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Physico-chemical and sensory characteristics of jellies made from seven grapevine (*Vitis vinifera* L.) varieties

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ABSTRACT

Jellies of seven grapevine varieties were physico-chemical and sensorial characterized for the first time. Jellies differed significantly in moisture and ash contents, colour, pH, acidity and antioxidant activities. 'Tinta Carvalha' was the darkest and redness jelly, showing the highest antioxidant activity. Regarding sensory characteristics, no significant differences in the appearance, taste, sweetness, acidity and global assessment were observed among jellies. Nevertheless, these attributes were positively evaluated. In conclusion, the production of different jellies will allow the valorisation of grapevine varieties with less potential for wine production, helping to preserve biodiversity, and be an economic alternative to grape producers who may elaborate an enjoyable product with interesting bioactivity.

Key words: grapevine, jellies, physico-chemical characterization, antioxidant activity, sensory analysis

IZVLEČEK

FIZIKALNO-KEMIČNE IN SENZORIČNE LASTNOSTI ŽELEJEV NAREJENIH IZ SEDMIH SORT GROZDJA (*Vitis vinifera* L.)

Fizikalno-kemične in senzorične lastnosti sedmih sort grozdja so bile prvič analizirane. Želeji so se značilno razlikovali v vsebnosti vode in pepela, v barvi, pH, kislosti in antioksidativni aktivnosti. Žele pripravljen iz sorte 'Tinta Carvalha' je bil najtemnejši in najbolj rdeč. V senzoričnih lastnostih med želeji ni bilo značilnih razlik v izgledu, okusu, sladkosti, kislosti in celotni oceni, vendar so bile te lastnosti pozitivno ovrednotene. Sklepamo, da bo izdelava različnih želejev omogočala ovrednotenje tistih sort vinske trte, ki imajo manjši potencial za pridelavo vina, kar bo prispevalo k ohranjanju raznolikosti žlahtne vinske trte in bo ekonomska alternativa vinogradnikom za izdelavo koristnega izdelka z zanimivo bioaktivnostjo.

Ključne besede: grozdje, želeji, fizikalno-kemično vrednotenje, antioksidacijska aktivnost, senzorična analiza

1 INTRODUCTION

Portugal has great tradition in wine production. The Northeast region is not exception and it is known for the different grapevine (*Vitis vinifera* L.) varieties that grow there. The quality and specificity of these varieties are the result of their diversity and adaptation to different agro-climatic conditions. Through the knowledge on these varieties and the processes that may contribute to their preservation, the development of differentiated products may be a great opportunity to increase market competitiveness of this sector, besides preserving biodiversity. Furthermore, consumers are increasingly demanding for natural and healthy products, being products rich in

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antioxidants a good example. Grape meets these requirements, since it has a high antioxidant potential, being part of this due to its skin (Bekhit et al., 2011; Katalinic et al., 2010; Poudel et al., 2008). Several studies report that grape skin is rich in phenolic compounds, whose profile varies with variety, maturation stage and origin of the fruit (Bekhit et al., 2011). In this way, different grape varieties may exhibit different chemical compositions that may consequently influence their antioxidant potential, both in fresh and grape sub products (Abe et al., 2007).

Jelly production is a good example of a product easy to produce and consume, with long storage periods that continue to have the value of fruit. Moreover, jelly production allows the employment of underused fruits, such as secondary quality (e.g. small) and over-ripe grapes that are often not desired by consumers and, hence, are generally wasted.

According to the Portuguese law (Law-Decree No. 230/2003), jelly is defined as a product sufficiently gelled that result from the mixture of sugar and juice and/or aqueous extract of one or more types of fruit. Unlike other jellies of other fruits, of our knowledge few studies have been conducted to date on grape jellies. The works performed until now have addressed the effect of using different gelling agents (Gaspar et al., 1998), the role of the enzymatic activity, namely peroxidase and polyphenol oxidase (Freitas et al., 2008), and the antioxidant activity of two jellies produced from grapes of *V. labrusca* and *V. vinifera* (Falcão el al., 2007).

In order to obtain more valuable data on this subject, in this study grape jellies of seven varieties of *V. vinifera,* namely, ‘Periquita’, ‘Touriga Nacional’, ‘Cornifesto’, ‘Tinta Barroca’, ‘Marufo’, ‘Trincadeira Preta’ and ‘Tinta Carvalha’, were produced and characterized in terms of physico-chemical properties, antioxidant activity and sensory characteristics.

2 MATERIALS AND METHODS

2.1 Grape samples

Seven red grapevine varieties, namely, ‘Periquita’, ‘Touriga Nacional’, ‘Cornifesto’, ‘Tinta Barroca’, ‘Marufo’, ‘Trincadeira Preta’ and ‘Tinta Carvalha’, were harvested at their technological ripening time in Valpaços, Northeast of Portugal. After harvest, the grapes were transported under refrigeration and on their arrival at the laboratory the fruits were washed with ultra-pure water (Milli-Q system, Merck Millipore, Massachusetts, USA). A grapes portion (ca. 900 g) was used to formulate jellies, while other portion (ca. 100 g) was used to separate the skins. The skins proportion for each variety was determined after separating them from the pulp and by fruit and skin weighting. Grapes and skins were packed properly at -18 °C until further use.

2.2 Jellies production

For jellies production the ingredients used were fresh grapes and sucrose. At the beginning 500 g of crushed grapes of each variety were macerated at room temperature (ca. 20 °C) for approximately 5 minutes and the mixture was heated to boiling for 10 minutes. Subsequently, the mixture was filtered through a strainer and the sugar added at a ratio of 1:2 (1 g of sugar per 2 ml of liquid). Afterwards, the solution was again taken to boiling until a Total Soluble Solids (TSS) value between 65-70 °Brix (Lago et al., 2006; Lago-Vanzela et al., 2011), measured on an Abbe refractometer (Optic Ivymen System, Madrid, Spain). Before cooling the mixture were poured into glass jars with 250 g capacity and closed with metal caps. Then the jars were placed in a hot water bath (100 ºC) for 15 minutes (Granada et al., 2005) and left to cool at room temperature (ca. 20 °C).

2.3 Physico-chemical analysis

Before jellies processing, the TSS values of the juices of the seven grapevine varieties were measured.

The following parameters were evaluated in the jellies: colour, pH, moisture, ash and acidity. Colour was measured with a CR-400 colorimeter (Konica Minolta, Tokyo, Japan) in the CIELab colour space, through the coordinates: L*, a* and b*, using the Spectra Magic Nx software (version

CM-S100W 2.03.0006, Konica Minolta, Tokyo, Japan). The instrument was always calibrated with a standard white tile before analysis. Illuminant C and 2º standard observer were used. pH was measured directly (Jenway potentiometer, model 370, Jenway, Essex, United Kingdom). Moisture and ash contents were determined by weight loss at 105 °C until constant weight and 550 °C for at least 4 hours (AOAC, 1999), respectively. Acidity was determined by titrimetric analysis, consisting of a titration with 0.10 mol l^{-1} NaOH, being the values reported in % of tartaric acid. Due to colour of the jelly, it was not possible to detect clearly the end point of the titration when using phenolphthalein as indicator. So, the pH of the solution was monitored continuously in order to obtain the titration curve. The pH at the equivalence point was established as 8.1, as indicated in the Portuguese rule NP-1421 (1977). The titratable acidity (*TA*) was calculated by Equation 1, according to NP-1421 (1977):

$$TA\ \ (\%\,tartaric\,acid) = \frac{c \times v \times MM}{2 \times m} \times 100 \qquad (1)$$

Where c is NaOH concentration (mol l^{-1}), v is NaOH volume spent at the titration (l), MM the molar mass of tartaric acid (150.087 g mol^{-1}) and m the sample mass (g).

The TSS contents (ºBrix) of jellies were measured with an Abbe refractometer (Optic Ivymen System, Madrid, Spain).

All reagents were p.a. (pro analysis) and were purchased to Sigma-Aldrich Fine Chemicals (St. Louis, MO, USA).

2.4 Antioxidant Activity

2.4.1 Grape jelly and skin extracts

Extracts were prepared by mixing 5 g of sample (grape jelly or skins) with 20 ml of methanol. In case of grape skins, these were previously deep-frozen and grounded. The solutions were placed under stirring for one hour. Subsequently the solutions were filtered through Whatman No. 2 filters (Whatman, Kent, United Kingdom) to round bottom flasks previously weighed. In order to evaporate the solvent, the flasks were placed on a rotary evaporator RE300DB (Stuart, Stone, United Kingdom) and afterwards in the oven UNB500 (Memmert, Schwabach, Germany) at 40-45 °C. The extracts were redissolved in methanol to an extract concentration of 50.0 mg ml^{-1}.

2.4.2 Total Reducing Capacity

Total reducing capacity (TRC) of the extracts was determined by the Folin-Ciocalteu's assay (Singleton and Rossi, 1965). To 100 µl of the extract solutions, 7.90 ml of deionized water and 500 µl of Folin-Ciocalteu reagent were added. The blank was prepared in a similar way, replacing the extract solution by methanol. After 3 to 8 minutes, 1.50 ml of sodium carbonate saturated solution was added. After two hours the absorbance values were read at 765 nm (Genesys 10UV, Thermo Scientific, Madrid, Spain). Gallic acid was used as standard, being the results expressed in g of gallic acid equivalents (GAE) per kilogram of extract.

2.4.3 DPPH (2,2-diphenyl-1-picrylhydrazyl) Radical Scavenging Activity

DPPH radical scavenging activity was determined by the procedure described by Delgado et al. (2010) with some modifications. DPPH assay evaluates the ability of the grape extracts to scavenge this free radical. To 0.30 ml of extract solutions (5.00 mg extract ml^{-1}) were added 2.70 ml of DPPH methanol solution (6.09×10^{-4} mol l^{-1}). After 1 hour at room temperature (ca. 20 °C) in the dark, the absorbance was read at 517 nm (Genesys 10UV, Thermo Scientific, Madrid, Spain). DPPH radical scavenging activity was calculated as follows:

$$\text{DPPH radical scavenging activity (\%)} = \frac{A_{DPPH} - A_{Sample}}{A_{DPPH}} \times 100 \qquad (2)$$

Where A_{DPPH} is the absorbance of the DPPH solution and A_{Sample} the absorbance of the solution when the sample extract was added. The blank was made with methanol.

2.4.4 Reducing Power

The reducing powers of the extracts were determined by the procedure described by Delgado et al. (2010). Extract solutions at different concentrations were prepared from the stock solution of 50.0 mg extract ml^{-1}. To 1.00 ml of each solution were added 2.50 ml of 0.20 mol l^{-1} phosphate buffer (pH 6.6) and 2.50 ml of 10 g l^{-1} $K_3[Fe(CN)_6]$. After stirring, the mixture was incubated at 50 °C for 20 minutes. Afterwards, 2.50 ml of 100 g l^{-1} trichloroacetic acid was added to the test tubes. 2.50 ml of the mixture were transferred to another test tube, to which 2.50 ml of distilled water and 0.50 ml of 1 g l^{-1} $FeCl_3$ were added. The absorbance values were read at 700 nm (Genesys 10UV, Thermo Scientific, Madrid, Spain). The extract concentration providing 0.5 of absorbance (EC_{50}) was calculated from the graph of absorbance versus extract concentration.

2.5 Sensory analysis

In order to evaluate the acceptability of the grape jellies a consumer panel was used, following the methodology of Lago et al. (2006). The sensory analysis took part at the University on two consecutive days due to the high number of samples, being four jellies analysed each day. Since there were seven grape jellies, one of these (‘Tinta Barroca’ grape jelly) was repeated in both days but identified with a different number. Around twenty-gram samples of jelly at room temperature were presented in white plastic plates labelled with three-digit random codes. A glass of water was offered to the consumers to rinse their mouths. To prevent biases related to the serving order, this was determined by random permutation. After a brief explanation of how to perform the sensory analysis, the consumers were asked to evaluate the samples according to a 9-point hedonic scale: 1 - Dislike extremely, 2 - Dislike very much, 3 - Dislike moderately, 4 - Dislike slightly, 5 – Neither like nor dislike, 6 - Like slightly, 7 - Like moderately, 8 - Like very much, 9 - Like extremely. The attributes evaluated were the appearance, colour, taste, acidity, sweetness and global assessment.

2.6 Statistical analysis

The statistical analysis was performed using the SPSS software (SPSS, Chicago, Illinois, USA), version 20.0. When analysing the physico-chemical properties and antioxidant activity data, the normality and homogeneity of variance were always checked by the Shapiro-Wilk and Levene Tests, respectively. When both conditions failed the nonparametric Kruskal-Wallis test was applied, followed by multiple comparison of order means. On contrary, when normality and homogeneity of variances were observed, an ANOVA followed by Tukey post-hoc test was used. Regarding the sensory analysis data, the nonparametric Kruskal-Wallis test was applied because ordinal variables were used. To check whether there were differences between the first and second days for the jelly that was repeated (‘Tinta Barroca’ grape jelly), it was used the Wilcoxon-Mann-Whitney test.

3 RESULTS AND DISCUSSION

3.1 Physico-chemical characterization of grape jellies

The juices of the seven grapevine varieties studied in the present work had different total soluble solid contents, varying between 19.1 ºBrix and 33.5 ºBrix for ‘Touriga Nacional’ and ‘Trincadeira Preta’, respectively. These values indicated differences in grapes sweetness.

Concerning grape jellies, their physico-chemical characterization is shown in Table 1. The moisture contents ranged from 38.6% (‘Periquita’) to 45.0% (‘Touriga Nacional’) and ash levels between 0.4% (‘Cornifesto’) and 0.7% (‘Marufo’), suggesting a higher mineral content in this jelly. Regarding colour and in particular lightness (L*), differences on jellies colour were found. ‘Periquita’ jelly was the one with the highest L* value (33.44), indicating that it was the clearest jelly, while ‘Tinta Carvalha’ was the darkest (31.84) jelly. Concerning a* ($^{-}$green-red^{+}) and b* ($^{-}$blue-yellow^{+}) parameters, the highest values were obtained for ‘Tinta Carvalha’ and ‘Marufo’ jellies, respectively, whereas ‘Tinta Barroca’ and ‘Tinta Carvalha’ jellies presented the lowest values. Accordingly, the differences found in grape jellies colour depended on grape variety. Regarding pH and acidity, significant differences between jellies were also observed. pH varied between 3.60 (‘Marufo’) and 3.74 (‘Touriga Nacional’) and acidity between 0.7% (‘Tinta Barroca’) and 1.0% (‘Touriga Nacional’). These results indicated that jellies prepared from some grapevine varieties were significantly different in colour because they had different CIELab parameters, as well as in flavour, due to differences on pH and acidity values, allowing the production of a wider range of products that may meet different consumer's tastes and wishes.

Table 1: Physico-chemical parameters of the jellies prepared in the present work from seven grapevine varieties

Variety	Moisture (%)	Ash (%)	Colour			pH	Acidity (% tartaric acid)
			L*	a*	b*		
Cornifesto	42.00±0.07[a]	0.40±0.06[a]	32.42±0.08[b,d]	0.05±0.01[b,c]	0.88±0.02[a,b]	3.64±0.01[b]	0.85±0.03[a,b,c]
Marufo	41.04±0.06[a,b]	0.69±0.08[a]	32.40±0.19[a,b,d]	0.27±0.03[a]	1.00±0.07[a]	3.60±0.06[a,b]	0.73±0.00[a]
Periquita	38.59±0.14[b]	0.56±0.02[a]	33.44±0.18[c]	0.09±0.03[b]	0.90±0.04[a]	3.68±0.01[a]	0.82±0.01[c]
Tinta Barroca	43.49±0.06[d]	0.51±0.00[a]	32.22±0.01[d]	-0.09±-0.04[c]	0.88±0.01[a]	3.71±0.02[a,b]	0.72±0.01[a]
Tinta Carvalha	43.90±0.43[d]	0.58±0.14[a]	31.84±0.05[a]	0.41±0.04[a]	0.77±0.04[a,b]	3.62±0.01[b]	0.75±0.14[a,b,c]
Touriga Nacional	44.97±0.29[c]	0.56±0.10[a]	32.31±0.02[b,d]	0.09±0.01[b,c]	0.81±0.05[b]	3.74±0.01[a]	1.01±0.00[b]
Trincadeira Preta	42.93±0.44[d]	0.51±0.02[a]	32.43±0.04[b]	0.04±0.01[b,c]	0.86±0.02[a,b]	3.66±0.01[b]	0.74±0.01[a]

*Different letters in the same column indicate significant differences ($p < 0.05$)

3.2 Antioxidant activity

3.2.1 Total Reducing Capacity (TRC)

TRC was measured according the Folin-Ciocalteau's assay. This method is currently used and the results are usually expressed in total phenols content; however, once different chemicals react (reducing saccharides, proteins, etc…) with this reagent (Singleton et al., 1999), the value of total phenols is overestimated. So, the use of total reducing capacity is more accepted.

The TRC of the extracts prepared from the jellies produced in the present work and from the berry skins are given in Figures 1A and 1B, respectively. The TRC of the jellies extracts were much lower than those of the berry skin extracts. These results were expected, since jellies were prepared from grape pulp and skins, as well as sucrose, being the skins the richest constituent in total phenols.

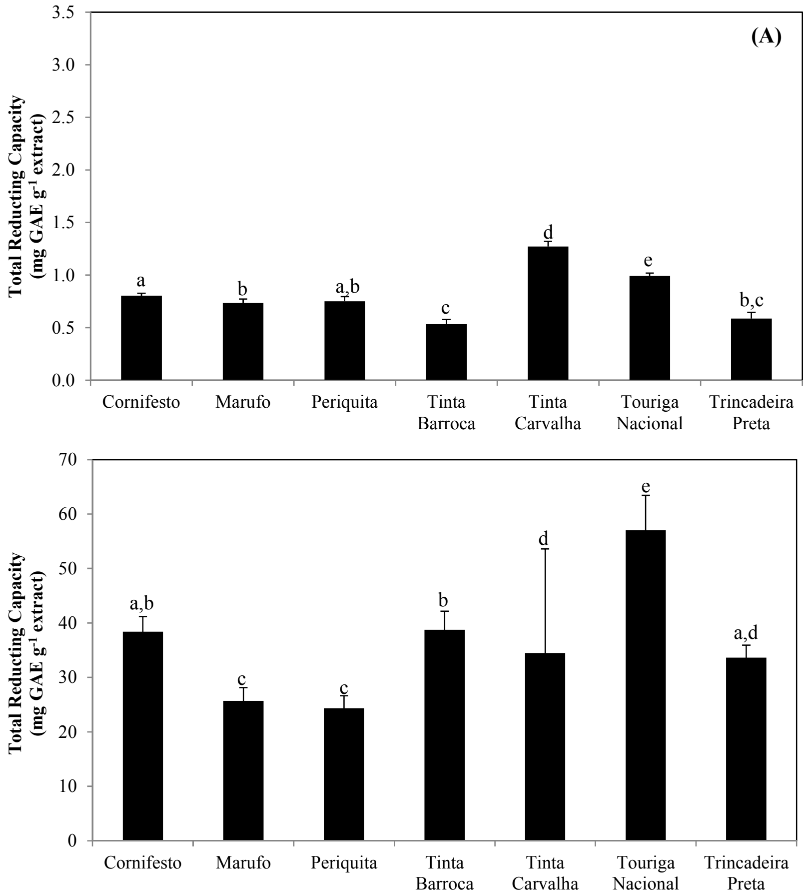

Figure 1: Total Reducing Capacity (mg GAE g^{-1} of extract) of jellies (A) and skins (B) of seven grapevine varieties.

When comparing grapevine varieties, significantly differences on TRCs of the jellies and skin extracts were found. The TRC of the jellies varied between 0.54 and 1.27 g of GAE kg^{-1} of extract of 'Tinta Barroca' and 'Tinta Carvalha', respectively. Nevertheless for berry skin extracts, higher TRC values were found and varied between 24.36 g of GAE kg^{-1} of extract ('Periquita') and 57.05 g of GAE kg^{-1} of extract ('Touriga Nacional'), respectively, showing that the grapevine varieties with skins with the highest TRCs were not those that originated the jellies with the highest antioxidant potentials.

After expressing the TRC in g of GAE kg^{-1} of jelly (Table 2), the values varied between 0.356 and 0.874 g of GAE kg^{-1} of jelly for 'Tinta Barroca' and 'Tinta Carvalha' varieties, respectively. The total phenol contents of the grape jellies produced in the present study were much lower than those reported by Falcão et al. (2007) for a model system of a jelly prepared from grapes of 'Isabel' variety, namely 63.4 g of GAE kg^{-1} of jelly and 95.1 g of GAE kg^{-1} of jelly when acetone and ethanol at 70% (v/v) were used as extraction solvents. However, even though the extraction solvents used were different to that employed in the present study, the production method of the jelly was much more complex, including the use of gelling agents, citric acid and anthocyanin extracts, which explain the higher antioxidant activity of the jelly produced by Falcão et al. (2007) than ours.

Taking into account the fruit quantity used in jelly production, the TRC values expressed on g of GAE kg^{-1} of fruit weight were determined (TRC_{fruit}). Then, through the skins proportion determined previously for each grapevine variety, the TRCs expected from the berry skins were determined and named by $TRC_{skin\ (expected)}$, expressed on g of GAE kg^{-1} of skin. After comparing these concentrations with the TRCs determined for the skins before processing (*in natura*) ($TRC_{skin\ (real)}$), recovery yields between 14.6% (‘Tinta Barroca’) and 62.3% (‘Periquita’) were found, indicating that during jelly production the diffusion rate of phenolic compounds for sucrose solutions or the loss of such compounds due to heating, depended on grapevine variety.

In general terms and considering the TRC obtained for all varieties (Table 2 and Figure 1A), ‘Tinta Carvalha’ seemed to be the most suitable grape variety for jelly production with the highest content of bioactive compounds (0.874 g kg^{-1} of GAE by jelly weight).

Table 2: Total Reducing Capacity (TRC) (mg GAE g^{-1}) of the jellies and berry skins of seven grapevine varieties studied in the present work.

Variety	TRC_{jelly} (mg GAE g_{jelly}^{-1})	TRC_{fruit} (mg GAE g_{fruit}^{-1})	$m_{(fruit)}$ (g)	$m_{(skin)}$ (g)	$TRC_{skin\ (real)}$ (mg GAE g_{skin}^{-1})	$TRC_{skin\ (expected)}$ (mg GAE g_{skin}^{-1})	Recovery Yield TRC skins (%)
Cornifesto	0.567	0.85	1.92	0.37	4.41	16.3	27.1
Marufo	0.516	0.77	3.24	0.41	6.12	12.0	50.8
Periquita	0.588	0.88	3.05	0.34	7.92	12.7	62.3
Tinta Barroca	0.356	0.53	2.79	0.56	2.66	18.2	14.6
Tinta Carvalha	0.874	1.31	2.77	0.44	8.26	14.8	55.7
Touriga Nacional	0.679	1.02	2.27	0.29	7.97	19.6	40.6
Trincadeira Preta	0.417	0.63	2.24	0.25	5.60	15.7	35.7

This jelly was the one that also showed the darkest colour (lowest L*) and the highest proportion of red pigments (highest a*), suggesting the presence of a high amount of anthocyanins. Nevertheless, these results also suggest that in the future, it will be of great interest to optimize the process of jelly production in order to extract a high number of phenolic compounds of the skins and increase their recovery yields.

3.2.2 DPPH (2,2-diphenyl-1-picrylhydrazyl) Radical Scavenging Activity

The antioxidant activity determined by the DPPH method for the extract concentration of 5 mg ml^{-1} (Table 3) showed that the seven grape jellies had different DPPH radical scavenging activities, varying from 9.8% (‘Periquita’) to 60.0% (‘Tinta Carvalha’). The extracts with the highest blocking effect on DPPH radicals were again those of ‘Tinta Carvalha’ jelly, in line with the TRC results. Regarding berry skins, similar values were obtained within grapevine varieties, ranging between 84.9% (‘Tinta Barroca’) and 89.9% (‘Periquita’). Once again it was found that the skins showed higher antioxidant potential than jellies, since the processing may affect the bioactive compounds present in vegetable products (Marquina et al., 2008).

Table 3: DPPH radical scavenging effect (%) for the concentration of 5 mg extract ml^{-1} of jellies and berry skins of seven grapevine varieties.

Variety	Jelly	Skins
Cornifesto	31.8±1.0^{d,e}	88.9±0.4^{b,c}
Marufo	22.5±0.5^{a}	88.3±0.8^{a}
Periquita	9.8±0.4^{a}	89.9±0.3^{d,e}
Tinta Barroca	59.0±1.2^{e}	84.9±0.7^{e}
Tinta Carvalha	60.0±0.2^{c}	89.7±0.2^{b,c}
Touriga Nacional	42.3±0.8^{b}	87.7±0.4^{b}
Trincadeira Preta	28.1±0.4^{c,d}	88.9±0.6^{c,d}

*Different letters in the same column indicate significant differences ($p < 0.05$).

3.2.3 Reducing Power

The reducing power of the jellies and skins extracts of the seven grapevine varieties studied in the present work increased with the extract concentration (Figure 2).

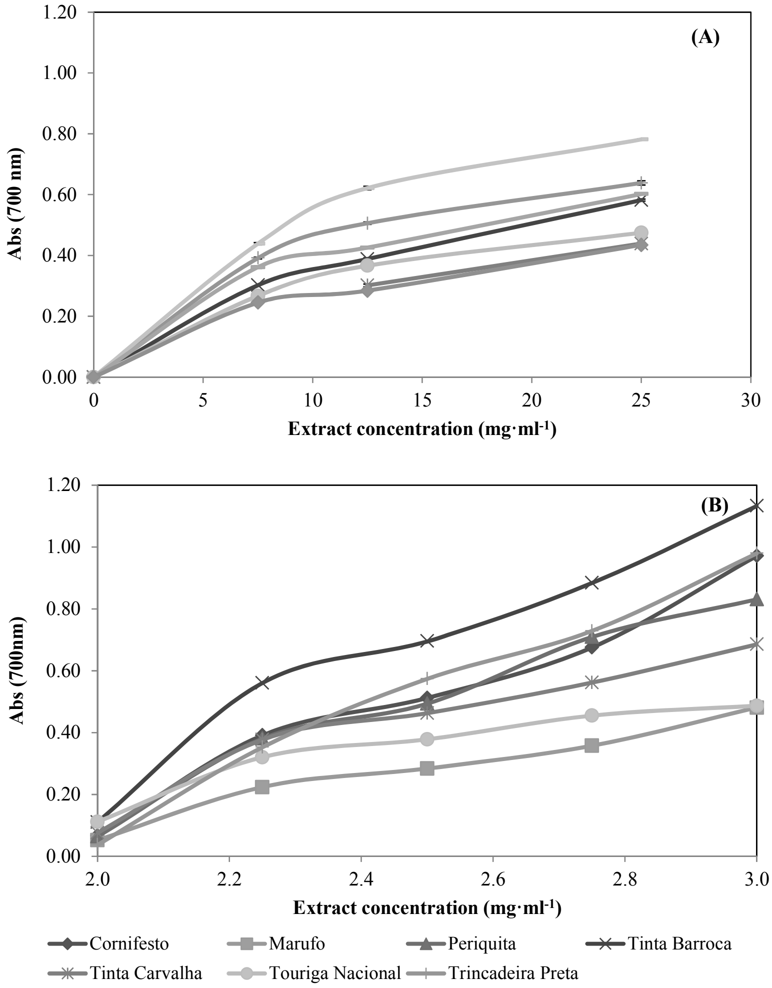

Figure 2: Reducing power (Abs 700 (nm)) versus extract concentration of jellies (A) and berry skins (B) of seven grapevine varieties.

However, it should be referred that similar reducing powers were obtained with solutions of skin extracts ten times more diluted than those of grape jellies. These results explained the EC_{50} values obtained (Table 4), being the lowest values determined for the skins (2.19 mg ml^{-1} to 2.60 mg ml^{-1}). Jellies presented higher EC_{50} values, varying between 9.17 mg ml^{-1} and 41.28 mg ml^{-1} for 'Tinta Carvalha' and 'Periquita' grape varieties, respectively. These results were expected since the EC_{50} value is inversely proportional to the antioxidant potential, demonstrating that the skins were richer in antioxidants than jellies. Moreover, the jelly produced from 'Tinta Carvalha' variety showed again the lowest EC_{50} value, suggesting a high antioxidant potential. Our results are in line with Abe et al. (2007) who stated that grapes with darker colour had a higher content of antioxidants. Indeed, as indicated earlier, 'Tinta Carvalha' was the variety that showed the darkest grape berries (lowest L* value) (Table 1) and redness colouration (highest a* value), suggesting the highest anthocyanins concentration, which may led to a jelly with the highest total phenol content (1.27 g kg^{-1} of GAE), the highest DPPH radical scavenging activity (60.0%) and the lowest EC_{50} value for the Reducing Power assay (9.17 mg ml^{-1}).

Table 4: EC_{50} values (mg extract ml^{-1}) determined on the reducing power assay of jellies and berry skins of seven grapevine varieties.

Variety	Jelly	Skins
Cornifesto	19.70±0.38	2.24±0.00
Marufo	26.93±3.76	2.60±0.08
Periquita	41.28±0.70	2.28±0.00
Tinta Barroca	12.22±0.03	2.19±0.00
Tinta Carvalha	9.17±0.17	2.35±0.00
Touriga Nacional	17.78±0.46	2.54±1.11
Trincadeira Preta	31.97±1.32	2.25±0.00

3.3 Sensory analysis

The test for acceptability was carried out by 54 consumers, 34 females and 20 males. The age of consumers ranged from 12 to 55 years.

Firstly, we started to compare the results obtained for the jelly analysed in both days. It was observed that most of the parameters evaluated for the ‘Tinta Barroca’ jelly did not present significantly different scores at $\alpha = 0.05$ on both days and no significant differences were detected between genders. In more detail, no significant differences on the appearance ($p = 0.088$), taste ($p = 0.054$), sweetness ($p = 0.309$), acidity ($p = 0.323$) and global assessment ($p = 0.077$) were observed. However, in terms of colour significant differences were determined ($p = 0.003$). One possible explanation was that ‘Tinta Barroca’ jelly was tested simultaneously with other jellies that had different colours, being ‘Tinta Barroca’ jelly colour judgment influenced by the colour of the other jellies. In fact, if jellies with colour that the consumer liked more were presented on the second day, the panellist would rate lower the colour of the repeated jelly.

When comparing the seven grape jellies, no significant differences on the attributes appearance ($p = 0.442$), taste ($p = 0.607$), sweetness ($p = 0.870$), acidity ($p = 0.911$) and global assessment ($p = 0.652$) were observed. On contrary, significant differences on colour ($p = 0.001$) were again observed. Observing Figures 3 and 4, it can be seen that all evaluated attributes presented medians above the 5 point scale (indifferent), being most of the cases close to 7 (like moderately). In terms of global evaluation, all jellies presented a sensory profile almost totally situated in the region of acceptance (>5.00). Regarding colour, ‘Tinta Carvalha’ and ‘Marufo’ jellies were the worst rated. On contrary, ‘Tinta Barroca’ was the preferable jelly mainly on the 2nd day, followed by ‘Touriga Nacional’ on the same day, and ‘Cornifesto’ and ‘Trincadeira Preta’ on the 1st day.

Generally, these results indicated that the seven grape jellies will have good acceptance by consumers, revealing good perspectives to broaden the application of grapes in food industry.

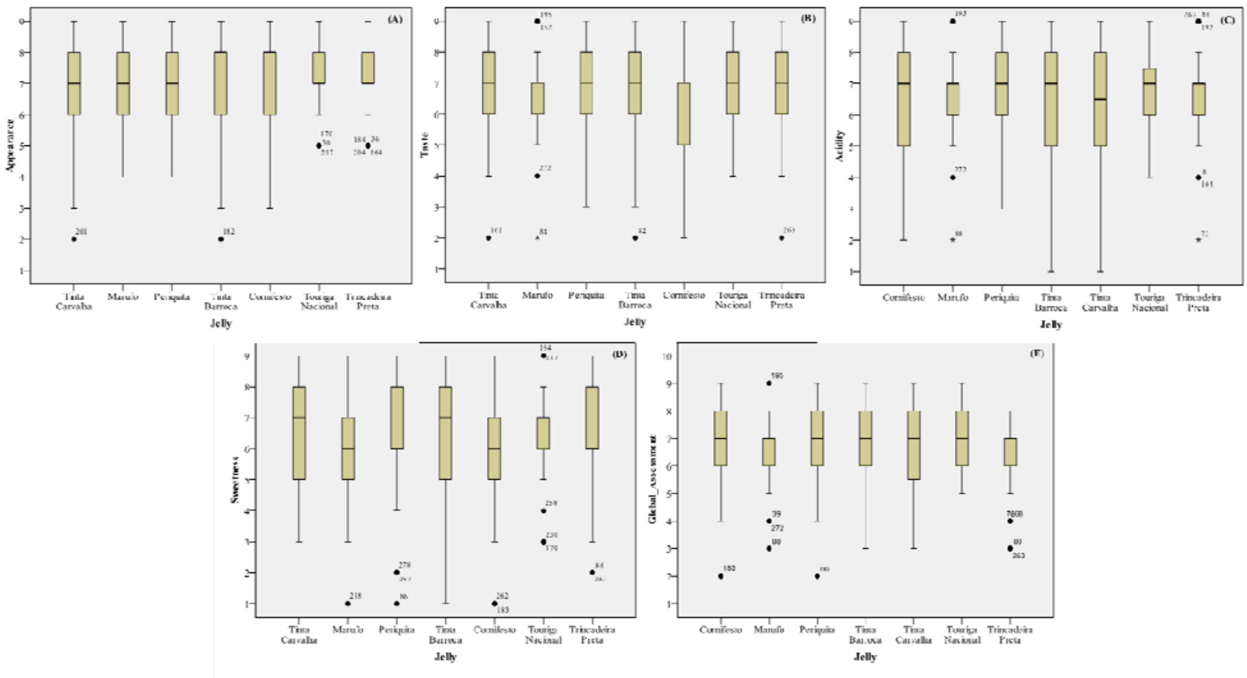

Figure 3: Box-plots obtained for the appearance (A), taste (B), acidity (C), sweetness (D) and global assessment (E) of jellies produced from seven grapevine varieties. (Not significant at $\alpha = 0.05$)

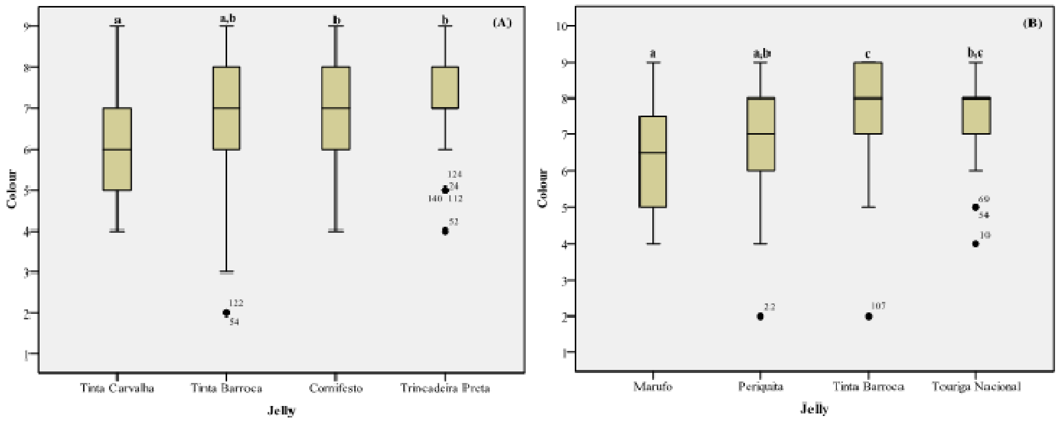

Figure 4: Box-plots obtained for the colour evaluation of the grape jellies on the first (A) and second (B) days of sensory analysis.

4 CONCLUSIONS

The present work showed that jelly production using different grapevine varieties seems to be a good option for small grape farmers and industrials and it will allow the valorisation of grapevine varieties with less potential for wine production and the preservation of grape biodiversity. After performing the physico-chemical characterization of the jellies significant differences were found in colour, pH, ash content and acidity, indicating that the production of grape jellies with different characteristics is possible in the future, meeting the wishes of a greater number of consumer types. ‘Tinta Carvalha’ jelly was the one that showed the highest amount of bioactive compounds, being also the darkest and redness jelly. Even though processing may cause the loss of some antioxidant activity, our results showed that jellies still have antioxidant potential and may emerge as an interesting product for the market, as they continue to maintain bioactive properties of the fresh fruit. Regarding sensory analysis, no significant differences were found among the seven jellies studied for most of the parameters, except colour. Regarding the overall assessment, consumers classified them as enjoyable.

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