	F	G
A	0.185	0.146	0.206	0.209	0.196	0.080
B	-	0.331	0.020	0.024	0.011	0.265
C	-	-	0.3518	0.356	0.342	0.067
D	-	-	-	0.004	0.009	0.285
E	-	-	-	-	0.013	0.289
F	-	-	-	-	-	0.276

Tabled t Student for 50 analyses = 2.864, source: Teixeira et al. (1997).

A general analysis of these wines shows that with the increase in initial °Brix of must, the wine obtained was characterized better acceptance in all sensorial attributes studied. It is also perceived that practically there is no effect of pulp mass on sensorial attributes studied, which indicates that its influence is smaller in the final product quality. However, of this Table 3, it concludes that: the best Barbados cherry wine was "B". This wine was obtained of a must with composition of 22 g/L of sugar and 1 kg of Barbados cherry pulp for each 6 liter of wine.

In Brazil, the Barbados cherry fruit buy for U$ 0.50/kg (same to the sugar price) and as 1 kg of fruit gives approximately 6 L of Barbados cherry wine; the wine cost is approximately U$ 0.16. Thus, the Barbados cherry fruit can be used to obtain a wine of good quality, product suitable for human consumption and low production cost, as will as; the wine manufacture may be a value-added product of Barbados cherry cultivation.

Verify of adjusting of wines to Brazilian laws

For fitting the Brazilian Laws the wine composition must be determined and compared to physical-chemical composition showed in this Norms. Table 7 shows the data obtained after the analysis of Barbados cherry wine samples. From this table, it could be observed that total acidity was within the range established as Brazilian standard (lower than 130 mEq/L) and practically all fermented samples did not characterize for any undesirable acidity which could be volatile, indicating presence of acetic acid or its derivatives. Such substances denature wine, modifying the aroma (pungent) and flavor of the same (bitter).

Table 7 - Physical-chemical analysis of Barbados cherry wines.

Characteristics	Mean value	Standard deviation (±)	Brazilian law standards
Reducing sugars (g/L)	6.670	0.780	-
Total acid (mEq/L)	5.798	0.780	130
Volatile acid (mEq/L)	0.139	0.121	< 55
Density	0.985	0.008	-
pH	3.0	0.5	3.1-3.9
Total solids (%)	4.123	0.126	-
Alcohol content at 20 °C (°GL)	11.0	0.5	9-15

The reducing sugars content in wines varied from 5-20 g/L, which indicates relative stability that a small quantity of sugar could reduce or inhibit any perturbation which may occur in the physical-chemical properties of wines due to microbial action. The dry matter content also was lower and hence it presented a clear appearance and low density due to the presence of non-volatile acids, superior alcohols, carbohydrates, inorganic minerals, tannins, etc. The wine pH was in the range of 3.1 to 3.9 which is very much desired and it results in avoiding microbial contaminations or alterations in color, flavor and in oxi-reduction potential (Delanoe et al., 1989; Garruti, 2001).

Conclusions

The wines obtained in this work had color, aroma and flavor characteristics of *acerola* and it was classified as suave. Its alcoholic gradation was approximately 11 °GL and had all other physico-chemical characteristics within the norms specified by Brazilian Laws.

The sensorial analysis demonstrated that there was no significant difference between the various wines manufactured and their mean acceptance was about 6 point in hedonic scale. The t Student test showed that did not present any significant difference among the

wines in both these sensorial attributes. The analysis of the sensorial data showed that the wines which were produced with the must of higher °Brix and lower quantity of pulp mass were more acceptable by panel members. The best Barbados cherry wine was obtained for a must with composition of 22 g/L of sugar and 1 kg of Barbados cherry pulp for each 6 liter of wine. This work demonstrated that it is possible to obtain good and commercially acceptable, which may serve as another form of aggregating value to the Barbados cherry culture.

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Appendix 1: Model of Questioner Used to Obtain the Sensorial Data.

Name: _____Date: ____/____/____
Instructions: You will go to receive a series from samples that will be served individually. You prove each one carefully and he evaluates, before the next one is served. You mark with a X in the position that better identifies the intensity of the evaluated characteristic.

Sensorial Characteristic: Appearance

Criterions	Samples						
	A	B	C	D	E	F	G
I liked not very extremely							
I liked not extremely							
I liked not regularly							
I liked not							
I perceived not difference							
I liked slightly							
I liked regularly							
I liked extremely							
I liked very extremely							

Sensorial Characteristic: Aroma

Criterions	Samples						
	A	B	C	D	E	F	G
I liked not very extremely							
I liked not extremely							
I liked not regularly							
I liked not							
I perceived not difference							
I liked slightly							
I liked regularly							
I liked extremely							
I liked very extremely							

Sensorial Characteristic: Flavor

Criterions	Samples						
	A	B	C	D	E	F	G
I liked not very extremely							
I liked not extremely							
I liked not regularly							
I liked not							
I perceived not difference							
I liked slightly							
I liked regularly							
I liked extremely							
I liked very extremely							

OBS:_____
_____
_____