

SENSORY CHARACTERIZATION OF PINK PORT WINES

CATPCA ANALYSIS, A STRATEGY FOR SENSORY DATA TREATMENT

Bebiana Monteiro^a, José Sousa Soares^b, Alice Vilela^c, Elisete Correia^d

^aMaster Student of Enology at Universidade de Trás-os-Montes de Alto-Douro, Apartado 1013, 5001 801 Vila Real

^bGran Cruz - Sociedade Comercial de Vinhos Lda., 4400 195 Vila Nova de Gaia

^cInstitute for Biotechnology and Bioengineering, Centre of Genomic and Biotechnology, (IBB/CGB-UTAD), 5001801 Vila Real

^dCentre for Mathematics (CM-UTAD), 5001 801 Vila Real

Vila Real, 2012



PORTO
CRUZ

ABSTRACT

A designação de Vinho do Porto deve-se à cidade do Porto, em Portugal. O vinho do Porto é um vinho fortificado pela adição de aguardente com o intuito de parar a fermentação para obter um vinho naturalmente mais doce, bem como para aumentar o teor alcoólico. O vinho do Porto requer especial atenção, quer pela sua história quer pela internacionalização do mercado, contribui consideravelmente para a economia local. O Vinho do Porto Rosé, designado por Pink, é uma variação recente do mercado, produzido com o objetivo de atrair um público-alvo mais jovem para o consumo de Vinho do Porto (Croft, 2012).

Análise descritiva sensorial ou perfil sensorial combinado com análise estatística multivariada tem sido usada para descrever diferentes vinhos, diferentes castas e diferentes regiões vitivinícolas. Contudo, apesar dos vinhos da Região Demarcada do Douro (RDD) terem uma longa história, pouco tem sido estudado no que diz respeito ao perfil sensorial destes vinhos, designados por Vinho do Porto Pink (Kontkanen *et al.* 2005; Koussissi *et al.* 2007; Etaio *et al.* 2008).

Os objetivos deste estudo foram caracterizar os principais atributos sensoriais que descrevem e diferenciam este estilo de Vinho do Porto Pink. Para tal recorreu-se à Análise em Componentes Principais Categórica (CATPCA). De todos os atributos, a cor “Pink” foi o descritor que melhor diferenciou os vinhos. Das cinco marcas estudadas (Calem, Croft, Cruz, Dalva e Offley), três marcas são muito semelhantes em termos de descritores, enquanto outras duas têm características organolépticas diferentes e são igualmente muito distintas de todas as marcas de vinho do Porto Pink em estudo.

Port Wine takes its name from the city of Oporto located at the head of the river Douro in Portugal. The wine produced is fortified by the addition of a neutral grape spirit known as “aguardente” in order to stop the fermentation, leaving residual sugar in the wine, and to increase the alcohol content. Among European wines, Port Wine deserves special attention because of its history, integration in international markets and its major contribution to local economy. Pink Port is a very recent variation on the market, produced with the aim to bring the delights of Port Wine to a younger market (Croft 2012).

Sensory descriptive analysis or sensory profiling combined with multivariate statistical analysis has been used to describe different wines from different grape varieties and different origins. Although wines from DDR (Demarcated Douro Region) have a long history few works have been done concerning sensory profiling of this kind of wines, namely, Pink Port wines (Kontkanen *et al.* 2005; Koussissi *et al.* 2007; Etaio *et al.* 2008).

The main purposes of this study was to describe a specific sensory method, including chemical compounds reference development, to establish the most important descriptive and discriminative sensory attributes in this novel Port wine style, the Pink Port. Interpretation of the CATPCA (Categorical Principal Components Analysis) results enables the characterization of the Pink Port wines by their sensory attributes. The attribute ratings created a multidimensional space on which each wine could be positioned. Among all the attributes the appearance attribute related to color “Pink” was the best to differentiate all de wines. From the five brands studied (Calem, Croft, Cruz, Dalva e Offley), three are very similar in terms of attributes, while the other two have different organoleptical characteristics and are also very distinct from each other.

INTRODUCTION

Port wine is produced from grapes grown and processed in the Douro Demarcated Region (Figure 1). The wine produced is then fortified by the addition of a neutral grape spirit known as aguardente in order to stop the fermentation, leaving residual sugar in the wine, and to boost the alcohol content. Is stored and aged in wood from 2 years to many decades, often in barrels stored in a cellar, at low temperatures and a higher degree of humidity, before being bottled (Reader and Dominguez 1995). The wine received its name, “Port”, in the latter half of the 17th century from the seaport city of Porto at the mouth of the Douro River, where much of the product was brought to market or for export to other countries in Europe (Rebello *et al* 2007). The Douro valley, where Port Wine is produced, was defined and established as a protected region, or appellation, in 1756, making it the oldest defined and protected wine region in the world. Among European wines, Port Wine deserves special attention because of its history, integration in international markets and its major contribution to local economy.

Differing periods of ageing and use of grape cultivars give rise to a diversity of Port styles, each with its own distinctive flavour character and colour. Pink Port is a very recent variation on the market, first released in 2008 by Croft, part of the Taylor Fladgate Partnership. Croft came up with Pink Port as a way to bring the delights of Port Wine to a younger market (Croft 2012).

To make a Pink Port, Croft had to pioneer a new process involving techniques from both red and white port production. It is technically a Ruby Port, but fermented in a similar manner to a rosé wine, with a limited exposure to the grape skins, thus creating the rosé color. Using a slow fermentation process, seven days or twice as long as normal and then adding some color from the pressed grape skins, produced a fresh and crisp port full of fine berry flavors (Croft 2012).

Lawless and Heymann (1998) showed that sensory evaluation comprises a set of techniques for accurate measurements of human responses to foods and minimizes the potentially biasing effects of brand identity. Sensory characteristics comprising appearance, odor and flavor are included within the quality food products. There are a number of internationally accepted standards on general methods in sensory analyses, such as: general guidance (ISO 6658:1985, revised in ISO 6658:2005), assessor’s selection and panel training procedures (ISO 8586:1993), and sensory tests (ISO 8587: 2006). These standards permit the selection, basic training of panelists and general application of discriminative and descriptive sensory methods. Sensory descriptive analysis or sensory profiling combined with univariate or multivariate statistical analysis has been used to describe different wines from different grape varieties and different origins.

The two main purposes of this study were to select and train a sensory panel for chemical sensory evaluation of Port wine and describe a specific sensory method, including chemical compounds reference development, to establish the most important descriptive and discriminative sensory attributes in this novel Port wine style, the Pink Port.

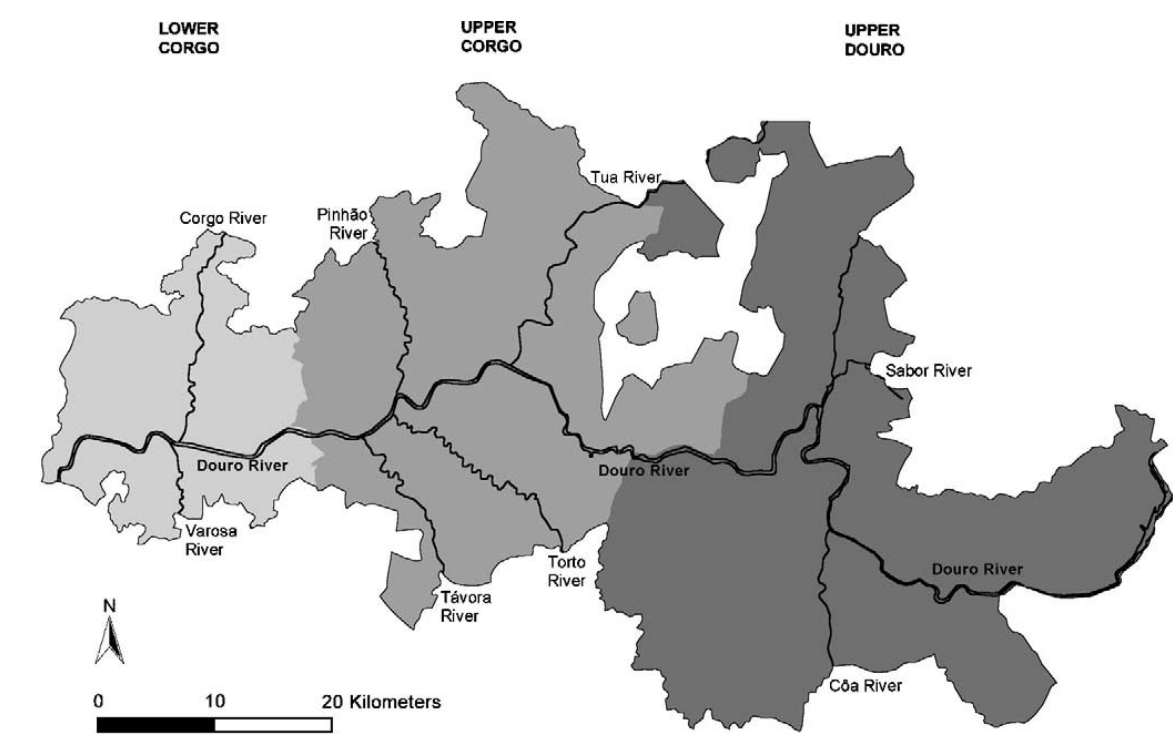


Figure 1. Sub-regions of the Douro Demarcated Region (Andersen *et al* 2004)

MATERIAL and METHODS

Wines

Five samples of five Pink Port wines from 5 wineries from RDD, with cellars in Oporto: Dalva, Croft, Calem, Offley, and Cruz were evaluated. These wines were commercial wines, presented in bottles of 0.75 L, and were produced according to the process of each winery/wine cellar.

Panelists

Twelve trained panelists.

Attribute Generation and Selection

Five Pink Ports were tasted and discussed by the panelists through three sessions to generate terms. A free choice off attributes to describe Pink Port was used. The duration of each session was around 1 hour. In all the sessions, Wine Aroma Wheel (Noble *et al.*1987) was provided to facilitate term generation. Appearance (color and clarity), aroma, taste, flavor and mouthfeel references were provided to facilitate the discussion.

Data Analysis

All statistical analysis was performed using SPSS (IBM SPSS Statistics 19).

RESULTS

Attribute Generation and Selection

After removing the hedonic, intensity, and inappropriate terms from a first long list of attributes; grouping together the synonyms and terms presenting similar meanings; and only using those descriptors that had a frequency of citation of 2.5%.

Table 1. Descriptors or attributes for Pink Port wines with more citation

Descriptors or attributes	Citations (%)
Appearance attributes	
<i>Pink</i>	76.0
<i>Orange pink</i>	14.0
<i>Clean</i>	100.0

Aroma attributes

<i>Fruity</i>	33.6
<i>Alcohol</i>	16.4
<i>Red fruits</i>	22.4
<i>Citrus</i>	3.4
<i>Vegetal</i>	4.3
<i>Woody</i>	5.2
<i>Floral</i>	6.9

Flavor attributes

<i>Red fruits</i>	7.5
<i>Fruity</i>	4.8

Taste/mouthfeel attributes

<i>Sweet</i>	17.8
<i>Bitter</i>	6.8
<i>Acid</i>	4.8
<i>Alcoholic sensation</i>	5.5
<i>Soft sensation (mouthfeel)</i>	6.2
<i>Spicy sensation (mouthfeel)</i>	3.4
<i>Body (mouthfeel)</i>	9.6
<i>Balance</i>	2.7
<i>Persistent (after-taste)</i>	18.5

Development of References

Several chemical compounds, natural compounds or reference brands of Pink Port wines were presented to the panel for discussion of their appropriateness for each attribute; all the references were presented in each booth with the same or very similar intensity, in each and every session.

The choice for using natural compounds for some references (natural products, associated with Port Wine aroma, placed in sensory tasting glasses - Figure 2) was due to the difficult of recreating with exactitude, with chemical compounds, some fruity aromas. It was also noted that the visual effect, the

To face the difficulty of scoring when the perceived intensity for an attribute - aroma or flavor - was lower than the reference, a complementary nominal scale (Table 3) was also developed.

Table 3. Nominal scale for aroma and flavor attributes intensity scoring

Description of the perceived intensity	Score
The attribute is not perceived at all	1
Doubts about the presence of the attribute	2
The attribute is clearly perceived, but the intensity is lower than the reference	3
The attribute is clearly perceived, and the intensity is close or similar to the reference	4
The attribute is clearly perceived, and the intensity is higher to the reference	5

Sensory Profile of five Pink Port wines from five different brands

Attribute intensities were scored with a 5-point scale (Table 3). For testing the equality of all distributions in all variables and groups a Nonparametric MANOVA was performed. The results obtain, indicate significant statistical differences between attributes and/or class of wine ($\chi^2(8) = 49^{\circ}0.916=44.884$; $N=50$; p value=0.00). To identify in which attributes and wines were observed significant differences we appealed to the Kruskal-Wallis test (Table 4). The results indicate that only for attribute *Pink* these differences are statistical significant (Chi-Square=22.643; $df=4$; Asymp. Sig.=0.000).

Table 4. Kruskal-Wallis Test applied to the results of the five Pink Port wines sensory scores

	Red Fruit (aroma)	Floral (aroma)	Persistent (after-taste)	Red fruits flavor	Fruity flavor	Clean	Fruity (aroma)	Alcohol (aroma)	Sweet taste	Body (mouthfeel)	Bitter
Chi-Square	2.264E1	6.514	2.362	7.315	5.234	3.803	3.935	4.095	8.159	3.645	6.799
df	4	4	4	4	4	4	4	4	4	4	4
Asymp. Sig.	0.000	0.164	0.669	0.120	0.264	0.433	0.415	0.393	0.086	0.456	0.147
Test Statistics ^a	a. Kruskal-Wallis Test; b. Grouping Variable: Wine										

Finally, Fisher’s least significant difference (LSD), show significant differences for all wines ($\alpha=0.05$), with the exception of B20 compared with either B22 or B24 (Table 5).



Figure 2. Natural products, associated with Port Wine aroma.

Table 5. Multiple Comparisons applied to the results of the five Pink Port wines sensory scores

(i) Wine	(j) Wine	Mean Difference (i-j)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
B20	B21	21.65000 ^a	4.838434	0.000	11.90489	31.39511
	B22	-3.100000	4.838434	0.525	-12.84511	6.64511
	B23	11.850000 ^a	4.838434	0.018	2.10489	21.59511
	B24	-1.400000	4.838434	0.774	-11.14511	8.34511
B21	B20	-21.650000 ^a	4.838434	0.000	-31.39511	-11.90489
	B22	-24.750000 ^a	4.838434	0.000	-34.49511	-15.00489
	B23	-9.800000 ^a	4.838434	0.049	-19.54511	-0.05489
	B24	-23.050000 ^a	4.838434	0.000	-32.79511	-13.30489
B22	B20	3.	4.838434	0.000	15.00489	34.49511
	B21	24.750000 ^a	4.838434	0.000	15.00489	34.49511
	B23	14.950000 ^a	4.838434	0.003	5.20489	24.69511
	B24	1.700000	4.838434	0.727	-8.04511	11.44511
B23	B20	-11.850000 ^a	4.838434	0.018	-21.59511	-2.10489
	B21	9.800000 ^a	4.838434	0.049	0.05489	19.54511
	B22	-14.950000 ^a	4.838434	0.003	-24.69511	-5.20489
	B24	-13.250000 ^a	4.838434	0.009	-22.99511	-3.50489
B24	B20	1.400000	4.838434	0.774	-8.34511	11.14511
	B21	23.050000 ^a	4.838434	0.000	13.30489	32.79511
	B22	-1.700000	4.838434	0.727	-11.44511	8.04511
	B23	13.250000 ^a	4.838434	0.009	3.50489	22.99511

^a. The mean difference is significant at the 0.05 level.

Results from ranks of the five Pink Port wines, taking into account the attribute *Pink*, show that the wine with higher average order is B22 ($M_i=34.40$), followed by B24 ($M_i=32.70$), B20 ($M_i=31.30$), B23 ($M_i=19.45$) and B21 ($M_i=9.65$).

For analysis by CATPCA all variables were treated as ordinal, we wish to retain the order of the initial variables, and two components were called for calculations. The internal consistency coefficients (Cronbach’s Alpha) for the first and second dimensions are 0.965 and 0.871 respectively. The two-dimensional CATPCA explain 86.48% of the total amount of initial variance, a value closer to those found in related works (Cristovam *et al.* 2000).

For the five wines we obtained a scatter plot (Figure 3), with each attribute (blue) and each wine (pink) plotted along dimension 1 and dimension 2.

Analysis of Figure 3 suggests that attributes such as *Red fruits aroma*, *Body*, *Floral* and *Soft sensation* are the attributes that better characterize B24 Pink Port wine, while attributes like *Red Fruits*, *Sweet*, *Alcohol*, *Clean*, *Pink* and *Fruity aroma* are distinctiveness of B20, B22 and B20 Pink Ports. The wine from B21 wine cellar is characterized by three mouthfeel or after-taste attributes - *Spicy sensation*, *Persistent* and *Acid taste* and a flavor attribute – *Fruity*.

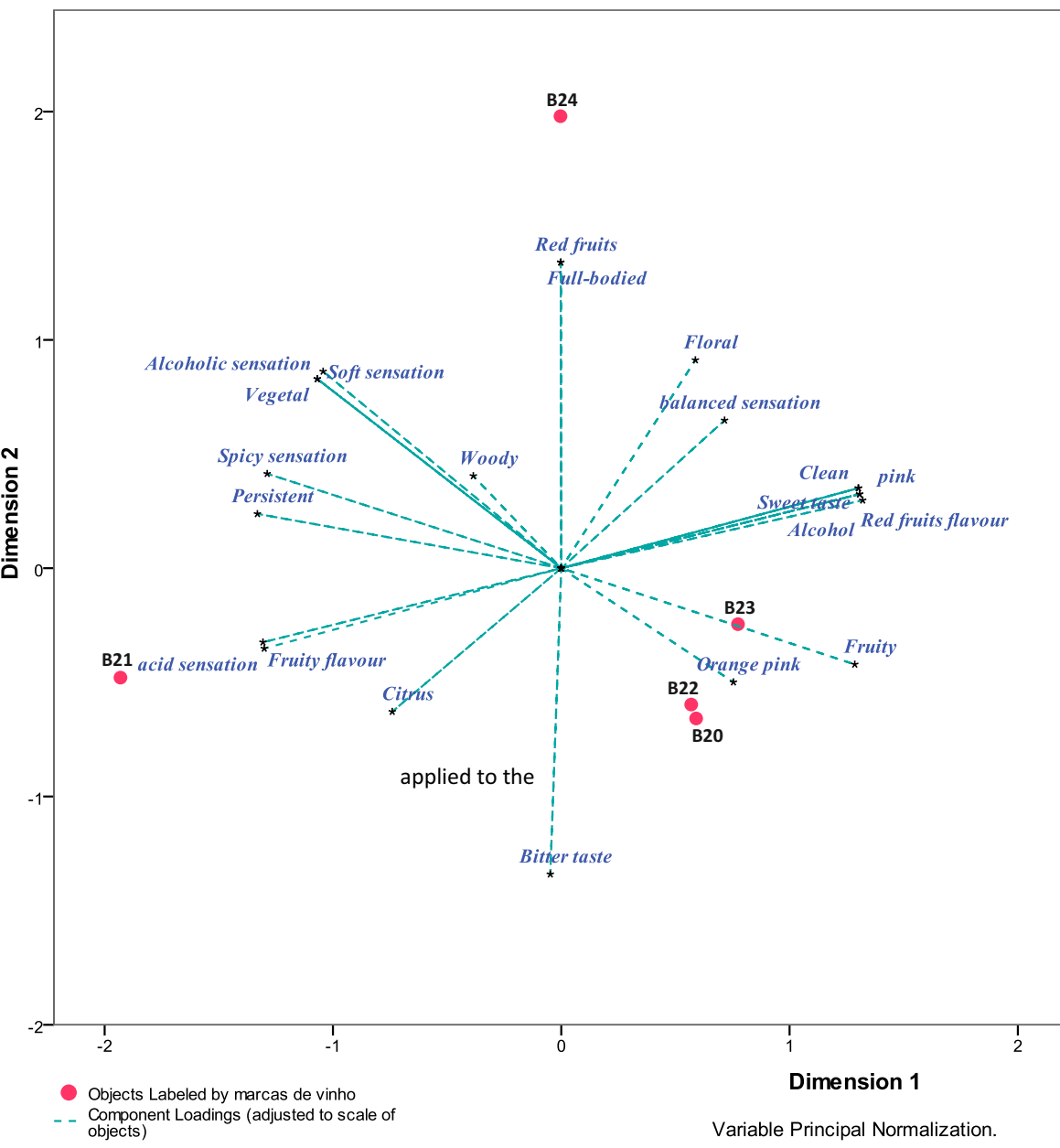


Figure 3. Projection of attributes loadings and wine factor scores (pink) on principal components 1 and 2

DISCUSSION

A group of descriptors or attributes is simply a set of words that describe the aroma/flavor/mouthfeel of a food product. This group of words, commonly named a lexicon, can then be applied or practiced using descriptive sensory analysis techniques. It provides a source list to describe a category of products or finished products (bread, orange juice, coffee, chocolate, wine). For instances, over the years, descriptive lexicons, in wheel form, have been developed for wine (Noble *et al.* 1984), beer (Clapperton *et al.* 1976; Melgaard *et al.* 1979) and spirits (Monica Lee *et al.* 2001) among others alcoholic beverages. Such wheels are visual aids in understanding a comprehensive sensory space. Although the descriptive panel generates its own list to describe the product array under study, a lexicon provides a source of possible terms with references and definitions for clarification (Drake and Civile, 2002). The panelists performed the descriptors selection using five Pink Ports, with the help of the Noble Wine Aroma Wheel (Noble *et al.* 1987). A long list of terms was compiled. After preliminary reduction, we only used those descriptors/attributes that had a frequency of citation higher than 2.5%. This methodology provide us a list of twenty one attributes, where we could find, among others, descriptor such as Fruity, Alcohol, Red fruits, Sweet, Body and Persistent. Some of these descriptors were common in quantitative descriptive analysis of wines produced from Niágara Rosada and Bordó Grapes studied by Barnabé *et al.* (2007) and from Brazilian varietal White wines by Behrens and Silva (2000). One descriptor – *Body* – recently studied by Runnebaum *et al.* (2011) was found to have great impact in the overall quality of wines.

Afterwards, five wines from five different wine cellars from Oporto: B20, B21, B22, B23 and B24; were sensory analyzed in three tasting series. Attribute intensities were scored with a 5-point scale (ranging from 1to 5). For testing the equality of all distributions in all variables and groups a Nonparametric MANOVA was performed. Only for attribute *Pink (intensity of wine’s pink color)* statistical significant differences were found. Ranking the wines according to this attribute (*Pink*) resulted in the following order: B22, as being the most *pinkest* wine, followed by B24, B20, B23 and B21.

Characteristics of flavor lexicons to be used in food products sensory profiles have been previously discussed by Civile and Lawless (1986) and by Lawless and Heymann (1998). One key characteristics of a good flavor lexicon is that it be discriminating and descriptive, if possible, for a descriptive language to be discriminating it must be able to differentiate the products for which it was developed. Such is the case in our work. The two-dimensional CATPCA explained 87.96% of the total amount of initial variance and a scatter plot, with each attribute and each wine plotted along dimension 1 and dimension 2 was obtained. This scatter plot allowed us to individualize each Pink Port according to the attributes better related to him. So, B24 Pink Port wine is characterized by attributes such as *Red fruits aroma* and *Body*, while attributes like *Pink* and *Fruity aroma* are distinctiveness of B23 Pink Port.

Conclusions

The aim of this study, to identify the sensory profile of five Pink Port wines, was achieved. The contribution of twenty one attributes was study and among all the attributes the appearance attribute related to color “*Pink*” was the best to differentiate all de wines. Nevertheless, attributes such as *Red fruits aroma*, *Body*, *Fruity aroma*, *Fruity flavor Spicy sensation* and *Persistent* were appropriated to and were able to discriminate the five brands of wines.

From the five brands studied, three are very similar in terms of attributes, while the other two have different organoleptical characteristics and are also very distinct from each other.

^{*}Corresponding author: bmonteiro@engenheiros.pt (e-mail address)

Acknowledgments

This work was partially sponsored by the Institute for Biotechnology and Bioengineering, Centre of Genomic and Biotechnology (IBB/CGB-UTAD) and by national funds through the Fundação Nacional para a Ciência e Tecnologia, Portugal FCT under the projects PEST-OE/MAT/UI0006/2011.

The corresponding author would like to thank the entire tasting panel from GRAN CRUZ, the winemaker (José Sousa Soares) for the interesting, suggestions and availability, and the CEO (Jorge Dias) for believing and providing human and material resources for this study, both from GRAN CRUZ.

References

- ANDRESEN, T., BIANCHI DE AGUIAR, F., and CURADO, M.J. 2004. *The Alto Douro Wine Region greenway*. Landsc. Urban Plan. 68, 289–303.
- BARNABÉ, D., FILHO, W.G.W. and BOLINI, H.M.A. 2007. *Quantitative Descriptive Analysis of wines produced from niágara and bordó grapes*. Braz J Food Technol. 10, 122–129.
- BEHRENS, J.H. and SILVA M.A. 2000. *Sensory profile of Brazilian varietal White wine by quantitative descriptive analysis*. Ciênc. Tecnol. Aliment. 20, 60–67.
- CIVILE, G.V. and LAWLESS, H.T. 1986. *The importance of language in describing perceptions*. J Sens Stud. 1, 203–215.
- CLAPPERTON, J.F., DALGUESH, C.E. and MELGAARD, M.C. 1976. *Progress towards an international system of beer flavor terminology*. J. Inst. Brew. 82, 7–13.
- CRISTOVAM, E. 2000. *Differentiation of port wines by appearance using a sensory panel: comparing free choice and conventional profiling*. Eur Food Res Technol. 211, 65–71.
- CROFT, 2012. *Croft Pink*. In: <http://www.menzendard.co.uk/portfolio/producers/producer-pdfs/croft-port/Croft%20Pink.pdf>, accessed January 9, 2012.
- ETAIO, I., PÉREZ ELORTONDO, F.J., ALBISU, M., GASTON, E., DIEDA, M. and SCHUCH, P. 2007. *Development of a quantitative sensory method for the description of young red wines from Rioja Alavesa*. J. Sensory Studies 23, 631–655.
- KONTKANEN, D., REYNOLDS, A.G., CLIFF, M.A. and KING, M. 2005. *Canadian terroir: Sensory characterization of Bordeaux-style red wine varieties in the Niagara Peninsula*. Food Res. Int. 38, 417–425.
- KOUSSISSI, E., PATERSON, E. and CRISTOVAM, E. 2002. *Sensory discrimination of dry red wines from Greece*. J. Wine Res. 13, 165–179.
- LAWLESS, H.T. and HEYMAN, H. 1998. *Sensory Evaluation of Food: Principles and Practices*. Chapman & Hall, New York.
- MELGAARD, M.C., DALGUESH, C.E. and CLAPPERTON, J.F. 1979. *Beer flavor terminology*. J. Inst. Brew. 85, 38–42.
- MONICA LEE, K.Y., PATERSON, A., and PIGGOTT, J.R. 2001. *Origins of Flavour in Whiskies and a Revised Flavour Wheel: a Review*. J. Inst. Brew. 5, 287–313.
- NOBLE, A.C., ARNOLD, R.A., MASUDA, B.M., PECORE, S.D., SCHMIDT, J.O. and STERN, P.M. 1984. *Progress towards a standardized system of wine aroma terminology*. Am. J. Enol. Vitic. 35, 107–109.
- NOBLE, A.C. 1987. *Modification of a Standardized System of Wine Aroma Terminology*. Am. J. Enol. Vitic. 38, 143–146.
- READER, H.P. and DOMÍNGUEZ, M. 1995. *Fortified wines: Sherry, Port and Madeira*. In: Lea AGH, Piggott JR (eds) Fermented beverage production. Blackie, London, pp 159–203.
- REBELLO, J., CORREIA, L. and CALDAS, J. 2007. *Globalization and Wine Business*. Proceedings of the I Mediterranean Conference of Agro-food Social Scientists, Barcelona.
- RUNNEBAUM, R.C., BOULTON, R.B., POWELL, R.L. and HEYMAN H. 2011. *Key constituents affecting wine body—an exploratory study*. J Sensory Studies 26, 62–70.