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FACULDADE DE CIÊNCIAS
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A CONTRIBUTION TO THE SENSORY PROFILE OF REGIONAL RED WINES FROM GEOGRAPHICAL INDICATIONS OF MAINLAND PORTUGAL

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Dissertação para a obtenção do Grau de Mestre em

Viticultura e Enologia

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STRUCTURAL INDEX

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ABSTRACT

Red wine sensory profiling on the 12 Protected Geographical Indications of Mainland Portugal was aimed by the application of extended sensory surveys to an expert panel including leading Portuguese winemakers, scholars, buyers and wine writers. Evidence of clusters grouping several wine regions under the same sensory profile, chiefly the three dominant influences – ATLANTIC (Coastal), VALLEYS (Continental Mountain) and SOUTHERN (Mediterranean), sometimes with sub-segments – was found and the description of typical sensory profiles was suggested.

Findings on close range between wines from Protected Geographical Indications and wines from Protected Designations of Origin located within each Geographical Indication boundary were discussed as well as the role of typicality.

S E N S O R Y P R O F I L E S R E D W I N E S Z O N I N G T Y P I C A L I T Y

RESUMO

O estudo dos perfis sensoriais dos vinhos tintos provenientes de cada uma das 12 Indicações Geográficas Protegidas de Portugal Continental foi realizado através da aplicação de amplos questionários sensoriais a um painel de especialistas que incluiu alguns dos principais enólogos portugueses, académicos, compradores e formadores de opinião. Evidências de clusters agrupando várias Indicações Geográficas sob o mesmo perfil sensorial, principalmente sob três influências dominantes - ATLÂNTICO (Litoral), VALES (Montanhas Continentais) e SUL (Mediterrâneo), por vezes com sub-segmentos - foram encontradas e a descrição de perfis típicos sensoriais foi sugerido. Resultados sobre a proximidade sensorial entre vinhos certificados como de Indicação Geográfica Protegida (ditos Regionais) e vinhos de Denominação(ões) de Origem Protegida localizada(s) no seio das respectivas áreas da Indicação Geográfica foram expressos, assim como o papel da tipicidade.

P E R F I S S E N S O R I A I S V I N H O S T I N T O S Z O N A M E N T O T I P I C I D A D E

RESUMO ALARGADO

O estudo dos perfis sensoriais dos vinhos tintos provenientes de cada uma das 12 Indicações Geográficas Protegidas de Portugal Continental foi realizado através da aplicação de amplos questionários sensoriais a um painel de especialistas que incluiu alguns dos principais enólogos portugueses, académicos, compradores e formadores de opinião. Evidências de clusters agrupando várias Indicações Geográficas sob o mesmo perfil sensorial, principalmente sob três influências dominantes - ATLÂNTICO (Litoral), VALES (Montanhas Continentais) e SUL (Mediterrâneo), por vezes com sub-segmentos - foram encontradas e a descrição de perfis típicos sensoriais foi sugerido. Resultados sobre a proximidade sensorial entre vinhos certificados como de Indicação Geográfica Protegida (ditos Regionais) e vinhos de Denominação(ões) de Origem Protegida localizada(s) no seio da respectiva áreas da Indicação Geográfica foram expressos, assim como o papel da tipicidade.

A hipótese experimental para esta dissertação baseou-se no trabalho profissional de prova de vinhos que o Mestrando tem publicado sob a forma de livro com periodicidade anual (Vaudour 2005; Coutinho 2009; Coutinho 2010; Coutinho 2011) e que agrega, respeitando as delimitações geográficas das regiões oficiais em vigor, a proposta de vinhos com certificação regional em 3 perfis sensoriais: vinhos do ATLÂNTICO DE PORTUGAL, Vinhos dos VALES (ou Montanhas) DE PORTUGAL e vinhos do SUL DE PORTUGAL. A descrição sensorial de cada perfil foi elaborada com o auxílio de um método expedito de agrupamento de descritores usados em milhares de notas de prova publicadas.

Num pequeno país como Portugal, com uma viticultura de baixo rendimento, idade média elevada das vinhas, pequena propriedade e pequeno produtor e empresário, o estudo metodológico de macro-zonamentos que encontrem denominadores comuns sem prejudicar a tipicidade, sobretudo ao nível de vinhos com certificação de Indicação Geográfica Protegida, pode ser considerado positivo e gerador de factores de escala que podem resultar em economias em diversas áreas, desde a certificação de vinhos trans-regionais mas sensorialmente próximos, até ao agrupamento por perfis com vista a uma mais clara comunicação com os compradores e consumidores finais.

Quanto à avaliação da cor, o escrutínio do painel de especialistas contribuiu significativamente para a agregação de várias Indicações Geográficas em poucos perfis.

A aplicação da Análise Multivariada de Componentes Principais às diversas variáveis que pretendem caracterizar o aroma dos vinhos tintos, e que foram compiladas de acordo com os mais recentes estudos sensoriais apontados na pesquisa bibliográfica, revelou uma simplificação de medidores que resultam suficientes para o painel de especialistas e que significam uma agregação de sensações que, a priori, a comunidade científica diferencia. Exceptuando a Intensidade Aromática (*NOSE_intens_mean*) que, por responder quantitativamente e não qualitativamente, se manteve isolada, os 18 descritores iniciais do aroma foram agregados em 5 componentes principais:*, NOSE_overripe_mean, NOSE_youngwoody_mean; NOSE_greenoffflavour_mean, NOSE_freshmineral_mean* e *NOSE_ripefruit_mean*.

A aplicação da Análise Multivariada de Componentes Principais às diversas variáveis que pretendem caracterizar a boca (o gosto e tacto) dos vinhos tintos, e que foram compiladas de acordo com os mais recentes estudos sensoriais apontados na pesquisa bibliográfica, revelou uma simplificação de medidores que resultam suficientes para o painel de especialistas e que significam uma agregação de sensações que, a priori, a comunidade científica diferencia. Os 14 descritores iniciais das sensações na boca foram agregados em 4 componentes principais: *TASTE_dryastringent_mean; TASTE_sweetviscous_mean; TASTE_coastalfresh_mean* e *TASTE_persistent_mean*.

A aplicação da técnica de análise multivariada de clusters ao conjunto das variáveis individualizadas e agregadas confirmou a existência de proximidades sensoriais globais que confirmaram, pelo menos parcialmente, a hipótese experimental e, sobretudo, validaram o objecto desta dissertação como potencial linha de investigação. No caso dos vinhos tintos, os resultados da avaliação sensorial do painel de especialistas apontam para a existência de 4 clusters cujo agrupamento é o seguinte: **SUL DE PORTUGAL** (IG Península de Setúbal + IG Tejo, IG Alentejano, IG Algarve); **VALES CENTRAIS** (IG Duriense + IG Terras do Dão); **ATLÂNTICO TEMPERADO** (IG Beira Atlântico + IG Lisboa) agrupado com **VALES PERIFÉRICOS** (IG Terras da Beira, IG Transmontano, IG Terras de Cister); **ATLÂNTICO SUPER HÚMIDO** (IG Minho).

Foi testado o desagrupamento do cluster intermédio em ATLÂNTICO TEMPERADO e VALES PERIFÉRICOS com resultados diferenciados e significativos ao nível da avaliação da cor e das sensações de boca. A descrição sensorial destes 5 perfis encontra fundamento científico na maioria dos estudos recentes que se focalizam em particulares áreas do conhecimento sensorial, vitícola e bio-climático, referidos nesta dissertação.

INDEX OF CONTENTS

LIST OF FIGURES

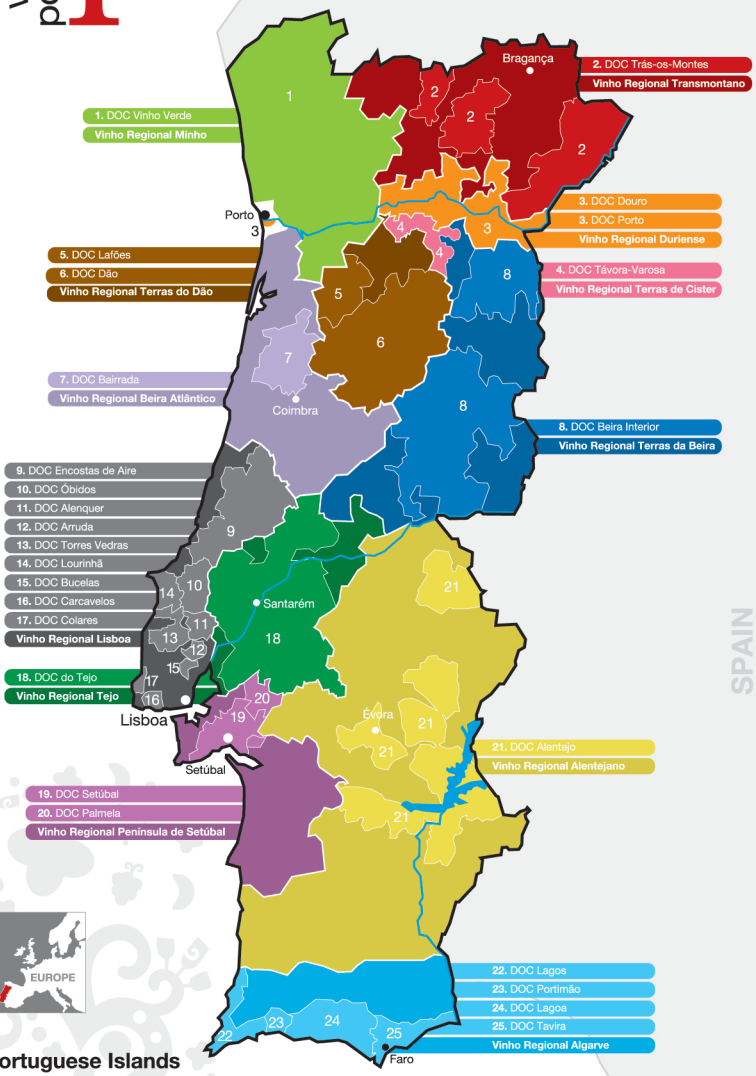
LIST OF TABLES

LIST OF ABBREVIATIONS

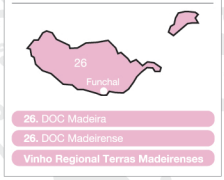
AOC – Appelation of Origin, the same as Designation of Origin
CMO – Common Market Organization
DO, DOC, DOP – Designation of Origin
EU – European Union
GI, GIs – Geographical Indication, Geographical Indications
IG – Geographical Indication
mDP – mean Degree of Polymerization
PDO – Protected Designation of Origin, same as Designation of Origin
PGI – Protected Geographical Indication, same as Geographical Indication

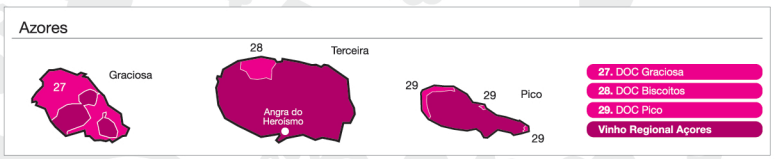
wines of portugal

Geographical Indications and DOCs



Portuguese Islands





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CHAPTER 1. GENERAL INTRODUCTION, PROBLEM STATEMENT AND RESEARCH QUESTIONS

1.1 General introduction

Talking about odds, may we say that finding exactly the same wine, regarding its sensory and biochemical data, in two different bottles of the same brand and vintage is like wining the lottery? Obviously the differences will grow enormously if we compare different brands and places of origin. Wine is a biological and natural product, with its own life & death cicle, just like any human being. But, like in Social Sciences, we may find groups and patterns of sensorial proximity that will allow us to define wine typicalities.

Numerous studies succeeded in differentiating between wines according to their geographic origin, based on the wines' sensory properties (Bauer 2011). However scarse evidence was found of works that questioned the actual size or number of wine regions, based on similar sensory and/or biochemical characterization of their respective wines. Due to the enormous implication on its economy and social reality, probably Portugal would welcome this field of academic studies.

As an historical wine country, Portugal offers a multitude of viticultural regions for still wines (Vin de pays, IG or Regional Quality Wines) and appellations (AOC, DOC or DO quality wines). Region specificities such as history, geography and culture can be mobilised to qualify regional products and confer a competitive advantage to certain products with origin in that region. In a previous research based on the domestic market, using a hedonic price function, which related the price of Portuguese regional wines to its various attributes, results showed that some regions of origin had a significant impact on product price.(Ribeiro 2007)

Is this awareness of the Portuguese wine regions a worldwide strength or is it just local? The quality of portuguese wines is being constantly confirmed in major international wine competitions. However, a recent study from UCDavis confirms what we may easily conclude just by looking at the categories used to place Portuguese wine tasting notes and ratings in the top international wine magazines: despite all efforts, checking on results regarding an application of a wine knowledge quiz including 15 multiple-choice queries to 190 american wine consumers selected by their willingness to pay for a bottle of wine costing at least $40, all questions related to Portuguese regions and/or cultivars where poorly answered, performing way under average. In the same study, researchers used sensory descriptive data to profile Wine Gurus (namely Robert Parker) preferences and scrutiny. Results showed that those Opinion Makers were able to profile wines from USA and France on multiple regional categories while only one category included all Portuguese wines (Machado 2011).

The most recent data on Portuguese wine exports confirms the anonimicity of Portuguese still wine (Port is a fortified wine and earned a different statute worldwide) envisaging a low cost driven business with an average price of aprox. 1 euro per litre.

The setting for this assay is, therefore, the enormous gap between an historical and self-conscious offer of several Portuguese wine regions – Designations of Origin (DO) and Geographical Indications (GI or IG) – and a global demand unable to understand those wine regions and/or unwilling to value the multiple portuguese wine typicality.

The author has published several Portuguese wine guides (Coutinho 2009; Coutinho 2010; Coutinho 2011) and, through those books and lectures, has tried to set an intermediate stage of three macro-regions that would encompass all Portuguese wine regions, generating three Portuguese wine profiles: the ***Atlantic wines***, born and raised in coastal fresh and humid temperate climates; the ***Valley wines***, from continental inland mountains, naturally concentrated and balanced; and the ***Southern wines***, typical round and sweet Mediterranean juices.

Recently the Portuguese authorities have approved a very important change on the viticultural official wine regions. The author's ideas of a three tier macro-zoning system are now possible to put in practice, as we may see by the following map comparison.

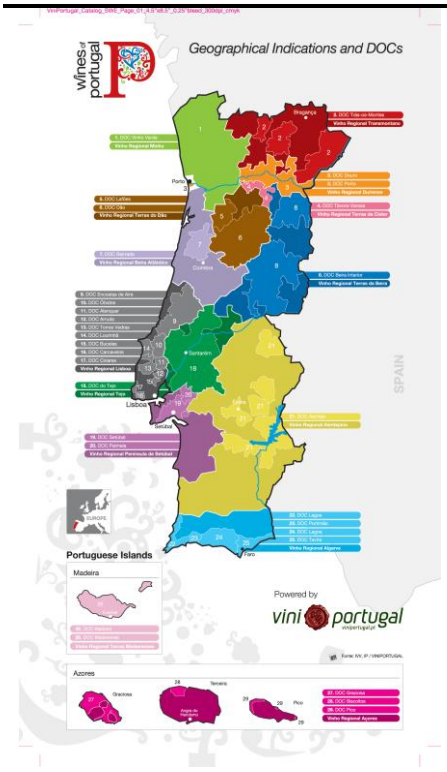

Figure 1: Official 2011 Map of Portuguese Viticultural GIs and DOs

Figure 2: Proposed Macro-Zoning for Portuguese Wine Styles (Coutinho 2009)

During this assay, statistical and sensory methods will be applied to profile red wines from the 12 Official Continental Portugal's IG regions, based on the assessment of a panel of referenced Portuguese wine experts.

1.2 Problem statement and research questions

This study has two focus points for which specific aims have been formulated: a scientific focus and an industry focus. Project goals have been formulated to effectively guide the decisions made during the experimental design of the project.

1.2.1 Scientific problem statement and research questions

Sensory analysis should be viewed as an important non targeted approach, where our peripheral senses and central brain processes apply structure-recognition techniques to identify authenticity and typicality of food products, beverages; and in wine even the impact of various terroirs (Bauer 2011). This study will use several sensory methods to question the historical approach of wine typicality in Portugal and the cognitive experience of wine preference. According to several authors, the typicality, character of what is typical, makes it possible to differentiate, identify, and recognize the product. It consists of two essential dimensions: historical/geographical and sensory (Cadot, Caille et al. 2010).

Sensory evaluation of wine flavour can be objective (analytical) or subjective (hedonic). Both involve processing of information by the brain. To make a judgment about "quality" or liking, perceived wine properties are compared to those previously experienced. This involves conscious processing and is highly individual (Noble 2011). One of the obvious cognitive factors that have major influence on sensory evaluation is the label information, chiefly its region of origin.

This study will provide some answers to the sensory authentication of Continental Portugal's historical/geographical based wine regions. Findings that the sensory profile of wines coming from 12 relevant and historically established Portuguese Geographical Indications can be grouped in fewer homogenous clusters are expected.

1.2.2 Industrial problem statement and research questions

Several studies have showed that wine region is a key factor in decision making regarding consumer´s choice and purchase (Cravidão 2010). Recent policies in the Portuguese wine sector have tried to focus on the development of the wine sector, implementing European directives oriented to an increase in the quality of wines. These policies focus primarily on local development of established wine districts, increasing the number of DO regions and improving the traceability of products coming from specific geographical areas. The assumption behind this strategy is that wine is valued for its regional origin, and for the reputation that a region has acquired over time. Through a hedonic model, a study was made in 2009 to test this assumption, obtaining some relevant information and a better understanding of the market. In general, confidence in the name of certain regions is a key added value in the selection of wines, and consumers are willing to pay more for those wines coming from very reputable DO regions such as Douro and Vinho Verde, which show a consistent competitive advantage for DO wines. On the

other hand, IG regional wines that received the highest credit were from Península de Setúbal (formerly Terras do Sado), Algarve, Alentejano and Lisboa (formerly Estremadura). However, in the cited work the authors have founded that DOC labelling is not a factor attracting a price premium per se, but rather that it is the interaction between the DO and the region of production that actually gives a premium. These results show evidence of premium discrimination depending on the reputation of the region of origin. The DOC labelling alone captures a significant discount, which suggests that DO wines are offered for sale at a lower price compared to the rest of the products. However, even if results are specific to a single study (sourced exclusively with data from a single top Portuguese retailer and related clients and prices), its findings showed the existence of a pricing scheme that disadvantages designations of origin and those producers coming from areas with low regional reputation. Whether this is due to the low bargaining power of DO producers, to inappropriate marketing strategies or to demand-led pricing is not clear, and the issue calls for further investigation. What remains is that, in general, small DO regions have higher production costs due to their small scale and production constraints, which are not compensated for in the market (Panzone and Simoes 2009).

Another study addressed the French quality wine regulation and its three level protection for Geographical Indications. Protection of GIs is supposed to help consumers choose wine that corresponds to their desired set of attributes. It turns out, however, that the system of GI protection for French wine makes life a little more complicated than that. A few survey results from Onivins, the French wine sector supervisory agency, tell the story (Onivins/CREGO 2005): the French—presumably the world's most knowledgeable set of consumers of French wine—have a tough time distinguishing between brands, AOCs, GIs and varietals. Onivins has concluded that "Bordeaux, Côtes du Rhône, Beaujolais, Saint-Emilion and Burgundy [i.e., GIs] are the best-known *brands* in France".. Coincidentally, the same source shows that they are also the most commonly (and incorrectly) cited ones! So even the world's most knowledgeable consumers find it "difficult" to choose from amongst the hundreds of different indications that can potentially figure on French wine labels.

To summarize, the benefits of GI protection could conceivably be diminishing in the number of GIs protected, at least after some critical point where consumer confusion becomes a serious issue (Shepherd 2006).

In contrast to many other foods or beverages, many wines are not marketed as commodities, but as regional products made from specific grape varieties. Thus, labels refer to numerous entities such as geographic origin, grape variety, vintage, national quality hierarchies and even winemaking techniques, such as ageing in oak barrels. Due to the multitude of legal specifications and the enormous price range in which wines are offered, the authentication of wine is a highly complex and ambitious endeavour (Bauer 2011).

The author is an acknowledged wine writer and has been interacting with Portuguese wine industry through his books, press articles and conferences. The industrial problems concerning the small scale of several Portuguese historical Geographical Indications, combined with the intensive regular blind tasting

of hundreds of Portuguese wines coming from all GIs, led to a proposal of three macro-regions that would encompass all Portuguese wine regions, generating three Portuguese wine profiles. As an historical wine country, Portugal offers a multitude of viticultural regions for still wines (vins de pays, IG or Regional quality wines) and Designations of Origin (AOC, DOC or DO quality wines). In accordance to the author's three-tier proposal, recently the Portuguese authorities have approved a very important change on the viticultural zoning. Should this new approach become scientifically validated, this would help consumers and buyers all over the world, to have a clear vision of the 3 major macro-terroirs and the sensory profile of its viticultural regions.

Regarding the 12 official wine regions, the input taken from the author's wine guides showed different representation of those regions:

1) **Minho – Located on the southwestern border of Continental Portugal, is referred as an Atlantic (Coastal) Region. It's Geographical Indication was regulated in 1997 and the Designation of Origin Vinho Verde is historical.**

   Less than 10 red wines from this region were assessed. Although those brands are leading ones, it is clear that this is not a statistically valid wine sample.

2) **Beira Atlântico – Located on the northern-centre coast of Continental Portugal, is referred as an Atlantic (Coastal) Region. It's Geographical Indication has been recently approved (2011) and it's Designation of Origin Bairrada is historical.**

   More than 50 reds from this region were assessed although mainly wines of origin (DOC Bairrada).

3) **Lisboa – Located on the central coast of Continental Portugal, north of Lisbon, is referred as an Atlantic (Coastal) Region. It's Geographical Indication has been recently renamed (2009) and it's several Designations of Origin are historical.**

   More than 50 reds from this region were assessed, mainly IG or regional quality wines (Regional Lisboa).

4) **Transmontano – Located on the northeastern border of Continental Portugal, is referred as a Moutain (or Valley's) Region. It's Geographical Indication has been recently renamed (2006) and it's Designation of Origin Trás-os-Montes is also recent (1989)**

   Less then 20 reds from this region were assessed. Although those brands are leading ones, it is clear that this is not a statistically valid wine sample. The typical supermarket wine shelf does not consider this wine region and include it's scarse references on the Douro shelf space.

5) **Duriense - Located on the north of Continental Portugal, covering the central and upper Douro Valley. It's Geographical Indication has been recently renamed (2006) and it's Designation of Origin Douro is historical, although officially regulated in 1982.**

More than 100 reds from this region were assessed although mainly wines of origin (DOC Douro).

6) **Terras de Cister – Located on the north of Continental Portugal, between the left bank of the Douro River and he north bank of the Dão River.It's Geographical Indication has been recently approved (2011) and it's Designation of Origin Távora-Varosa is also recent (1989).**

As a wine writer, the author never assessed still wines from this new wine region for his wine guides. The author would be inclined to refer this region as a Mountain (or Valley's) one, but it is obviously without scientifical or empirical support.

7) **Terras do Dão - Located on the center-north of Continental Portugal. It's Geographical Indication has been recently approved (2011) and it's Designation of Origin Dão is historical.**

More than 100 reds from this region were assessed although mainly wines of origin (DOC Dão).

8) **Terras da Beira – Located on the centre-northeastern border of Continental Portugal, is referred as a Mountain (or Valley's) Region. It's Geographical Indication has been recently approved (2011) and it's Designation of Origin Beira Interior is also recent (2005)**

Less then 20 reds from this region were assessed. Although those brands are leading ones, it is clear that this is not a statistically valid wine sample. The typical supermarket wine shelf does not consider this wine region and include it's scarse references on the Bairrada/Beiras shelf space.

9) **Tejo – Located on the centre-south of Continental Portugal, on both banks of the Tagus River, is referred as a Southern Region. It's Geographical Indication has been recently renamed (2009) and it's Designation of Origin Tejo was also recently renamed (2010)**

More than 50 reds from this region were assessed, mainly IG or regional quality wines (Regional Tejo).

10) **Península de Setúbal – Located on the south coast of Continental Portugal, along the Sado River and including the Arrábida Mountain, is referred as a Southern Region. It's Geographical Indication has been recently renamed (2009) and it's Appelation of Origin Palmela is also recent (1986) despite the historical Designation of Origin for Setúbal Muscat fortified sweet wine.**

More than 50 reds from this region were assessed, mainly IG or regional quality wines (Regional Península de Setúbal).

11) **Alentejo – Located on the south of Continental Portugal, this big mediterranean inland is referred as a Southern Region. It's Geographical Indication has been recently approved (1992) and it's Designation of Origin Alentejo is also recent (1998).**

More than 100 reds from this region were assessed, mainly IG or regional quality wines (Regional Alentejano).

12) **Algarve – Located on the south coastal border of Continental Portugal, is referred as a Southern Region. It's Geographical Indication has been recently approved (1993) and it's Designations of Origin, although historical, are fading out in terms of shelf presence.**

Less than 20 reds from this region were assessed, mainly IG or regional quality wines (Regional Algarve). Although those brands are leading ones, it is clear that this is not a statistically valid wine sample. The typical supermarket wine shelf does not consider this wine region and include it's scarse references on the Alentejo shelf space.

Based on The People's Wine Guide, an annual publication signed by the author which includes several hundred tasting notes of off-trade (supermarket) Portuguese wines, all the descriptive texts were statistically grouped by the MAXDictio program, which enabled word counting according to its frequence. This technique allowed a qualitatitive content analysis and supported the definition of different sensory patterns along the 3 Continental Portugal´s major macro-terroirs, as explained formerly by the author and now judged as this academical assay's hypothesys. The results are written in English and Portuguese because the input/output data is Portuguese written only. This data is showed in Annex 1.

The Atlantic Regions

This area is governed by the Atlantic climate. The higher humidity and precipitation, the lowest temperature range influences decisively the viticultural year. The soils have a higher percentage of sand due to river estuaries and dune systems. We are in the area of greater soil fertility and vegetable hydro-production. It is a region with great diversity of grape cultivars but all mature with more difficulty. The wines of the Atlantic have a huge range of combination with our traditional cuisine due precisely to its high acidity and young and vibrant tannins that combine easily with food proteins. This is a superb area for the production of white and rosé wines for their freshness, longevity and gastronomical drive. The Atlantic region has a mountainous barrier that encloses the amphitheatre facing the ocean. The wine regions of the Atlantic Terroir are the Minho (including the DO Vinho Verde), Beira Atlântico (including the DO Bairrada) and the Geographical Indication Lisboa with several minor Designations of Origin such as Alenquer, Bucelas or Óbidos.

Atlantic (Coastal) Red Wines | Vinhos Tintos do Atlântico

Cor granada violácea de média (3,25%) a forte (1,3%) intensidade. Aromas simples (1,04%) de frutos vermelhos (5,72%), de ameixa (2,08%) e cereja (1,43%), notas de madeira (1,17%) e madeira doce

(1,43%) como baunilha (1,17%). Boca de densidade mínima (1,04%) a média (1,04%), elegante (2,08%), com intensa frescura (4,16%) e impacto de taninos (1,95%), por vezes rústicos (1,04%).

Garnet Violet colour with medium (3,25%) to strong (1,3%) intensity. Simple (1,04%) red fruit aromas (5,72%), also plum (2,08%) and cherry (1,43%), woody (1,17%) or sweet woodied notes (1,43%) such as vanilla (1,17%). Light (1,04%) to medium size palate(1,04%), elegant (2,08%), extremelly fresh (4,16%) and tannin driven (1,95%), with rustic roughness (1,04%).

The Valley (Mountain) Regions

Under extreme continental influence, this macro-terroir has the highest recorded temperature ranges of the country. Vineyards are grown in deep rivered valleys such as the Cávado, and further down the Douro, the Dão, the Mondego and Zêzere, because it includes all the Geographical Indication Terras da Beira (including the DO Beira Interior) and the IG Terras do Dão (including the DO Dão). Also Trás-os Montes and the Douro appellations are included. Here man has submitted himself to the penalties of slope vineyards and crafted the terraces of the Douro, a world heritage site since 2001. This is the region of *Touriga Nacional* and *Tinta Roriz* (which is called in the South *Aragonez*). The slope gives rise to fully manual work and lower productivity that generate naturally concentrated wines of great depth and elegance. The most intense and protein rich meat or the big and driest sea food, like salmon or cod, will be the perfect match.

Valley (or Mountain) Red Wines | Vinhos Tintos dos Vales (Montanha)

Cor granada violácea de média (3,86%) a forte (1,64%) intensidade, ou com nuances de carmim (2,91%). Aromas cativantes (0,9%) de frutos vermelhos (3,75%), de ameixa (2,11%) e cereja (111%), notas frescas de bergamota (1,37%), de madeira (1,37%), madeira fresca (1,27%) e madeira doce (1,06%). Boca arqueada (0,95%) e redonda (0,9%), corpo elegante (2,59%), densidade ampla (0,85%) a média (0,79%), textura sucrosa (1,32%), com boa frescura (1,85%) e taninos concentrados (1,16%), de guarda (0,95%). Persistência longa (1,32%)

Violet Garnet colour with medium (3,86%) to strong (1,64%) intensity, also with ruby hues (2,91%). Charming aromas (0,9%) of red fruits (3,75%), plum (2,11%) and cherry (111%), fresh bergamot notes (1,37%), woody (1,37%), fresh (1,27%) and sweet oak (1,06%). Arched (0,95%) and round (0,9%), elegant (2,59%), high (0,85%) to medium density (0,79%), sugary texture (1,32%), good freshness (1,85%), concentrated (1,16%) and long lasting tannins (0,95%). Long persistence (1,32%).

The Southern Regions

The great South is preferred by one in two Portuguese consumers when selecting a bottle of wine. In fact, the Geographical Indication Alentejano (including the DO Alentejo) was the last great awakening as a wine-producing spot and is the undisputed leader of the national market. In addition to the great

"Inland Sea", as José Saramago used to call Alentejo, under the influence of the Mediterranean dry and sunny macro-terroir, are also the IG Tejo (including the DO do Tejo), the IG Algarve and IG Península de Setúbal (including the DO Palmela), protected from the Atlantic breeze by the massive Arrábida mountain. The great South has the highest homogeneity of cultivars, with the dominance of *Castelão*, *Trincadeira* and *Aragonez* as red varieties. The South offers the fruity and delicious smoother wines, with easy and round tannins, matching the style of the new world and the international consumer. Medium range, grease-free food such as daily specials or winebar offers is the perfect match.

Southern Red Wines | Vinhos Tintos do Sul

Cor granada carmim de média (3,48%) a forte (0,74%) intensidade ou com nuances violáceas (3,06%). Aromas expressivos (1,59%) e simples (1,01%) de frutos vermelhos (5,03%), de ameixa (2,41), notas de tosta de madeira (2,72%), madeira fresca (0,76%), madeira doce (0,98%) como baunilha (1,03%) e especiaria (0,64%). Boca de densidade média (0,76%) e elegante (1,74%), redonda (1,03%), textura sucrosa (0,93%) ou agridoce (0,91%), com média frescura (1,72%) e taninos menos presentes e macios (0,71%). Persistência longa (1,32%)

Ruby Garnet colour with medium (3,48%) to strong (0,74%) intensity, also with violet hues (3,06%). Intensive (1,59%) and simple (1,01%) red fruit aromas (5,03%), also plum (2,41), woody and toasty (2,72%), fresh (0,76%) and sweet oak (0,98%) such as vanilla (1,03%) and spice (0,64%). Medium (0,76%) and elegant (1,74%), round palate (1,03%), sugary (0,93%) or sweet and sour texture (0,91%), medium fresh (1,72%) discrete and softer tannins (0,71%). Long persistence (1,32%)

Taking into consideration the author´s published work and macro-terroir grouping concepts, previously stated and stated as this assay's working hypothesis, during the present study a group of acclaimed Portuguese wine experts will be answering, assessing and mapping Geographical Indication or Regional quality wines from the 12 official Continental Portugal Geographical Indications, exclusively based on their enormous and regular empirical and cognitive knowledge and will confirm or infirm the validity of the author's stated macro-zoning based on their own wine profiling skills. The author is well aware of certain limitations regarding the simplicity of the proposed qualitative analisys method for the working hypothesis – with classical quantitative descriptive analysis other clusters rather than the three proposed could be statistically validated.

Portuguese teams (Catarino 2011; Rodrigues, Otero et al. 2011) have recently published scientifical data relating lab research results and geographical wine typicality. For example, a recent analysis used for determining the concentration of 17 elements in wine samples from four different wine-growing regions

in Portugal, has shown that trace elements are good indicators of wine origin and that their concentrations can be used as criteria for guaranteeing authenticity (Rodrigues, Otero et al. 2011). The present study will not use any analytical and chemical laboratorial work, which will be envisaged as a next step of knowledge.

This assay will not encompass the study of Portuguese Island's Wine Regions. Despite a long and acclaimed history of Madeira Fortified Sweet Wine, the still wines from Madeira and Azores are very scarse and consumed locally. The typical supermarket wine shelf does not consider those wine regions.

CHAPTER 2. LITERATURE REVIEW

When the concept of typicality is applied to oenology, it represents wine characteristics on the whole, resulting from type of vine, soil, and wine making process. The typicality can be defined as a set of properties of belonging and distinction (Sauvageot, Urdapilleta et al. 2006). Knowledge of the wine style concepts significantly increases consumer's preferences for the wines during an informed wine style tasting. The cognitive influence of wine style knowledge is therefore powerful in terms of influencing a consumer's wine preferences (Bester 2011). The typicality concept is supported by the existence of a common memorized prototype which represents the image of all the previous experiences of wines from the type. The literature review will address some areas of knowledge that will support this research on Portuguese still wine styles.

2.1 An overview on Portuguese wines and wine regions

2.1.1 Portuguese wine industry: past and present

The foundation of Portugal, in 1143, was certainly celebrated with wine; Afonso Henriques, first king of Portugal was son of Henry of Burgundy, grandson of Robert I of France, Duke of Burgundy, and nephew of St Hugh, abbot of Cluny. Better techniques and new varieties were introduced by the monks who followed the Christian expansion, but the vine reached the South (Algarve and Setubal), millennia before the birth of the nation, probably brought by Phoenician merchants. The Romans continued the production of wine as a healthy option to quench their thirst. From the twelfth century there are numerous documents and royal charters that confirm the spreading of vineyards throughout the country. Two centuries later, the treaties of London and Windsor, signed by England and Portugal, were the official milestone for Portuguese wine exports.

In the fourteenth century, under the leadership of Prince Henry, son of King John I, expansion in the Atlantic mobilized all sections of Portuguese society. The occupation of Madeira and the Azores by noble families led to them producing wheat, sugar and wine. By the end of the sixteenth century, Portuguese wine could be found around the world. However, such vast territorial domains were difficult for a small country to manage and were eyed greedily by the Spanish and Dutch. To finance the recovery of the empire, after the Spanish occupation, the Portuguese used wine exports to generate resources and achieve economic stability. English merchants settled in Porto and Viana and expanded the market in England in the face of competition from French clarets. The Treaty of Methwen in 1703 ensured preferential rights for Port Wine and Portugal opened its markets to English products. During the reign of Joseph I in 1756, his minister Marquis of Pombal created the first demarcated wine region of the world, the Douro. He insisted on quality and expertise in the production of wine, banned adulterated compounds and added flavours. The late nineteenth century was a dark period for the vineyard. The

plague of powdery mildium and phylloxera, which first appeared in the Douro region in 1865, quickly spread throughout the country, devastating most of the wine regions (Coutinho 2007).

In the mid-1870s, the cultivation of vines covered about 200.000 ha of the country. Although this remains 30% below the average area prior to the advent of powdery mildew, it represented about 25% of agricultural production. With close to 100.000 ha of vineyards, producing an average of 450 000hl of wine (22% of national production), the Douro remained the main wine region. More than half the production of this region would go to port wine, a product that contributed to 35% of Portuguese external trade. Viticulture was also prominent in the surrounding regions, and in some municipalities in the district of Viseu was the dominant culture. The advantages cultivation of vines offered over cereal production was growth of domestic demand and export which led to the rapid spread of viticulture throughout the country. In the post-phylloxera period, the situation of national viticulture changed significantly. In the early twentieth century, the production of the districts of Leiria, Santarém and Lisbon represented almost half of national production while the Douro has fallen to less than 15%.

In 1907 the process of government regulation started for several appellations (other than Port and the Douro demarcation), including the famous wines of Madeira, Moscatel de Setúbal, Dão and Vinho Verde.

The New State (1926/1974) started the process of "Corporate Organization and Economic Coordination," and assumed powers of direction and supervision of all activities and agencies involved in the production of wine. In this era of dictatorship, wine was promoted as food, large merchants prospered and cooperatives were created in response to the high consumption of the metropolis and colonies. The Carnation Revolution, in April 1974, has set the start of the modernization of the wine sector. The concept of wine typicality has been harmonized with EU legislation and improved the rating of *Regional Wine* for table wines with geographical indication. Aiming towards management objectives, application, monitoring and enforcement of related *Designations of Origin* and *Geographical Indications* regulations were allocated to Regional Wine Committees (associations governed by their own statutes), which have a key role in preserving the quality and prestige of Portuguese wines (Coutinho 2007).

According to Statistics Portugal (INE 2010) from 1980 until 2009 there is a reduction on wine production by volume. However, a growth in value took place after Portugal´s integration on the European Union, (annual growth of 6,2%), justified by the new legislation favouring quality wines with Geographical Indication and Designations of Origin, instead of table wines..

Decree-Law n.º 212/2004, from 23 August, has reset the institutional matrix of the wine sector, making a profound reform, disciplining the recognition and protection of designations of origin and geographical indications used in wine products, as well as its control and certification, defining both the legal regime applicable to certification bodies.

The most recent data from 2009 (ViniPortugal 2011) reports that Portugal produced 569 million litres from planted area of 237.000 hectares (the ratio of this area over the total area of Portugal is probably the largest in the world). This means that the production yield is very low (less than 3.000 kg per ha).

Domestic consumption is very important but has been declining steadily. In 2009, the Portuguese drank 442 million liters or 42 liters / capita / per year. The key factor for the next decade is export. Unfortunately, the most recent data shows that Portugal has lost several battles, after centuries of wealth, power and leadership. In 2009, exports of still bottled wine were up to 105 million litres at an average price of 2 euros per litre. In 2009 Portugal ranked tenth in export volumes, behind Argentina and far below South Africa, Germany and the United States (OIV 2011).

2.1.2 Portuguese wine regions: Knowledge from historical cartography

The European Union, especially after the reform of the common agricultural policy in 1992, sought to substantiate extensification policies, using, in part, the memories of material and immaterial territories of rurality which were always characterized by a dense and diverse historical typicality. The designations of origin and protected geographical indications of origin were tied up to the territories which refer to specific ways of knowing and doing, crossing tradition with specificity and identity. In the case of European viticulture, since early ages the wine quality was bonded with the virtuous combination of soil, climate, sun exposure and cultivars ,as in the Pombalina Demarcation of the Douro, which occurred in 1756. Considered by François Guichard "the first demarcated and regulated appellation of origin in the world in the contemporary sense of the term", the Wine District of the Alto Douro, demarcated by Marquis of Pombal, eventually granted this portuguese wine appellation, as stated Gaspar Martins Pereira, an identity that came to our days (Fernandes 2011).

The first viticultural maps of the Douro valley were drawned on the first half of the 19th century. The author, Joseph James Forrester, future Baron of Forrester, a merchant/tradesman of Scottish origin, edited them, in close relation with the economic, social and political conditions of Portugal, the wine trade markets and the international exhibitions of London (1851) and Paris (1855). Based on British cartography which dates back to the Napoleonic wars in the Iberia Peninsula, the "Map of the Wine District of the Alto Douro" (1943) and "The Portuguese Douro and the adjacent country and so much of the river as can be made navigable in Spain" (1848) had had different editions in London, Edinburgh and Oporto (Santos-Garcia 2009).

The emergence of cartography treating aspects of vine cultivation and wine production was enhanced by relevant publication of 37 sheets of Carta Corographica do Reino, scale 1:100.000, initiated by Philip Folque in 1856 until 1904, but particularly by the Carta Geographica de Portugal, scale 1:500,000, published in 1865 by the Geographical Institute. The first case is exemplified by "Paiz Vinhateiro da Bairrada" map from 1867, laid over an extract copied from sheet #13 of 1:100.000 chart, where, it is identified, in red, the production area for "export embarquing red wine", in yellow, the" export embarquing white wine area" and in sepia, the "home consumption table wine area".

The earliest known maps representing Portugal's wine production data, are two on the 1:1.000.000 scale of, both named "Carta Vinicola de Portugal, produção approximada, Media 1884 a 1888", issued by the Agricultural Statistics directed by Gerardo Péry and published in the Bulletin of the Directorate

General for Agriculture (1890) and already contemplating, clearly visible, the territorial clippings from 9 viticultural regions of continental Portugal created in 1886 (Fernandes 2011). Those 9 regions were: 1st - Entre Douro e Minho, 2 nd - Traz os Montes; 3rd - Douro; 4th - Beira Litoral (Leiria, Coimbra, Aveiro); 5th - Viseu and Guarda; 6th - Castelo Branco and Portalegre , 7th - Oeste (Lisboa, Santarém, Setúbal), 8th - Beja and Évora; 9th - Algarve.

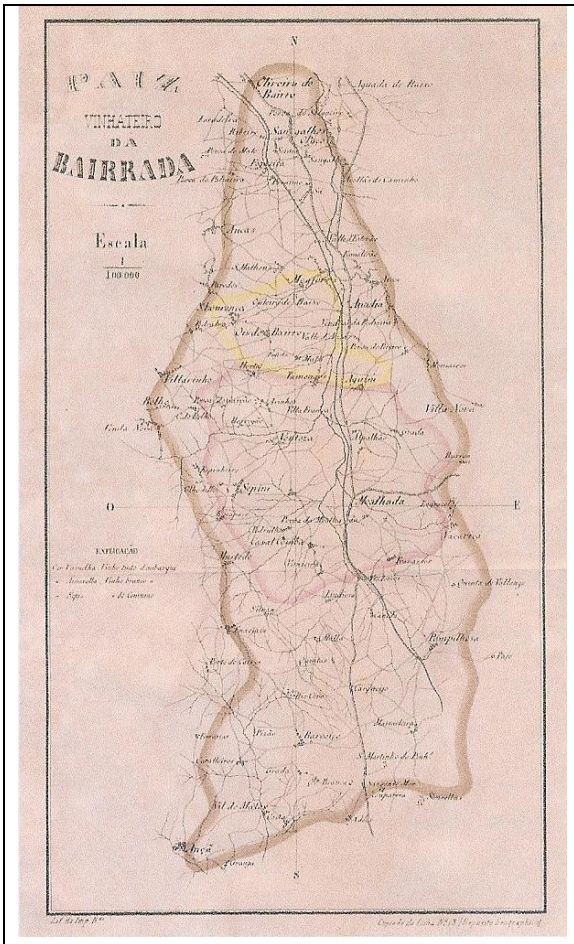

Figure 3: Paiz Vinhateiro da Bairrada", scale 1:100.000, 24x35 cm

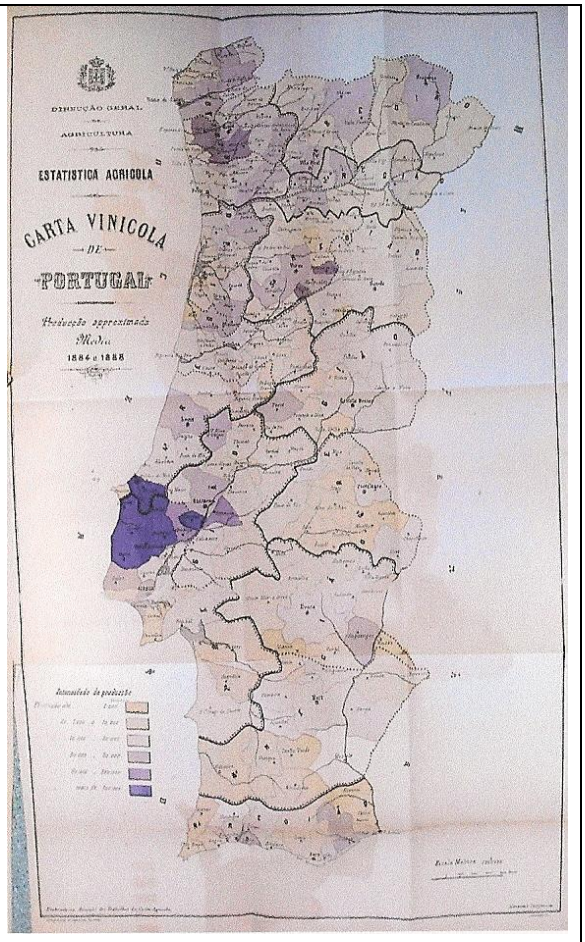

Figure 4: "Carta Vinicola de Portugal, Produção approximada, Media 1884 a 1888", 1:1.000.000, 42x68 cm

Also relevant to the country's macro-zoning wine territories were the "Carta de Producção dos Vinhos Comuns ou de Pasto de Portugal para Servir na Exposição Internacional de Vinhos de 1874 em Londres" (1:1.000.000. Lisboa); cartography produced by antiphylloxera commissions between 1888 and 1892 (eg the ""Carta Phylloxerica de Portugal, em 1892", Directorate General for Agriculture, scale 1:1.000.000); maps of the work coordinated by Cincinnato da Costa and Luiz de Castro, 1900 (the Portugal au point de vue agricole, Lisboa, Imprensa Nacional, which contains the "Carte Vinicole du Portugal " and "Carte Viticole du Portugal " both in scale 1:200.000), culminating with the approach of the demarcation of the wine regions of 1907 and 1908, the latter adjusted to parishes which corresponds essentially to the main Portuguese existing wine regions. (Marques 2009)

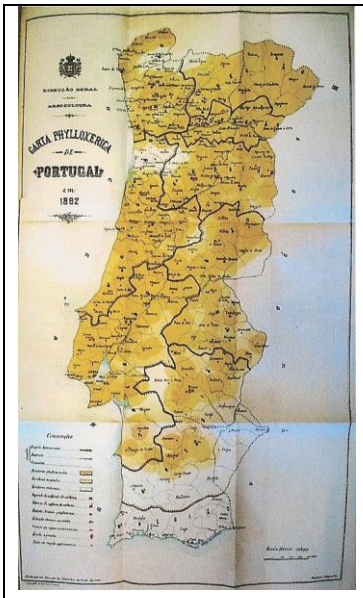

Figure 5: "Carta Phylloxerica de Portugal, em 1892", escala 1:1.000.000, 41x68 cm

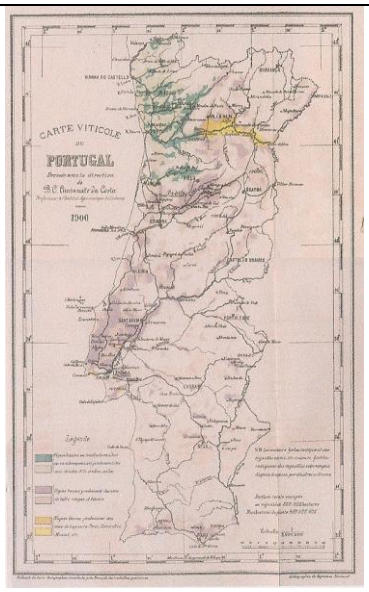

Figure 6: "Carte Viticole du Portugal" 1:2.000.000, 32x21 cm

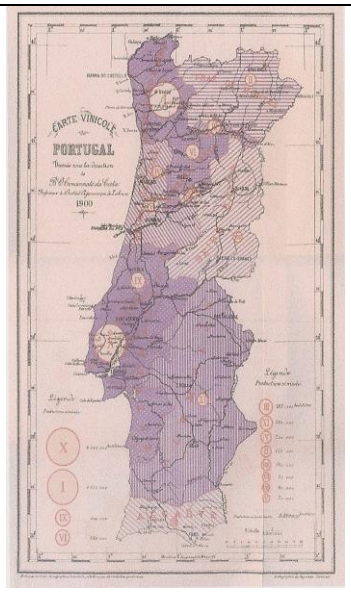

Figure 7: "Carte Vinicole du Portugal" 1:2.000.000, 32x21 cm

Since the crisis of phylloxera the issue of the territorial definition of viticultural regions assumed contours of first necessity and claim on behalf of the influential producers from Northern Portugal, struggling with very low crops and rising competition from fertile and ample lands of the Center-South, and facing a mitigate demand from main export markets, more tempted by cheap wines from Spain and the promiscuity of homeland blended wines from newcoming regions, that aimed to offer the prestige of the renowed regions at very low price. New foreign and highly productive cultivars offering effective resistance to powdery mildew and phylloxera were introduced in the centre-south of Portugal. French grapes arrived, judged of better quality, and with an unforeseen long term impact on erosion of regional typicality. The portuguese programme for the Universal Exhibition in Berlin in 1888, showed clear evidence of this trend. Portuguese wines were then presented in three classes, one being of "blended wines from various regions of the country, even from the south and the north, forming mass market table wines for immediate consumption." The Bulletin of Directorate General for Agriculture, February 1889, indicated that "these blends were greatly appreciated, not only because of its Médoc ordinary and similar style, but mainly for their affordable price." (Marques 1998)

The Letter of the Law of 18 September 1908 formalized the most famous demarcated regions such as the Vinho Verde, the Dão, Colares or Setúbal. This law responded to a period in which the historical growers demanded measures to control typicality and to combat fraud (Marques 1987). The legislation of the years 1907/8 has imposed a new economic and commercial discipline and was a milestone in the construction and ranking of national wine regions and industry. Its basic design was adopted by the New State – a Dictatorial Republican Regime - and still remains, despite the corrections and adjustments to the new criteria set by the Common Market Organisation for Wine (CMO) of the European Union.

After the 1933 Constitution and the establishment of the New State regime with the policy of government control over the homeland economic activity, bodies of coordination were generated,

amongts others, the National Wine Board – Junta Nacional dos Vinhos. The area of influence or action of JNV was limited to the ordinary table wines from all over the country, whose area corresponded to the majority of wine production, excluding specific demarcated regions from 1908 Law (Dão, Vinho Verde, Douro, Moscatel de Setúbal , Bucelas, Carcavelos and Colares) as well as Madeira and the Azores. (Pereira 2007)

Unlike other European wine countries, modern forms of cooperation were in Portugal, not only late arrivals, but mainly dependent on state funding. In 1953, due to the huge surplus production, sprayed in rudimentary facilities of small and very small producers and not having a capable number of Cooperatives, the Ministry of Economy approved the creation of cooperatives in the area of jurisdiction of the JNV, and also determined that corporate bodies from 1908 demarcated wine regions should draw up studies on the constitution of the respective system of cooperatives (Marques 2009), which came to pass between 1955 and 1957. Starting by defining a regional division of the country, aimed at planning the study of the cost of production, for purposes of economic reasons but primarily in geographical and ecological terms, seeking to define natural wine-growing region, the JNV established the constitution of 14 areas of cooperative interest:

I – Trás-os-Montes, II – Beira Transmontana, III – Lafões, IV – Beira Litoral Norte, V – Bairrada, VI – Baixo Mondego, VII – Leiria, VIII – Baixo Zêzere, IX – Beira Baixa, X – Oeste ou Torres, XI – Ribatejo, XII – Península de Setúbal, XIII – Alentejo, XIV – Algarve

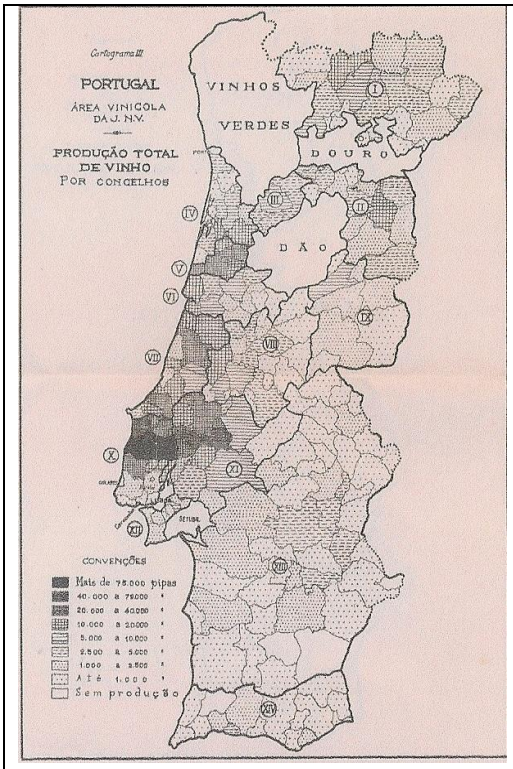

Figure 8: Área Vinícola da J.N.V., Densidade de produção [litros por ha] de vinho, por concelhos", s/autor

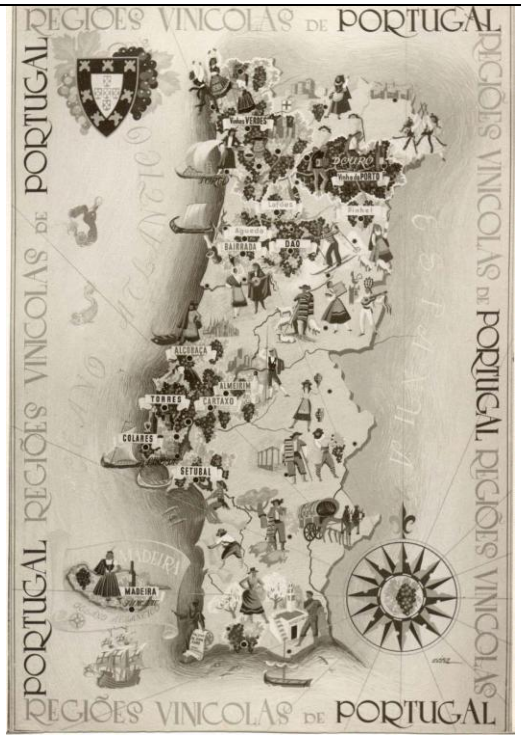

Figure 9: Mapa das Regiões Vinícolas, Mário Costa, Edição da Junta Nacional do Vinho

What truly marked this period was the increase in production of undifferentiated wine. Sustained by an internal and external market (overseas provinces) undemanding for a technical development that enabled increased productivity and greater stratification of the peasantry connected to this sector, the wine offer grew reaching a historic high in the early sixties. From that point, the country entered a period of transition that led to profound changes both in terms of production, as in trade and consumption patterns, which will culminate, in the eighties, with the beginning of the approach focused on quality.

The traditional division focused on the dichotomy between the Port and the remaining wine, evolved into a more diverse logic of value. The polarization of the sector into two spheres was smoothened by the development, at the European Union level, of intermediate products which increased the gradation of quality wines and table wines, such as the Geographical Indication of origin wines, known in Portugal as “Regional” wines.

In Portugal, the adoption of this european policy resulted in several major facts. First, the growth from 8 to 48 designations of origin, from 1979 to 1994, with all the ensuing institutional changes: adequacy of the management bodies of the ancient regions to the new interprofessional structure; proliferation of such organizations in the management of new appelations and certification of Regional wines; creation of socio-professional associations claim to represent the interests of the new structures.

Another consequence of the adoption of EU wine policy, was the construction of a new management model for the Portuguese wine industry: extinction of ancient organisms (JNV) and constitution of new public institutes, namely the Institutes of Vine and Wine (IVV), Port and Douro Wine (IVDP) and Madeira (IVBAM) (Simões, 2003).

The Decree-Law n. º 212/2004 of 23 August, established the institutional organization of the wine sector, carrying out a thorough reform, regulating the recognition and protection of designations of origin and geographical indications used in wine products, as well as its control and certification, defining both the legal regime applicable to certification bodies.

More recently certification bodies were regulated and the principle of concentration of existing Regional Viticultural wine commissions was applied. The intention was to reduce their number to obtain critical mass, economies of scale on human and technical resources to enable the full exercise of its powers, and its reorganization, including the abolition of the State's representative on the governing bodies, being assured by supervisory board or single supervisor for the monitoring of their activity in accounting and management. With this objective Order no. º 22 522/2006 of 17 October has been published establishing the conditions and organizational, technical, human and material, and the deadlines for submitting applications of certification bodies that wish to be recognized and designated to exercise the functions of production control and certification of trade and wine products entitled Designation of Origin (DO) or Geographical Indication (GI) in order to assure consumers the fulfillment of quality and typicality criteria. (G. d. P. and. P. MADRP, 2007)

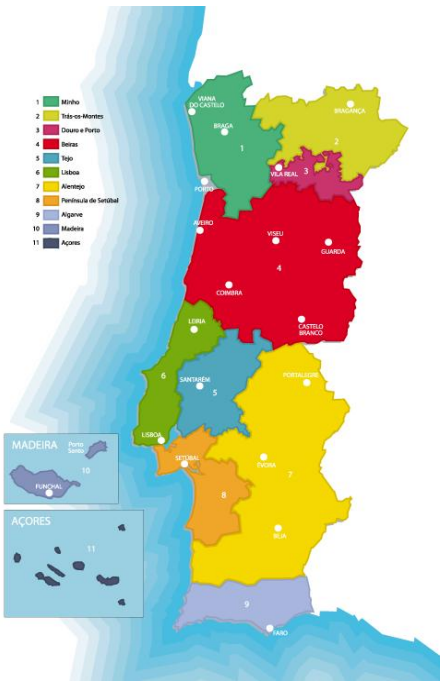

Figure 10: Official 2011 Map of Portuguese Viticultural GIs

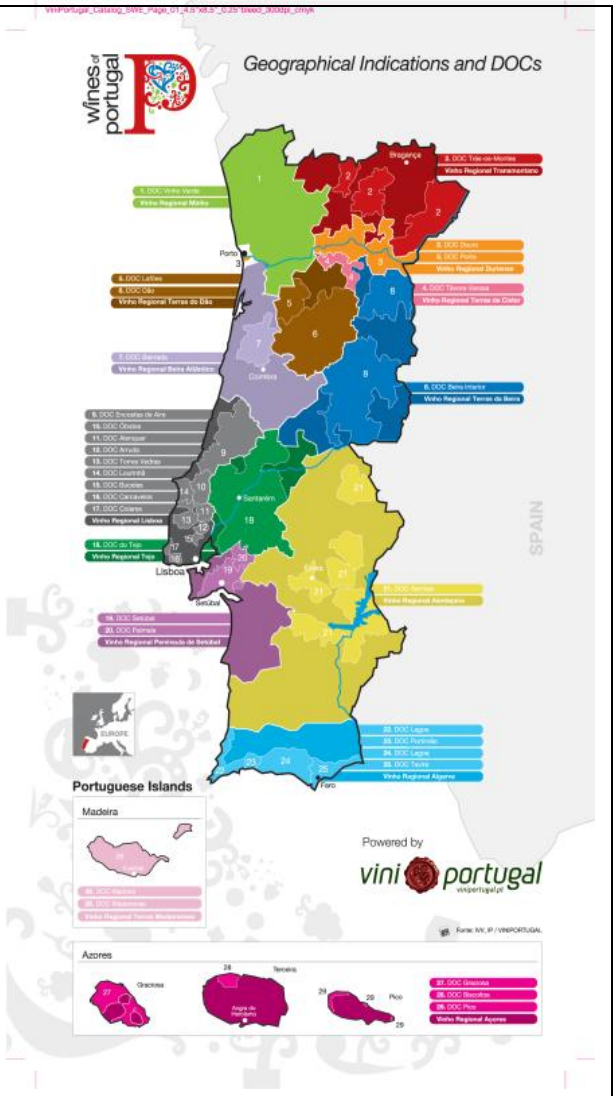

Figure 11: Official 2011 Map of Portuguese Viticultural GIs and DOs

Regarding the portuguese wine regions, one can still recognize the historical lineage and traditional base remains unchanged since the genesis of specialist cartography. Comparing the scenario after joining the European Union and the Common Agricultural Policy with appelations of origin of 1907/1908 and the cooperative division of Portugal from 1955 (see Table 1), the country maintains the historical and long agreed viticultural regions with significant adjustements in Central Portugal, especially with the recent cision of extensive Beiras region. The author adds a final column with the hypothetycal macro-terroirs and respective wine profiles, the subject of this assay, fully framed in the current composition of the national wine regions.

	Política do Estado Novo	Política Agrícola Comum (1994)	Revisão PAC (2004)	Perfis de Vinho por Região (Coutinho, 2011)
Carta-Lei 1907	A - Douro	Regional Duriense	IG Duriense	Vales de Portugal
JNV, 1955	III – Lafões	Regional Beiras	IG Terras do Dão	Vales de Portugal
Carta-Lei 1907	C - Dão	Regional Beiras	IG Terras do Dão	Vales de Portugal
JNV, 1955	I – Trás-os-Montes	Regional Transmontano	IG Transmontano	Vales de Portugal
JNV, 1955	II – Beira Transmontana	Regional Beiras	IG Terras da Beira	Vales de Portugal
JNV, 1955	VIII – Baixo Zêzere	Regional Beiras	IG Terras da Beira	Vales de Portugal
JNV, 1955	IX – Beira Baixa	Regional Beiras	IG Terras da Beira	Vales de Portugal
Carta-Lei 1907	B - Vinhos Verdes	Regional Minho	IG Minho	Atlântico de Portugal
JNV, 1955	IV – Beira Litoral Norte	Regional Beiras	IG Beira Atlântico	Atlântico de Portugal
JNV, 1955	V – Bairrada	Regional Beiras	IG Beira Atlântico	Atlântico de Portugal
JNV, 1955	VI – Baixo Mondego	Regional Beiras	IG Beira Atlântico	Atlântico de Portugal
JNV, 1955	VII – Leiria	Regional Estremadura	IG Lisboa	Atlântico de Portugal
JNV, 1955	X – Oeste ou Torres	Regional Estremadura	IG Lisboa	Atlântico de Portugal
JNV, 1955	XI – Ribatejo	Regional Ribatejano	IG Tejo	Sul de Portugal
JNV, 1955	XII – Península de Setúbal	Regional Terras do Sado	IG Península de Setúbal	Sul de Portugal
JNV, 1955	XIII – Alentejo	Regional Alentejano	IG Alentejano	Sul de Portugal
JNV, 1955	XIV – Algarve	Regional Algarve	IG Algarve	Sul de Portugal

Table 1: Comparison between wine regions in different chief moments

2.1.3 Portuguese wine regions: Bioclimatic characterization of Portugal

A team of researchers from the University of Trás-os-Montes and Alto Douro have studied the influence of climate in the portuguese winelands referring, perhaps without a thorough review over the historical specificity of Portuguese viticulture, that the fundamental criteria which governs the demarcation of any viticultural area is entirely associated with the concept of ecosystem, defined by the interaction of soil, climatic and biological environment, the latter represented fundamentally by the set of traditional varieties of the region, which provide, by viticultural and oenological techniques, personality and typicality of its wines. (Magalhaes, 1995). They concluded that, although the climate of Portugal is Mediterranean, with two well-defined periods, the summer, hot and dry, and winter, cold and rainy, it was found by calculating the water balance that there is great diversity of situations. In general, the climate becomes wetter and milder on the sea coast compared to inland, and the South is warmer and dryer when compared to the North, with the exception of the Douro and neighbouring regions in Trás-os-Montes and Beira Interior. Findings of super-humid and humid climate for the DO Vinho Verde, on the northwest border were confirmed. The humid climate covers the lower part of the Douro (Vila Real and Régua), known as the Baixo Corgo sub-region, the Dão, Bairrada, part of Beira Interior, Lisbon sub-regions, such as Óbidos, Alcobaça, Encostas d'Aire and the Northern Alentejo and Ribatejo, Tomar and Portalegre, these two sub-regions contrasting with all other zoning on the southern Portugal (Alentejo, Tejo, Setúbal and Algarve), ranked as sub-humid. The Upper Douro ranks extremely as sub-arid. (Magalhães, 1995).

One of the first authors to attempt a division of the country into climatic provinces was the geographer Hermann Lautensach in 1932. This author considered the marginal position of Portugal as the most significant influence on the global climate of the territory, whose regional characteristics are a function of latitude and distance from the coast. Thus defined a first variation gradient from north to south, along which the precipitation sharply decreases, and a second gradient, from the west coast to the interior, which corresponds to a decrease in precipitation, but also a strong increase of annual thermal amplitude which translates into an increase in continentality. Lautensach divided the territory into climatic provinces with the definition of three major regions: Maritime Region, which extends about 40-60 km into the coast; Continental inland, and Highlands, corresponding to the territories 800-1000 m above the quota, alternating between the two previous ones, in the north of the country. The provinces climate defined by this author were not mapped (S. Fernandes, 2005).

At biological level, the influences of climate and soil led to a three-tier division of Continental Portugal. In 1896 Willkom published the Botanical Districts of the Iberian Peninsula. The chief unit recognized by the author was called Botanical District. Continental Portugal was divided into three districts: *West-Atlantic* (including sub-districts *Cismontanas, Montanas* and *Meridionais*), *South-Atlantic* (including sub-districts *Zona Halófita, Litoral* and *Barrocal Algarvio, Monchique* and *Costa de S. Vicente, Serra Leste-Algarvia, Costa Alentejana, Baixo Alentejo*) and *Central-Iberian* (*Meseta do Norte, Sistema Central Divisório* and *Meseta do Sul*).

The geographical division of Portugal proposed by geographer Orlando Ribeiro (1986), took into account climatic factors as well as lithological and orographical, reflecting the grove coverage (maritime pine, deciduous oaks, chestnut, holm oak, cork oak, stone pine, almond tree, fig and carob tree). This author has divided the country into two main divisions: Atlantic (1-7) and Mediterranean (8-23), which in turn were subdivided into 23 clusters.

The first division of the Portuguese territory at phytogeographycal level was Carta Xilográfica ou Mapa dos Arvoredos, made by Barros Gomes and published in 1878. This author sliced the Portuguese territory into three major divisions according to the area of dominance of the maritime pine, deciduous oaks ("Quercetum" deciduous) and persistent oaks ("Quercetum" evergreen).

Given the dominance of several trees, Barros Gomes segregated twelve Natural Regions (figure 12): *Douro Litoral* (Roble oak and maritime pine), *Além Douro Transmontano* (Pyrenean oak and chestnut), *Beira Transmontana* (Pyrenean oak and chestnut), *Beira Meridional* (chestnut, pyrenean oak , cork oak and holm oak), *Beira Central* (chestnut, Pyrenean oak, roble oak and maritime pine), *Beira Litoral* (Maritime pine, wild olive tree), *Centro Litoral* (Portuguese oak, wild olive, stone pine and maritime pine), *Baixas do Sorraia* (cork oak, holm oak, stone pine, maritime pine), *Baixas do Guadiana* (holm oak, wild olive, cork oak), *Baixo Alentejo Litoral* (cork oak and stone pine), *Alto Alentejo* (cork oak and holm oak) and *Algarve* (carob, wild olive and holm trees) (Costa 1998).

Figure 12: Mainland Portugal divided by B. Barros Gomes, (1878)

In 1900, the National Press (Imprensa Nacional) printed *Le Portugal au point de vue agricole*, a book with a thousand pages published in French for the Paris Universal Exhibition. Bernardino Cincinato da Costa, Professor of the Instituto Superior de Agronomia of Lisbon, was responsible for the wine maps and the winelands report. The Introduction was written by Francisco Manuel de Melo Breyner, Count of Ficalho. This scholar, naturalist and botanist, introduced the division of the country in three "botanical regions": Mediterranean (Algarve and the majority of Alentejo), Atlantic and the "*Partie centrale de la Peninsule Ibérique*", today the continental Iberian (Trás-os-Montes and the upper part of inland Beira), pointing out the respective areas of transition, with limits more or less abrupt. A century later, remains, overall, the timeliness of this division. For his demonstration, the Count of Ficalho used information sources where mapping had a prominent place, namely the already referred Maps by Barros Gomes. He also mentioned the geological map of 1876. (Devy-Vareta 1999)

The climate of a certain region is defined as the set of weather conditions prevailing in the referred area, and it is possible to characterize it by the average behavior of its meteorological elements over a longer or shorter period of time (usually 30 years). Main factors and elements of weather with a direct impact on the growth, development and potential yield of crops are solar radiation, precipitation and temperature. The large variations occurring in those parameters across the continent, are the result of a combination of four major types of influences that occur on our territory - Atlantic, Continental and Mediterranean – those three joined by each land site Orography (MADRP 2004).

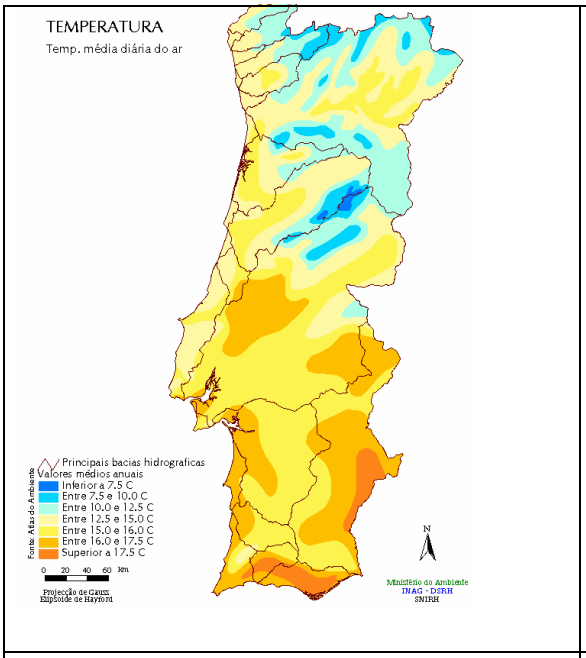

Figure 13: Regional thresholds of average temperature

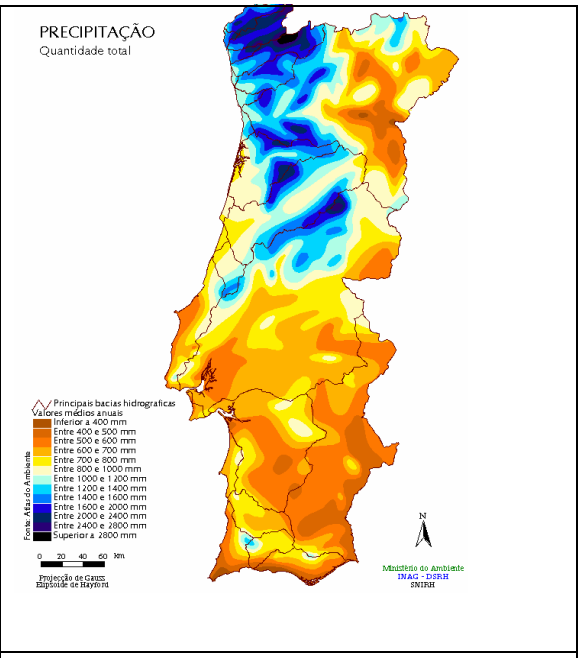

Figure 14: Regional thresholds of rainfall

According to information from maps in Figure 13 and 14 and more statistical data (MADRP 2004), some important conclusions are:

- Solar Radiation increases from northwest to southeast, with minimum values (around 140 Kcal/cm2) in Minho, the Northwest border, and maximum (170 Kcal/cm2) inland and on southern Algarve coast;

- Annual Average Temperature presents a variation from north to south, with minimum values of 7.5 ° C and maximum of 17.5 ° C;

- The average annual rainfall is an element that presents a wide variation, with values oscillating between 2800 mm (Northwest) and 400 mm (southern inland);

- Identical pattern of variation (but reverse) is presented by evapotranspiration, with minimum values in the coastal region of Minho and maximum in inland Alentejo.

Given that soils are an essential element for the development of crops and thus for the proper planning of agricultural activities, it is important in this assay to show an updating on the existing Portuguese soil types, its main features and its distribution throughout the territory. The figure below shows two maps, one with the geographical distribution of the main types of soils found in Portugal and the other with the geographical distribution of altitude levels greater or equal to 800 meters.

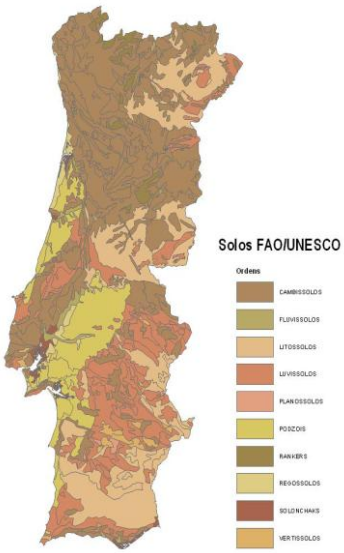

Figure 15: Geographical distribution of soils in Mainland Portugal

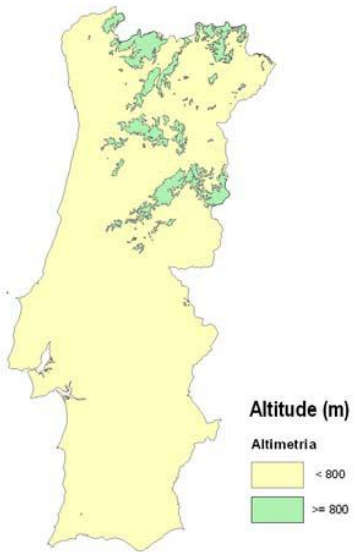

Figure 16: Geograhical distribution of altitude levels, lower and higher than 800 m

The predominant soils are Cambisols, representing more than 2/5 of the total area of the country. The following are Entisols and Luvisols which represent, each, approximately 1/5 of the area of the country. If we add Podzols to the previous, we get a sampling of more than 93% of the total area of the country.

This literature review reveals, for all factors of climate and soil, a number between 2-4 macro-zoning territories in Portugal. Although the specifics and results of each study are not coincident, the studies showed interesting and encouraging similitude with the three-tier macro-zoning hypothesis of this dissertation.

2.2 An overview on viticultural zoning and typicality

Viticultural zoning studies can be divided broadly into two main approaches: the first approach is based largely on the geographic differentiation of wine, grape or grapevine characteristics, while the second approach focuses on the geographical differentiation of land capability or vineyard suitability studies in which soil and climate are normally the key environmental variables used with varying degrees of importance. In the case of the first group, the geographical differentiation derived from results obtained from experimental plots or commercial wineries and has been widely demonstrated using physicochemical analysis more often than sensory analysis. However, in many of these studies, the sites or wineries are often roughly spatially referenced and/or the environment poorly defined. Moreover, the numbers of representative sample-sites or wineries are often inadequate to accurately demarcate the sensory/chemical zones boundaries or those relating to the grape/wine quality. In spite of the

diversity of terroir-related scientific studies, researchers have paid very little attention to the spatial modelling of terroir and issues related to the spatial scale (Vaudour 2005).

2.2.1 Impact of geography on wine and consumers

Recently, a study on the importance of the Wine Region of Origin in the United States of America concluded that 85% of buyers indicated the Wine Region as analyzed when evaluating a wine label, so a very important element in the purchase decision and more relevant then Brand and the Year of Harvest (Cravidão 2010). Results highlighting the importance of Region of Origin in the evaluation of wine were also conducted in Portugal by Ribeiro et al. (2008) and Yon (2003). There is however a big difference between the "Old World" and "New World" because the terroir (tripartite combination of variety, climate and soil) is much used and valued in European countries ("Old World") as a selling point.

A Region-made-Brand tends to overcome the cognitive assessment because it adds an emotional side inherent in the product's origin. In international wine trade, the message of quality as a selling point is saturated, the capital that you can add to mark the origin of the wine region will avoid switching between wine and that competition is not solely based on price. The images of the Regions are powerful stereotypes that influence buying behaviour (Cravidão 2010).

Wines endorsed by the Designation of Origin system, protected by the European food and agriculture authorities, typically represent a good example of a specific set of conventions adopted by a network of producers and consumers. The geographical interest in the so-called ‘quality food’ has recorded a remarkable dynamism in Europe during the last two decades. The available literature emphasizes its advantages for producers (product differentiation, access to market niches, higher profits) and for consumers (control over their diet, guarantees about the origin and the processing of food, commitment with the social and natural environment) and underlines its potential contribution to the development of specialized rural areas. To our knowledge, and after a careful monitoring of the literature, such an attempt to settle a reliable methodology to measure conventions which allows for comparative studies among DOs, regions and even countries has not been addressed yet (Sanchez 2011).

2.2.2 Wine typicality

Wine sensory typicality can be assessed in a simple way, through a single question. Agreement analysis between assessors allows to validate the existence of a typicality and could be use as a tool to objectivise the typicality of Appellation of Origin wines (Perrin and Pages 2009).

Numerous studies succeeded in differentiating between wines according to their geographic origin, based on the wines’ sensory properties. However, some experiments flawed by the fact that wines of different vintages were evaluated at the same time and wines of the older vintage were more aged. Hence, the effect of vintage was artificially enhanced by the additional year of maturity (Bauer 2011).

The typicality, character of what is typical, makes it possible to differentiate, identify, and recognize the product. Applied to the wines of "Appellation d'Origine Contrôlée" (AOC; protected designation of origin), the typicality, which corresponds to biochemical and sensory characteristics, is the most synthetic expression of the soil, contributing to making AOC wine an original product that can be considered as typical. The typicality consists of two essential dimensions: historical/geographic and sensory (Cadot, Caille et al. 2010). When the concept of typicality is applied to oenology, it represents wine characteristics on the whole, resulting from type of vine, soil, and wine making process. Thus, the typicality includes sensory, technical, and environmental dimensions (Sauvageot, Urdapilleta et al. 2006). The typicality can be defined as a set of properties of belonging, and distinction. There is great sensory variability within the same sensory space, particularly for wine. In fact, the members of categories considered more prototypical are those with most attributes in common with other members of the category and least attributes in common with other categories, so there is a representativeness gradient within a product category, with some items considered more typical than others. The boundaries between neighbouring categories are not clear-cut; membership in a category is not dichotomous (all or none) but graded. Some studies showed that wine categories are organized along a typicality gradient (Cadot, Caille et al. 2010).

Principal component analysis of the sensory data permitted differentiation between Albariño wines from different geographic areas in Rías Baixas (Vilanova and Vilarino 2006).

The distinctive New Zealand wine style "Marlborough Sauvignon blanc" was investigated by sensory characterisation, by judgments of typicality, and by chemical analysis of selected aroma compounds. Typicality was defined in terms of perceived representativeness where good examples of the concept were considered more typical. Wine professionals undertook three sorting tasks. The unique characteristics of a product from a delimited geographical area, chemical and sensory, give the product typicality, meaning that the product is representative of its terroir (Parr, Green et al. 2007).

A wine is typical if some of its own characteristics can be identified and make it recognizable as belonging to a type and distinctive from others. Typicality can be explored from two points of view:

a) The production point of view which relates to the distinctiveness of a product, linked to a geographic place.

b) The consumer point of view which is representative of a product in its category.

Wine is one product whose concept of typicality is prevalent. Most of its economic model is built on typicality, especially in Europe (Maitre, Symoneaux et al. 2010).

In light of authentication, two very important questions arise: Does the specific configuration of natural factors, which defines a distinctive geographic origin, increasingly referred to as "terroir", cause a sufficient impact on the chemical composition of finished wines, so that wine experts and even consumers are indeed able to discriminate them by sensory means and actually recognize similar types of bedrock such as lime stone, slate or sandstone? If this is true, the next question would address the

role and importance of individual climatic and topographic factors defining specific vineyard sites or terroirs on sensory properties and chemical wine composition, especially volatiles. (de Orduna 2009)

2.2.3 The European system of geographical wine regulations

The Lisbon Agreement for the Protection of Appellations of Origin and their International Registration, signed in October 31 of 1958, defines on its article 2 the Notion of Designation of Origin as the geographical name of a country, region, or locality, which serves to designate a product originating therein, the quality and characteristics of which are due exclusively or essentially to the geographical environment, including natural and human factors. According to this definition, an appellation of origin can be considered as a special kind of indication of source, because the product for which an appellation of origin is used must have quality and characteristics which are due exclusively or essentially to its geographical origin.

The demarcation of registered designations of origin, appellations of origin or protected geographical indications is one of the most obvious of zoning aims. This practice, which originated as early as the XIXth century in Europe, is now widely applied in the relatively young wine-growing countries, such as South Africa, Canada, Australia and New Zealand. Some demarcations are pre-established, whereas others need to be determined. (Vaudour 2005)

The TRIPS Agreement (Trade Related Aspects of Intellectual Property Rights) celebrated in the scope of WTO (World Trade Organisation) provides the following definition of geographical indication: "Geographical indications are, for the purposes of this Agreement, indications which identify a good as originating in the territory of a Member [of the WTO], or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin". The definition of geographical indication in the TRIPS agreement does not expressly refers to appellations of origin or designations of origin, but it adopts a new concept that covers a broader scope than appellations of origin. This is a very good example of approach (in a trade-off environment) between different groups of industrialized countries and how this definition of geographical indication became so useful to developing countries. According to the above definitions we may conclude that indication of source includes geographical indication and appellation of origin. Indications of source only require that the product originate in a certain geographical area (the true principle). On the other hand, geographical indications imply a particular quality, reputation or other characteristic of the product. Finally, all appellations of origin are geographical indications, but some geographical indications are not appellations of origin.

Let's look now to the European Regulation (EC) No 510/2006 of 20 March 2006 on the protection of geographical indications and designations of origin for agricultural products and foodstuffs. Designation of origin means the name of a region, a specific place or, in exceptional cases, a country, used to describe an agricultural product or a foodstuff: originating in that region, specific place or country; the quality or characteristics of which are essentially or exclusively due to a particular geographical

environment with its inherent natural and human factors; and the production, processing and preparation of which take place in the defined geographical area. Geographical indication means the name of a region, a specific place or, in exceptional cases, a country, used to describe an agricultural product or a foodstuff: originating in that region, specific place or country; which possesses a specific quality, reputation or other characteristics attributable to that geographical origin; and the production and/or processing and/or preparation of which take place in the defined geographical area. So, the link with the region is much stronger when we have appellations of origin than when we face a geographical indication. This difference will have effects on the juridical functions of these signs. (Almeida 2008)

In Portugal the adoption of the European Common Agricultural Policy implied the growth from 8 to 48 appellations of origin, from 1979 to 1994, with all the ensuing institutional changes: adequacy of the management bodies of the ancient regions to the new interprofessional structure; proliferation of such organizations in the management of new appelations and certification of Regional wines; creation of socio-professional associations claim to represent the interests of the new structures.(Simões 2003)

The first European framework for the registration of geographical indications and designations of origin was created in 1992. A feature of Community policy on agriculture and product quality, Regulation 2081/92 was enacted with the twofold objective of increasing the quality of products and promoting the diversification of production, so as to better balance supply and demand, improve the incomes of farmers and benefit rural areas.

Community Regulation 510/2006 on the Protection of Geographical Indications provides two different types of geographical indication. Groups of producers are entitled to apply for registration of either a PDO or a PGI. The first question therefore as to the choice of instrument, requires knowledge of the distinguishing features of the PDO and PGI.

While the PDO and the PGI each bear a distinctive relationship to the place of production, each differs in the character of that relationship. The requirements for a protected designation (or appellation) of origin (PDO) are more stringent in so far as the product must not only originate in the place but its quality must be exclusively due to a particular geographical environment with its inherent natural and human factors. To qualify for a PDO, the product must be produced within the specified geographical area, and the product's quality or characteristics must be 'essentially due to that area'. By comparison, the protected geographical indication (PGI) is broadly enough defined for most locally-based products to take advantage of its protection. The PGI requires the product to be produced, processed, or prepared in the geographical area, and the quality, reputation, or other characteristics to be generally 'attributable' rather than 'essentially due' to that area. At its most attenuated point the definition of a PGI simply requires a link between the product and the reputation of the place. Significantly, no specific criteria exist for delimiting the geographic area. Factors extraneous to the linkage of quality production with the land, notably political or linguistic boundaries are not considered relevant, in so far as the natural and human factors inherent in a given product are likely to transcend administrative borders (Evans 2010).

The geographic indication (GI) is a credential attribute, which distinguish the quality of the product of a specific region. This research aimed to identify the sources of information, the degree of appreciation and credibility, and quality factors related to the concept of GI on fine wines from the perception of wine specialists of Brazilian wine associations. A brasilian study indicates that 62% of the consulted wine experts identified a high relation between GI and the quality in wines. The edaphoclimatic and production aspects are more important to the perception of quality than other factors related to the GI concept (Falcao and Palma Revillion 2010).

2.2.4 The macro-perspective of viticultural zoning

In centuries-old viticultural countries, marked attention has always been paid to the influence of vineyard conditions on the quality of grapes and their distinctive characteristics, an influence that is normally embodied in the French notions of 'terroir', defined as a spatial and temporal entity for the production of grapes and/or wine that is characterised by the interaction between homogeneous or dominant features of soil, climate and topography at a given scale, as well as biological (variety and rootstock) and human (social, historical experience and winemaking) factors. Because the terroir notion integrates many human and environmental factors, it is unlikely that every vineyard in the world can possess the same combination of characteristics. Their spatial scale and the qualitative and quantitative methods of analysis may vary greatly, depending on the individual authors and the characteristics of the vinegrowing region, and consequently it is difficult to make international comparisons. In spite of the diversity of terroir-related scientific studies, researchers have paid very little attention to the spatial modelling of terroir and issues related to the spatial scale. Over the past three decades, most terroir-related scientific studies have focused mainly on the plant or plot (or subplot/block) level through a network of experimental sites. There are three organisational or spatial levels which stem from climatology and which are commonly referred to in grapevine research: (i) the 'macro' or regional scale (from tens to hundreds of kilometres), (ii) the 'mesoscale' for a topographical unit or a block/vineyard (tens of metres up to kilometres) and (iii) the 'microscale' for the canopy (millimetres to metres).(Vaudour 2005)

This assay will have the 'macro' or regional scale as its setting.

2.3 Sensory science as a link between typicality and wine profiling

Sensory science is an interdisciplinary field comprising measurement, interpretation, and understanding of human responses to external and internal stimuli as perceived by the senses such as sight, hearing, smell, taste, and touch. In classical terms, the word "sensorium" was often defined as a part of the brain or the brain itself regarded as the seat of sensation, which might give too static associations. The senses are not passive receivers but operate in an active and fundamental way for human beings and their relation to the external world: [Human] perception is the act of becoming aware of a stimulus and its

qualities based on the sensations that are caused and the interpretation of those sensations based on previous experience (Lawless 2010). A multitude of external chemical and physical stimuli from the environment (e.g., foods, music, data plots) interact with a multitude of internal and mental stimuli (e.g., memory, previous experiences, expectations, bodily condition), resulting in a repertoire of responses (see Figure 17). A response may be both a descriptive, verbal response and a report of experiences, emotions, and behaviour.

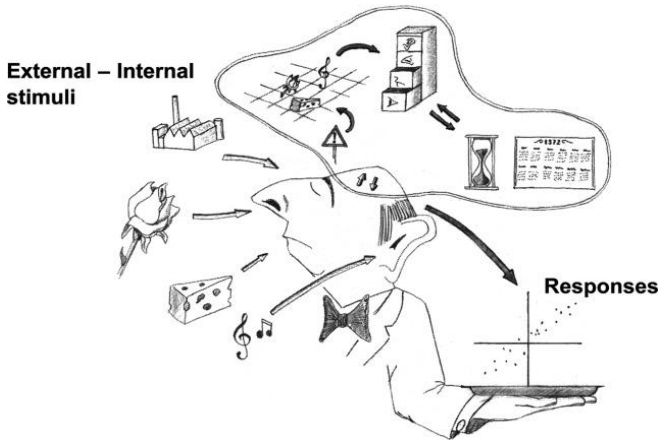

Figure 17: Perception as information processing. This is an interactive and dynamic process where a flux of external efferent stimuli from the environment interact with a flux of internal afferent stimuli. This basis point is symbolized by the arrows in the brain (Martens 2010).

2.3.1 Research methods for wine sensory data

Human perceptions of foods and consumer products are the results of complex sensory and interpretation processes (Lawless 2010). The distinctive Vitis vinifera grape flavour and aroma characteristics are expressed as a result of the physical and cultural environment (Parr, Green et al. 2007). Within each cultivar, one can furthermore identify different wine styles that are the results of specific cultivation and harvest methods (e.g. sugar level during harvest), the wine production process (e.g. type of yeast used during fermentation), maturation specifications (e.g. type and duration of wood maturation), to name but a few. Recently, the South African wine industry started to investigate the opportunity for classifying different Chenin blanc wines according to different wine styles and to market these wine styles to the consumer target markets. It is therefore important to investigate the sensory methods that could possibly be used to classify and describe various wine styles and establish which product factors are responsible for driving these preferences (Bester 2011). Even though the most accurate results are obtained from using human senses instead of instrumental tests one has to keep in mind that human testing automatically includes vast amounts of uncertainty and biasness into the data as different people perceive and prefer various sensorial factors differently. It is therefore important to reduce the amount of data variance; however, no answer in sensory science will ever be without any uncertainty.

There are three different test methods in sensory evaluation: classification tests, descriptive tests and affective tests (Lawless 2010). All these tests are used to reach specific objectives.

Discrimination tests are typically classified as analytical tests where the aim is to investigate whether various products in a sample set are different to one another in some way. The type of panellists used here can be either trained or untrained.

Descriptive tests on the other hand focuses on quantifying the specific sensorial differences between two products in a sample set. Only highly trained panellists are used to conduct this analytical test. Lastly the affective tests aim to establish how well the products within a specific sample set is liked or preferred with regards to one another. This is classified as a hedonic test where the sensory analyst will only make use of untrained users of the product, i.e. consumers.

Focusing on discrimination and descriptive tests, these two methodologies will force the panellists to use different cognitive processes during sensory evaluation. Sensory profiling tests, such as QDA, are assumed to be a bottom-up cognitive evaluation process, as panellists are trained to make analytical judgements about the intensities of the product's sensorial characteristics. On the other hand the classification method, such as a sorting task, enhances the panellists focus on the holistic or global perception for a group of similar products and this implicates higher-order cognitive processes, i.e. top-down evaluations, which will reflect a panellist's level of experience or expertise (Parr, Mouret et al. 2011). Which of these two methods is therefore most important to investigate? Due to the fact that consumers are the endusers of wine it is important to evaluate the method that they use during cognitive assessment of the wines. Consumers often sort products together according to similarity and seldom focus on individual aspects of a product. The sorting task is a natural and everyday exercise for consumers as it does not require a quantitative response which is associated with bottom-up cognitive processes such as used during conventional profiling.

Various sensory research and product profiling methods are therefore available for researchers in order to investigate product sensory profiles, product similarities, as well as panel perceptional comparisons for example experts versus consumers versus trained assessors, and to determine consumer preferences and explain drivers of liking for specific products.

In sensory analysis, one of the most important tools is the quantitative characterization of the perceivable product attributes. In the literature, this tool is referred to as ‘‘descriptive analysis", or ‘‘profiling". These methods use trained or expert panels. Because of their routinely use of the type of products in question, and because of dedicated training sessions, these panels seem to be more able to characterize products in an accurate way than naïve consumers. On the other hand, hedonic questions are also of great importance and most practitioners use consumers for hedonic tasks. So trained panels are required for sensory profiles and consumers are required for hedonic profiles. In the literature, many warnings are given concerning the use of consumers for profiling:

– ‘‘. . .as with any untrained panel, beyond the overall acceptance judgment there is no assurance that the responses are reliable or valid" (Stone & Sidel, 1993, cited by (Worch 2010))

– ‘‘. . .consumers can only tell you what they like or dislike” (Lawless & Heymann, 1999, cited by (Worch 2010))

According to these practitioners, profiling results from consumers lack two essential qualities: consensus between respondents and reproducibility. In market research, most companies need quick answers about their products. Hence, they do not always have the possibility to train panels (which is time consuming). Because of these two notions (training panels takes time, and consumers are not allowed to profile products), a number of faster methods for collecting sensory data have been developed (Worch 2010).

The results are informative for statistical practices to meet project goal. Panel performance can be examined by interaction of product and panelist; product difference can be diagnosed by means of a one-way AOV based on attributes. Statistical procedures, such as multivariate analysis of variance, principle component analysis, factor analysis, cluster analysis can be widely applied to dataset; means of attributes in the same sensory category can be graphically presented by a “spider web” with each line referring to each wine sample (see figure 18).

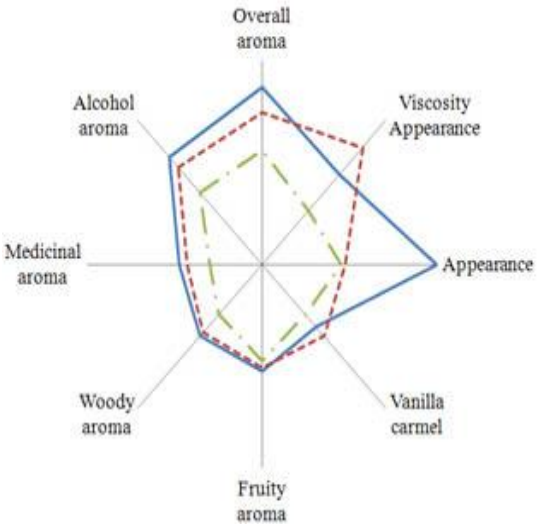

Figure 18: Graphical display of sensory attributes based on QDA result

A classical way to describe these sensory characteristics is to select a small group of panelists and train them to identify and quantify the main sensory dimensions of the products. This type of method, called sensory profile, is quite efficient but also very expensive and time consuming. Thus, it is necessary to develop other sensory methods to obtain sensory information about products. Among these new methods, the sorting task has been one of the most popular in the domain of product descriptions (Chollet, Lelievre et al. 2011).

2.3.2 Review of sensory outputs related to wine tasting

In his (referenced) book The Taste of Wine, Professor Émile Peynaud sets aside a whole chapter, and sections of other chapters, for an in-depth look at wine tasting vocabulary. He begins the chapter (9) by pointing to the importance of paying attention to the language of tasting, and admits:

"…in this subjective area the relationship between sensation and expression, between the word and the quality it describes, is not as straightforward as it is elsewhere."

However, the problems for Peynaud lie not in the objective world of wine tastes and smells, but in our imperfect knowledge of the smells and tastes, and our "lack of vocabulary" (Bruce 1999).

An award winning essay (Brochet 2001) studied the representations of wine tasting, using three different methods. Text corpuses were selected from highly referenced wine critics. The first corpus was taken from a very well known and published work, the Hachette Wine Guide (France). Hachette were kind enough to give us the notes of 10 editions of its guide which totaled more than 100,000 tasting notes. The tastings were conducted collegially and samples were tasted anonymously. The second extract was a weekly publication which is now stopped, from Gault Millau. Most of these tastings were conducted by J. Dupont. The third corpus identified 29,000 tasting notes from the well known American author of the bimonthly publication "The Wine Advocate," Robert Parker. Every 2 months the Wine Advocate has published since 1978 about 1,000 tasting notes. Its influence has grown steadily over the past 3 years. The tastings were conducted blind and Mr. Parker did not give us his notes. The author purchased the 9000 Notes on CD ROM acquired from the Massachusetts Company that markets it. Other two corpuses were analyzed. Major findings that summarize the specifics of the organization of lexical fields from textual analysis by Alceste were:

- Classes are not indexed according to a well known global standard, instead they define "Wine Types or Styles".

- Results showed a strong prototypical character. These descriptive prototypes are marked preference of the tasters, making them highly individual. Above all, they are highly indexed to wine color.

- The authors' descriptions and vocabulary are different.

- Classes are attached to preferences.

- The color segments the classes of all corpuses.

- The cultural information is present in sensory descriptions.

The influence of color on the perceptions of smell and taste of wine has been clearly demonstrated as well as the interference from the prototypical memory. Finally, the hesitant and unstable characteristic of representation has been confirmed as well as the highly interindividual variability (Brochet 2001).

Although the majority of sensory studies on wine are focused on particular scientifical aspects, some works use a global tasting assessment. A Spanish team asked a committee of 12 expert judges, specially trained in the employment of scales and aroma descriptors used, to fully evaluate (colour-nose-taste)

the same tempranillo wines from 4 different appellations aged in different oak casks. Samples were presented in standard glasses in random order. An unstructured 7-unit scale, in which 1 was “attribute not perceptible” and 7 was “attribute highly perceptible”, was used. The attributes selected by expert judges were related to visual, olfactory, and gustatory parameters, grouped in four families: descriptors of visual phase (color intensity, blue-violet, garnet-red, and red brown), descriptors of olfactive phase related to primary and secondary aromas and off-flavors (olfactive intensity, herbaceous/green, vegetal/cabbage, fruity, ripened fruit, sulfhydric, acetaldehyde, dirty/mold, oxidized, and reduced), descriptors of olfactive phase related to the wood-wine interaction (woody, vanilla, coconut, spicy, nutty, animal/leather, toasty, white coffee, chocolate, roasted, and wood-wine interaction), and finally descriptors of gustative phase (grease, acidity, astringency, green tannins, hard tannins, round tannins, dry tannins, and wine-wood interaction), and those were referred to as the overall sensory analysis (balance and global valuation). Data from all judges for all samples were used, and the average values were compared using the so-called “spider web diagrams”. In this diagram, the center of the figure represented the lowest average intensity, with the intensity of each attribute increasing to an intensity of seven at the perimeter (de Simon, Cadahia et al. 2008).

2.3.3 Review on Wine Colour

The first task in sensory assessment of wines is the judgment of its visual characteristics and its color. Wine is poured inside a standard tasting sampler filling one third of its capacity. The wine taster then assesses the color of wine holding the tasting sampler in front of a white background and tilting the glass ~45º. In this way, the wine surface adopts a rather oval shape inside the tasting glass, and the thickness of wine varies from ~30 mm in the center of the oval to negligible values near the border, called rim. This reveals a complete range of color nuances, which can be distinguished by the taster looking through the glass. Direct daylight is recommended for wine color evaluation but artificial illumination resembling the characteristics of daylight is also appropriate. After color assessment, all other sensory attributes are evaluated. The overall process heavily relies on the expertise of the wine taster. This expertise is acquired with adequate instruction and training and developed and improved with practice and experience. Not surprisingly, wine assessment is said to be an art. It requires from the taster innate qualities, preparation, and experience (Hernandez, Saenz et al. 2009).

Wine tasters use color terms such as ruby or garnet and frequently combinations of two terms to describe and classify red wine colors. Visual color appraisal is thus a classification process.

The aging of red wine gradually alters the purple hue of young wine to brick-red and is considered to render the tannins less astringent. The change in hue is related to the formation of more stable pigments such as vitisin A and B and their derivatives from grape anthocyanins, as well as oxidative browning (McRae and Kennedy 2011).

Phenolic compounds are one of the main determinants of the quality in red wines. Anthocyanins, which are the main compounds responsible for the color of red wine, are extracted from grape skins during the

maceration and fermentation processes. Other phenolic compounds present in skins and seeds are also extracted. Among these compounds, proanthocyanidins, also known as condensed tannins, are the main determinant of texture sensations such as body, bitterness, and astringency. During winemaking and ageing, phenolic compounds undergo progressive structural changes, which undoubtedly influence the organoleptic characteristics of the wine. In particular, anthocyanins, which are unstable, present a high chemical reactivity, which gives rise to new more stable pigments. Different mechanisms have been proposed to explain the formation of new pigments. Some of these involve the direct condensation of anthocyanins and flavanols without the participation of oxygen, but the most important reactions are probably those involving oxygen. During winemaking and aging, the presence of small quantities of oxygen leads to the formation of ethanal from ethanol. The ethanal can in turn react with flavanols to induce the formation of a very reactive carbocations that quickly react either with another flavanol molecule or with an anthocyanin, producing ethyl-bridged flavanol-flavanol or flavanol-anthocyanin oligomers. All these reactions result in a gradual shift in the color of the wine from the initial purple-red to a reddish-brown.

The flavylium cation (red) is the main anthocyanin structure in very acidic pH conditions, but its concentration decreases progressively as the pH increases, which in turn generates the appearance of the quinoidal base (blue) by deprotonation or the hemiketal form (colorless) by dehydration and deprotonation. This hemiketal can originate the chalcone form (slightly yellow) after the overture of the heterocyclic ring. Depending on the pH, anthocyanins can act as electrophiles in the flavylium form or as nucleophiles in the hemiketal form. Therefore, it is quite logical that the pH can influence the reactivity of anthocyanins to oxygen. The lower the pH, the higher the proportion of flavylium cation and, therefore, the higher the contribution of red-colored anthocyanins. (Kontoudakis, Gonzalez et al. 2011)

Colour indices and colour descriptors are obtained from absorbance measurements at a reduced number of wavelengths. The so called Glories parameters are obtained from absorbance values at 420, 520 and 620 nm: colour density (A420 + A520), colour tint (A420/A520), colour intensity (CI = A420 + A520 + A620), percentage of yellow (100 x A420/CI), red (100 x A520/CI) and blue (100 x A620/CI). Individual wavelengths have been also used to quantify colour changes in white wines. In particular the absorbance at 420 nm (A420) is used as a browning indicator.

Wine tasters describe colour using some specific colour names like Rubi or Garnet for red wine, Straw yellow or yellowish green for white wine and Raspberry or Redcurrant for rose´ wine. Although assigning wine samples to categories is straightforward, naming the categories becomes a delicate issue because there is no international agreement on the color vocabulary used to describe this product. For instance, the Spanish term ‘‘cereza’’ (cherry) is frequently used to describe the color of red wines. Even the names of different varieties of cherries are used. According to this and to avoid ambiguous names, recent studies have limited the use of colour names to those that are common in international publications. Although particular color names may differ between countries, there is general agreement that extreme hues for red wines are the violet hues, which can be found in very young wines made out of some grape varieties and the brown hues present in old wines, aged for years, or even decades.

Color Category
Violet–Purple
Purple–Ruby
Ruby–Garnet
Garnet–Brick red
Brick red–Brown

Table 2: Distribution of wine samples into color categories

It is known that the color of red wine evolves with ageing. In general, violet nuances are typically found in young wines while aged, older wines exhibit brick–red or brown tints.

There is a subjective component inherent to visual color assessment, particularly when no color reference standard is used for comparison and everything depends on experience, training, and personal abilities.(Hernandez, Saenz et al. 2009)

Although written in Portuguese, all the People's Guide editions (Coutinho 2011) and respective tasting notes have a colour characterization well aligned and compatible with the latest bibliographical findings.

2.3.4 Review on Wine Aroma

Regarding the determination of olfaction thresholds, a panel made up of 26 individuals whose ages ranged from 23 to 40 years was used. Samples of known concentrations of the odorants of a synthetic wine (11% v/v ethanol, 7g/l glycerin, 5g/l tartaric acid, pH adjusted to 3.4 with 1M NaOH) were prepared and assayed in triangular tests against blanks prepared with synthetic wine. In one series one sample contained the target compound dissolved in the synthetic wine and the other two samples were the synthetic wine, while in another series the presentation was reversed. The tests were performed with standardised wine tasting cups (ISO 3591:1977) following the directions given by AENOR (Asociación Española de Normalización, 1997). The lowest concentration of odorant that could be recognised by at least 50% of the individuals as different from that of the blank was taken as the threshold value (Ferreira, Lopez et al. 2000).

The odor of two varietal wines, Chardonnay and Melon de Bourgogne, were studied as sensory concepts. We tried to better understand from a cognitive as well as from a perceptual point of view, how the expertise level plays a role in the degree of overlap between the perceived odors of these two types of wine. The analysis of typicality judgments showed large differences between experts' and novices' mental representations of the two types of wine. Experts, unlike novices, showed well defined and common mental representation of the odor of these two varietal wines. No common mental representations emerged from the novices' typicality judgments. On the other hand, from a more perceptual point of view, the comparison of respective similarity spaces reveals that, experts and, to a lesser extent, novices tend to cluster the wines by grape variety. These results show clear conceptual differences between experts and novices and suggest perceptual differences as well (Ballester, Patris et

al. 2008). Recently, several papers have investigated color induced olfactory biases in wine tasting. Odor representations of red and white wines exist independently of a visual activation. In terms of wine description, a clear segmentation was obtained between white and red wines. White wines were described by yellow or orange odorant sources, while the red wines were described by dark odorant sources (Ballester, Abdi et al. 2009). Eighteen wines (six red, six white, and six rosé) were selected from a local supermarket. All wines came from different French vineyards, were from the 2005 vintage, and were considered as premium or popular premium. Only trained panelists carried out a free sorting task. Participants had first to smell each of the samples in the order in which they were presented. Then, participants had to sort the samples according to their odor similarity. Participants were allowed to make as many groups as they wished and to put as many wines as they wanted in each group. The description of the odor of the wines was carried out by the members of the trained panel. For each sample, participants were first asked to select at most five attributes among a list of 115 (Table 3). Then, they had to rate the intensity of the selected attributes on a five-point structured scale anchored between "very weak" (score=1) and "very strong" (score=5).

Fruity	
White fruits	Quince–apple–pear
Yellow fruits	Apricot/peach–melon
Nuts	Date–dried fig–prune
Dried fruits	Almond–walnut–hazelnut
Tropical fruits	Pineapple–banana–passion fruit–lychee–mango–coconut
Citrus fruits	Bergamot–lemon–orange–grapefruit
Red fruits	Cherry–strawberry–raspberry–redcurrant
Black fruits	Blackcurrant–blueberry–blackberry
Other fruits	Cooked fruits–candied fruits–Muscat–kernel/bitter almond
Floral	Wattle–chamomile–honeysuckle–orangeblossom–geranium–jasmine–lilac-rose–lime blossom–violet
Spicy	Anise/fennel–cinnamon–clove–curry–juniper berry–ginger–laurel–nutmeg–pepper–licorice–thyme–vanilla
Plant	
Vegetal	Artichoke–asparagus–cabbage–celery–green bean–bell pepper–olive
Other vegetal	Hay/dried leaf–herbaceous–pine/resin–menthol/fresh
Undergrowth	Mushroom–humus/earth–moldy
Burnt/woody	
Burnt	Caramel–roasted coffee/chocolate–toast
Woody	Fresh wood–smoke
Animal	Leather–meat extract–musk/civet–cat pee–wet dog
Others	Alcohol–Kirsch–butter–lactic–yeast–cookie–fruitdrop–honey–cider–rubber–cardboard–incense–ink–bitumen–flint–dust–sulfur–cold tobacco–sweat

Table 3: List of 115 attributes (translated from the original French used in the experiment) by odor families used for wine description (Ballester, Abdi et al. 2009)

All these new studies and findings cite the pioneer work of UC Davis Professor Ann Noble and her Wine Aroma Wheel which is an incredible tool to learn about wines and enhance one's ability to describe the complexity of flavour in red and white wines. The wheel has very general terms located in the centre (e.g. fruity or spicy), going to the most specific terms in the outer tier (such as strawberry or clove). These terms are not the only words that can be used to describe wines, but represent ones that are most often encountered. More recently, Prof. Ulrich Fischer researchers' team developed a specific wine aroma wheel for the german red wines (Fischer 1999).

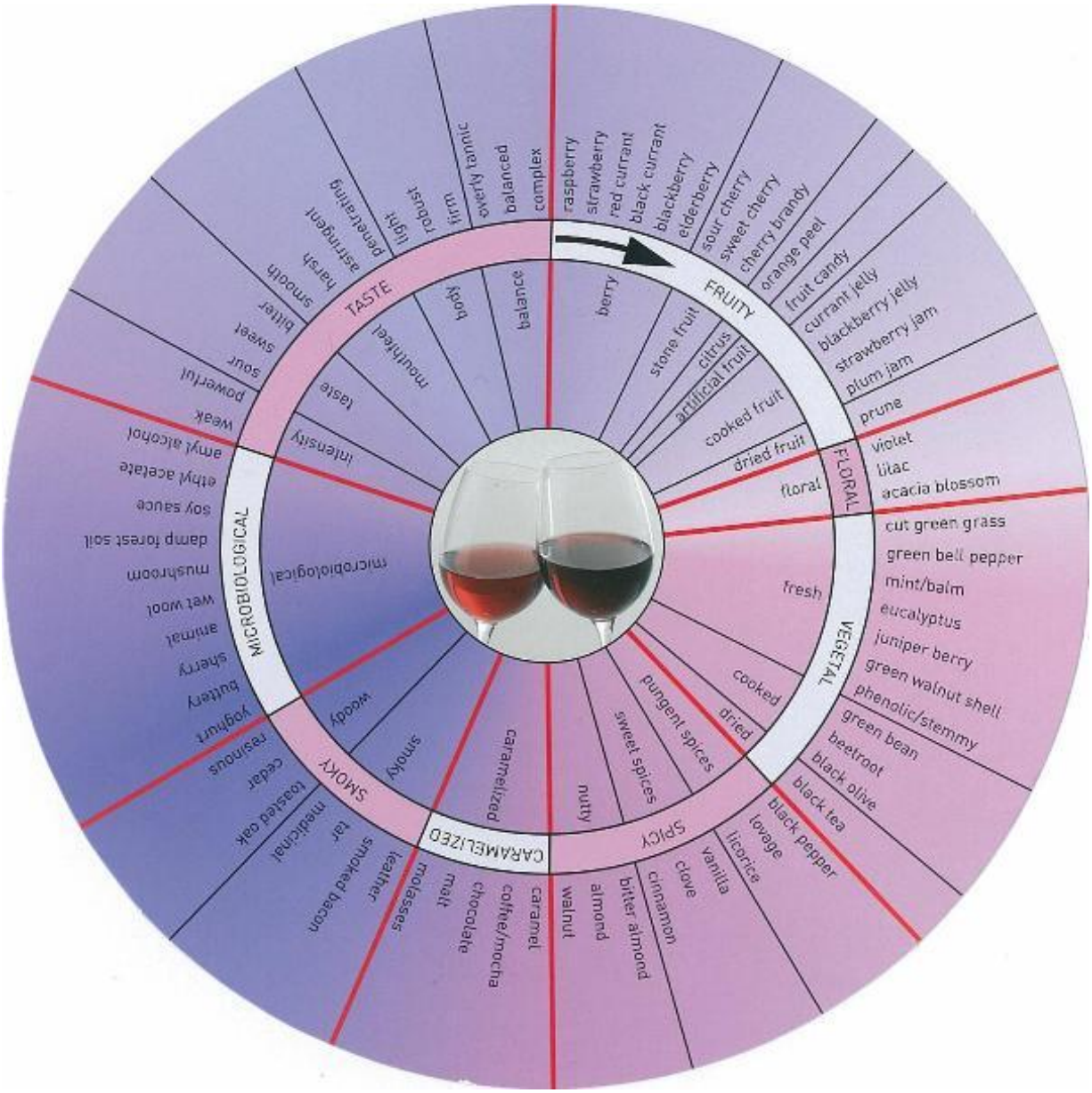

Figure 19: Aroma Wheel for German Red wines

2.3.5 Review on Wine Taste

An interesting essay (Coutier 1994) analyzed lexical tropes identified in hundreds of tasting notes through two sources of metaphors thematic fields: the field of the human body and that of spatial reality.

In the same way, Professor Émile Peynaud notes that we use language to attempt to make the imaginary real. He suggests tasters form “a physical image of the wine”, making it “feel like a substance with three dimensions”. Peynaud identifies a clear orientation among tasters to manifest a wine in structural and spatial terms. Tasters talk of (wine’s) contours and its architecture as though the liquid had a design, a particular surface texture, an internal structure. A wine’s ideal form is the sphere, which represents a space in perfect equilibrium. Also interesting, given contemporary interest in the metaphor of the body, is the anthropomorphic vocabulary used to describe wine in physical terms. Peynaud begins by addressing this issue as a category of “size” and “balance”, but the terms are a catalogue of anthropomorphic distinctions. Peynaud cites the following pejorative terms for light or insubstantial wines – ”thin, tenuous, slight, narrow, lean, skimpy, puny, gangling, and stunted” – and for full-bodied wines – ”stout, thick, heavy, fat, and podgy”. It is at this point in his book *Le Gout du Vin* that Peynaud is drawn to trying to represent wine vocabulary in graphic terms, in its own architectural arrangement. He offers structural models for the vocabulary of wine, placing the vocabulary in a matrix which attempts to pin down descriptive terms’ relationships to each other. If matching vocabulary to the taste of an actual wine is elusive, and the tasting competence or physical propensities of tasters is endlessly variable, perhaps the terms themselves can be placed in an objectively valid relationship to each other. Peynaud’s own scheme is spatial and orientational, but he cites another which attempts to place a vocabulary of wine terms describing ‘balance’ in wine in a spatial relationship to each other, as in Fig. 20 below:

It is interesting that only a few of these terms offer analogies with fruits or other substances we conventionally associate with bouquet or aroma (honeyed, bitter, sweetish). They are predominantly anthropomorphic, cast in our own image and, as we see below, often heavily gendered. It is noticeable in the diagram below that one of the 3 spectra we are offered is “masculine <-feminine”. The descriptions are easily recognised as standard stereotypes, with expressions like “harsh, thick, rough and robust” associated with masculinity, and “fleshy, unctuous, honeyed, soft, supple and cloying” associated with femininity (Bruce 1999).

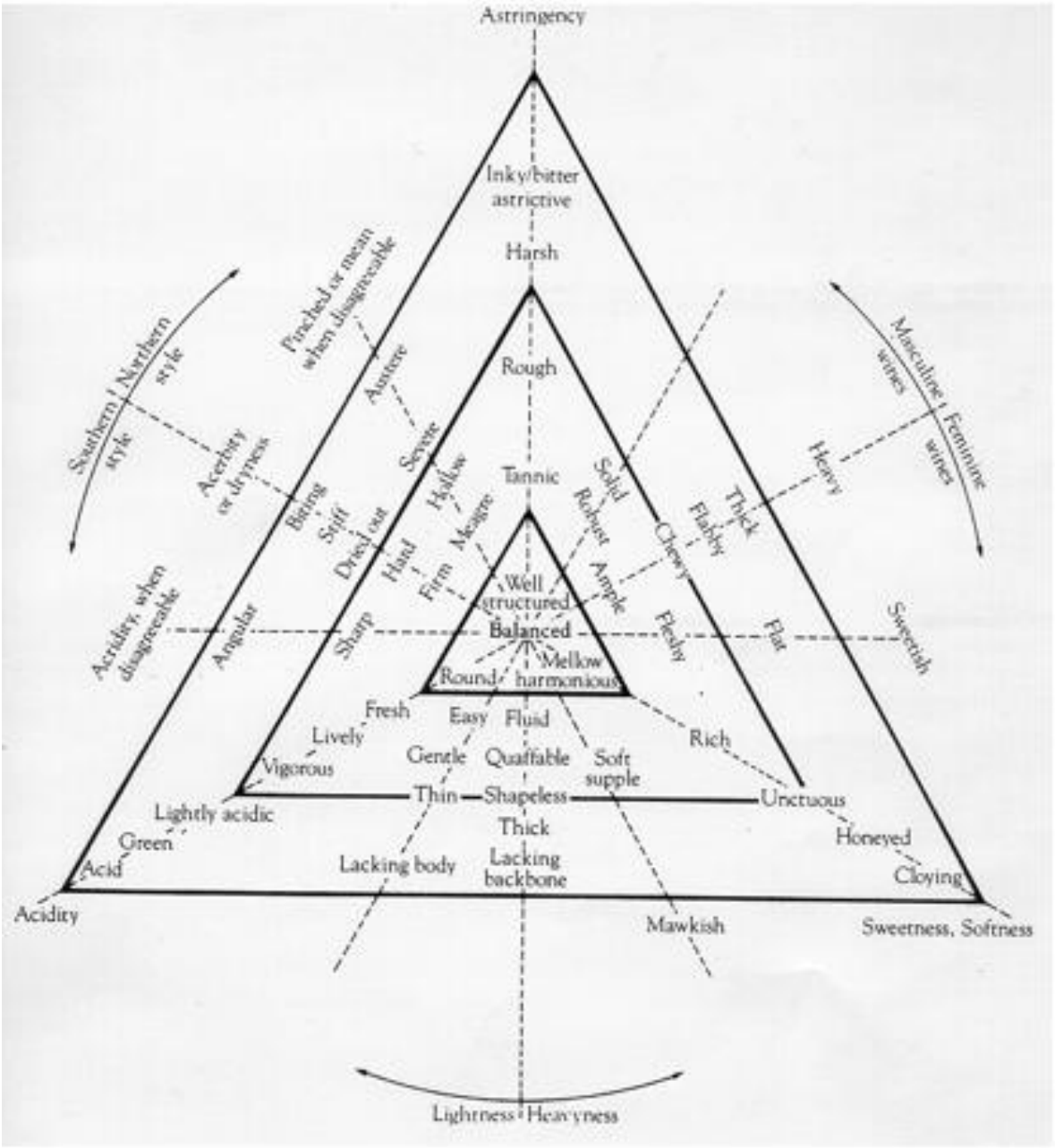

Figure 20: A graphic representation of terms relating to balance (after Vedel 1972)

Wine is renowned for the variety and complexity of sensations that it elicits. It is a visual (hue, intensity and clarity), olfactory (ortho- and retro-nasal aroma), taste (sourness, sweetness, bitterness, saltiness) and tactile stimulant. In the tactile 'domain' there are a range of qualities of relevance to wine, with perhaps 'mouthfeel' being the best known. Mouthfeel refers to the group of sensations characterised by a tactile response in the mouth, for which polyphenolic compounds (tannins) are the main elicitors in red wine (Table 5). Mouthfeel is widely recognised as an important quality indicator for red wine and may be an important component of overall consumer appeal (Gawel 2000).

Outer-tier descriptors Definition	Intensity terms/levels and scale anchor terms Standard type (oral, manual e conceptual assessment)
Sweetness	
Acidity	Sourness
Saltiness	
Tingle	A sense of irritation usually associated with carbonation
Pucker	A reflex action of mouth surfaces being brought together and released in an attempt to lubricate mouth surfaces
Mouth-water	A reflex reaction characterised by excess production of saliva
Expansion	The rate of mousse evolution and de-evolution in the mouth
Volume	The sense of fullness created by the mousse in the mouth
Persistence	How long mousse is retained in the mouth
Weight	The sensation of 'body' when the wine is stationary in the mouth
Viscosity	Varying degrees of viscosity from thin through to thick
Warm & hot	Differing intensity of heat sensation
Silk, satin and chamois	A surface texture of varying degrees of softness/smoothness
Emery & sharp	An increasing degree of roughness in surface texture
Talc, chalky, Plaster, grainy	Particulate sensations ranging from fine through to coarse particles
Numbing	Loss of sensation in the mouth
Baby oil, sunflower oil, olive oil	Mouthcoat sensation
Bitterness	
Dry & parching	An overall drying sensation as experienced by the loss of moisture in the mouth. Parching refers to the excess removal of moisture from the mouth
Short, medium and long	The persistence of any oral sensation

Table 4: Definition, intensity terms and reference standard type used for outer-tier descriptors of discrete sensations

With the use of the mouth-feel wheel© (Gawel 2000) wines with varying pH values and ethanol concentrations can be characterized in terms of astringent sub-qualities.

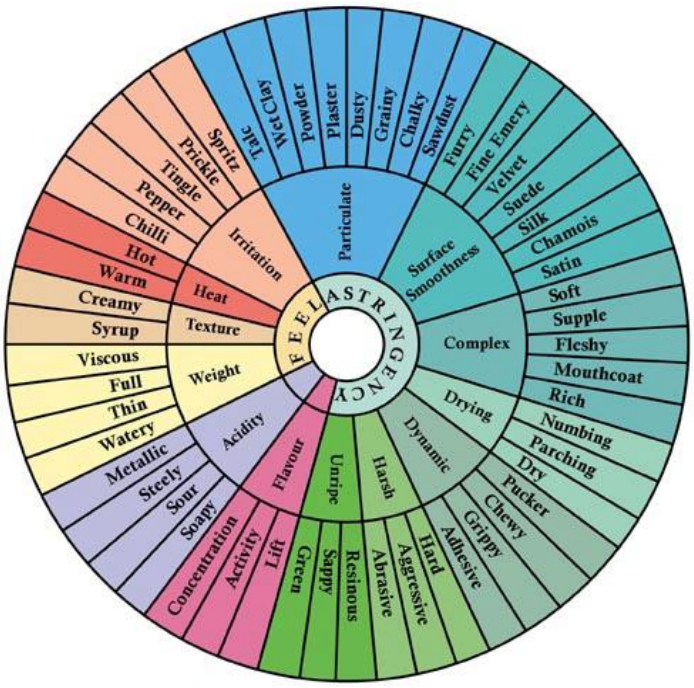

Figure 21: A 'Mouth-feel Wheel' showing a hierarchical representation of terms that can be used to describe the mouth-feel characteristics of red wine

A Portuguese study focused on profiling astringency as a response to different Degrees of Tannin Polimerization (mDP). A panel of experts assessed model solutions and the list of terms, from lower to higher mDP was : Soft/Salty; Chalky/Fine; Green; Hard/Chalky; Grippy/Rough/Clalky and Round/Soft (Vieira-de-Moura 2007).

2.3.6 The impact of wine zoning and typicality on sensory studies

The microclimate (canopy temperature, leaf and grape exposition) of vineyards may be positively or negatively influenced by macroclimate (geographical latitude and altitude, topography, relief) and mesoclimate (temperature, wind, precipitation, exposition, relative humidity). Since many viticultural and enological factors greatly influence the types and concentrations of flavour components, the ability to determine each individual component would provide an approach to optimise the operational conditions (Rocha, Rodrigues et al. 2004).

Sensory analysis may not be used as widely as it should because wine professionals think of it as a research tool rather than as a business tool. The integration of sensory and market research approach is critical to ensure the production of wine styles according to both consumer flavor and sociodemographic segments (Lesschaeve 2007).

Few studies have utilised sensory data alone or in addition to chemical data, to discriminate among wines according to their geographical origin (Sivertsen, Holen et al. 1999). The previously cited team demonstrated that French red wines could be differentiated according to region of origin using a sensory lexicon for wine.

Sun exposure is necessary for accumulation of monoterpenes, which may impart fruity, floral or spicy aromas. Several studies suggested that, at equivalent sugar concentrations, higher temperatures led to lower levels in white aromatic grape varietals thus potentially reducing aromatic intensity. Higher temperatures are also likely to exacerbate oxidative reactions in pre-fermentation stages (destemming, crushing, pressing, settling). The concentration of several precursors of aroma compounds containing thiol groups that have been identified as key odorants in grape cultivars such as Cabernet Sauvignon and Cabernet Franc, have been shown to decrease as a result of oxygenation (de Orduna 2009).

A relevant portuguese research on several wine regions showed strong differences on wine composition. Yield parameters were related to different cultivars and terroirs, such as quality parameters in grapes and musts. Sensory analysis revealed also, significant differences in the wines of the various plots, differences corroborated by the values obtained in some parameters of phenolic composition (Fernandes 2010). Total acidity rose from South to North while the pH rose inversely. Phenolic compounds (anthocyanins, total poliphenols and colour intensity) showed the lowest values in Alentejo (South) and their highest in the Dão appellation (Mountain & North Continental area).

Data from the Heliothermal Index (IH) showed that, on 2008, the Dão (Mountain & North Continental area) spot had the lowest levels (between 1500 and 1800), being considered a cold climate area. The

atlantic spots (Leiria, Lisboa and Lourosa) showed interim levels (between 1800 and 2400), and were classified as temperate climate areas. With IH levels between 2400 and 3000 and classified as hot climate regions, the higher results were obtained on the South Alentejo spots of Cabeção and Vidigueira. The freshness index (IF) and the drought index (IS) pointed inversely. The IF was higher on the northern spots (both atlantic and continental) and the IS was higher on the southern measurements. The content of pigmented anthocyanins was found to be highly related to the wine pH, in an inverse order. The alcohol level seems to have a slight increase, from North to South, in both cultivars (Fernandes 2010).

Another portuguese team showed that the content of antocianyns was significantly higher in the continental areas where the temperature amplitude was higher (15º night – 30º day) when compared with the atlantic areas with levelled temperature (Marques-da-Silva 2010).

On the southern hemisphere, a study on discrimination of Brazilian red wines according to the viticultural region, varietal, and winery origin showed that Wines made in the Vale do São Francisco (SF) had higher values of potassium (K), pH (pH), density (DEN), and volatile acidity (VAC). Figure 2 shows that wines from Serra do Nordeste A (SNA) were characterized by higher values of titratable acidity (TAC) and those from Planalto Superior B (PSB) by hue (HUE).

Wines made in São Joaquim (SJ), a somewhat colder and higher altitude viticultural region − about 1,200 m high −, had higher values of variables related to wine color and body. On the other hand, those from Toledo (T), State of Paraná, and from Vale do São Francisco (SF), States of Pernambuco and Bahia − this one a semi-arid region presenting high temperatures − had lower values. Phenols and anthocyanins are influenced by many factors, where night and day temperatures during ripening are especially important. The results showed that this region of São Joaquim has climatic conditions to produce wines with intense color and body. On the other hand, wines produced in high-temperature regions, such as Toledo (T), had opposite characteristics (Miele, Rizzon et al. 2010).

High temperature related increased potassium levels and lower total acidities have thus a combined effect on increased pH levels, that are now more frequently observed. Must pH values above 4 are readily reached in hot climates and have been recorded in traditional cool climates, too (de Orduna 2009).

In the Loire Valley, differentiated results were reached on different terroirs: 15% on sugar content, about 2 degrees alcohol, 63% on the malic acid, 38% on anthocyanins and 35% for the index of polyphenols (Morlat 2001). In the Loire Valley, a tasting of red wines from the various soils was conducted by a panel of thirty trained tasters. The data were interpreted using multiple factor analysis. The results were used to form three large groups of wines: whatever the vintage, the wines that presented more intense colour, aroma and taste derived from the specific soil where the harvest was richer in noble compounds. Inversely, the wines characterized by less intense sensory properties, all came from specific soils, particularly from the northern vineyards where the harvest was less rich in compounds such as sugars and anthocyanins.

The astringency of wine is influenced by a number of factors, including the structures and quantity of the tannin in wine, the presence of macromolecules such as polysaccharides and residual sugars, the concentration of smaller molecules such as anthocyanins and catechin monomers, the acidity and ethanol concentration. Tannins, including grape-derived condensed tannins (proanthocyanidins) produce sensations of astringency in food and drink and form the 'structure' or 'body' of red wine. (McRae and Kennedy 2011). A brief review about the chemical structure and related sensory properties of condensed tannins or proanthocyanidins is based on the written materials concerning *Bitter and Astringency* of the Instituto Superior de Agronomia's Master of Viticulture and Oenology (Ricardo-da-Silva 2011). Procyanidins and Prodelphinidins are oligomeric proanthocyanidins with interest in Oenology. Their monomeric units are represented in the table below.

Name	Name	R1	R2	R3
Procyanidin	**Catechin**	H	OH	H
Procyanidin	**Epicatechin**	OH	H	H
Prodelphinidin	**Gallocatechin**	H	OH	OH
Prodelphinidin	**Epigallocatechin**	OH	H	OH

Table 5: Procyanidin and Prodelphinidin Monomeric Strucures

Proanthocyanidins are high-molecular-weight polymers. Oxidative condensation occurs between carbon C-4 of the heterocycle and carbons C-6 or C-8 of the attached A and B rings (Figure 22).

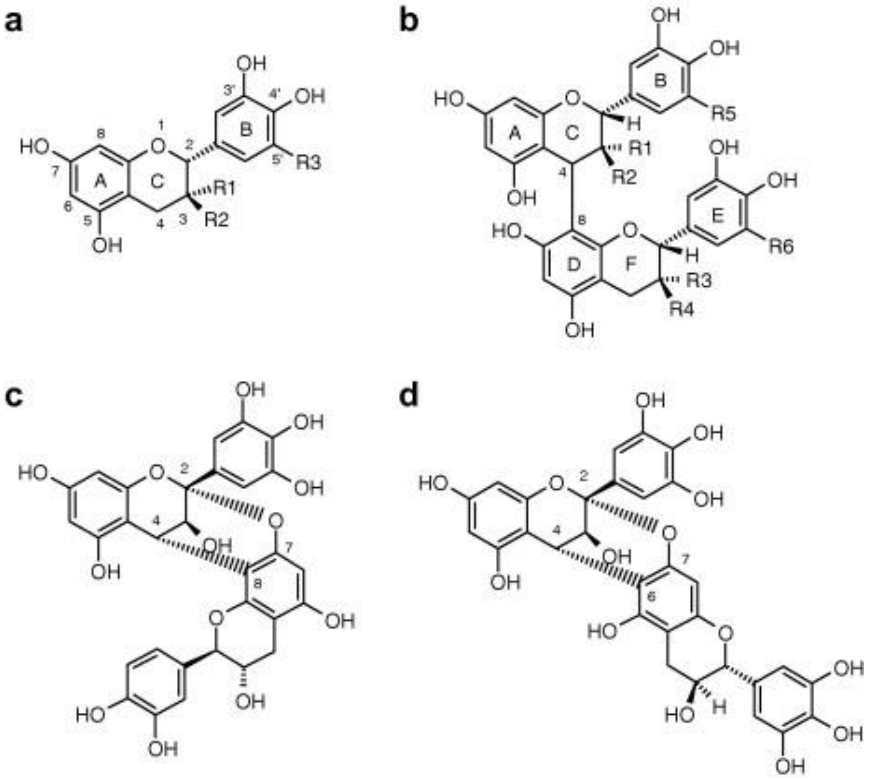

Figure 22: (a) Structure of the flavanol-3-ol units: (+)-catechin (R1 = H, R2 = OH, R3 = H), (-)-epicatechin (R1 = OH, R2 = R3 = H), (-)-gallocatechin (R1 = H, R2 = R3 = OH), and (-)-epigallocatechin (R1 = OH, R2 = H, R3 = OH); (b) B-type dimer proanthocyanidins C4–C8. Procyanidin: B3 (R1 = H, R2 = OH, R3 = H, R4 = OH, R5 = R6 = H); Prodelphinidins: B3 (R1 = H, R2 = OH, R3 = H, R4 = R5 = OH, R6 = H), B9 (R1 = OH, R2 = H, R3 = H, R4 = R5 = OH, R6 = H); (c) A-type dimer prodelphinidins: ent-epigallocatechin-(4a-8, 2a-O-7)-catechin and (d) A-type dimer prodelphinidins: ent-epigallocatechin-(4a-6, 2a-O-7)-catechin

Molecular sizes, and especially the monomeric composition of the proanthocyanidins, have a great influence on the sensation of astringency. More concretely, the greater degree of polymerization and the greater percentage of galloylation, will provoke a greater sensation of astringency (Carmen del Llaudy, Canals et al. 2008). Other studies have acknowledged the important relation between the Mean Polymerization Degree (mDP) of Proanthocyanidins and the sensory intensity of bitterness and astringency. It seems that bitterness shows a peak for medium level of mDP. (Lea 1985). An extensive review over this subject (Ricardo-da-Silva 2011), considering all the tannins in a given part of the grape cluster or the wine, revealed that mDP is higher on skin compounds (27-45), then on pulp compounds (18-21) and lower on Seed and Stem tannins (8-16). Studies with red wine have a 4 to 12 mDP and there is a study that reached 18 in the most polymerized fraction isolated (Sun 2001). The same review found that monomers and small flavanol oligomers are mainly bitter but at a high concentration they can also be astringent. Epicatechin was found to be more bitter than the catechin. Regarding astringency, in general, skin condensed tannins are less astringent than see and stem condensed tannins, at the same concentration; prodelphinidins proved to be more astringent than procyanidins (due to the third OH group in B ring); the gallic acid esterification at C_3 increased the astringent feeling; the linkage C_4-C_6 between monomers proved to be more astringent then the C_4-C_8 one. Combinations of condensed tannins with anthocyanins, for a given mDP, decreased slightly the astringency and bitterness (Ricardo-da-Silva 2011).

It is generally considered that ripeness strongly influences the phenolic composition of red wines. It has been reported, for example, that not-wellripen grapes have a lower extractability of anthocyanins and proanthocyanidins from skins and a higher extractability of proanthocyanidins from seeds. For this reason, it is generally considered that not-wellripen grapes may produce more astringent wines because their seeds can release a higher amount of proanthocyanidins, which are highly galloylated.

These data are in agreement with those of other studies and confirm the already described influence of ripening on anthocyanin extractability: the higher the degree of maturation, the greater the anthocyanin extraction.

These results also indicate that ripening has a great strong influence on proanthocyanidin extraction in all cluster components. Skins and stems generally release larger amounts of proanthocyanidins when the grapes are more mature, whereas seeds behave contrary.

Ripening generally had a great influence on astringency from all cluster components—the greater the degree of maturation, the lower the astringency. This behavior is more marked in the case of seeds. In the case of seeds there is a parallelism between the release of proanthocyanidins and final astringency—the higher the proanthocyanidin concentration, the higher the astringency. In the case of skins and stems, however, there is a no direct relation—proanthocyanidin release increases with maturation, but astringency decreases simultaneously. With the same mDP, the proportion of oligomers could be different affecting the astringency and bitterness. However, the release of skin

proanthocyanidins increases and astringency decreases along maturation. In this case, the mDP cannot explain this pattern because there are no clear changes in this parameter during ripening. A possible explanation may be that skins also contain polysaccharides and anthocyanins that can considerably modulate the final astringency of the medium (Carmen del Llaudy, Canals et al. 2008).

Results show differences between vines located on the West of Portugal from those located on the North of Portugal. Proanthocyanidins and catechin levels in varieties from the North were generally higher than those from the West (Atlantic) (Sun 2001).

While bitterness is an important attribute of red wines, it is often considered an undesirable attribute in white wines. Although bitterness is elicited by a wide range of chemical compounds, the primary source of bitterness in wine is generally thought to be phenolic compounds (Fischer and Noble 1994).

Ethanol enhances bitterness and hotness. Decreasing ethanol enhances astringency in red wines and sourness in white wines. Further, greater ethanol concentrations may also increase the lubricity of the oral cavity, reducing the perception of roughness. We still need to learn more about the specific role of ethanol in wine sensory, its role regarding typicality and its appreciation by consumers (Fischer 2009).

The application of time–intensity procedures was found particularly useful in the evaluation of astringency and bitterness of wine (Noble 1994). Trained judges rated the astringency and bitterness of catechin, gallic acid, grape seed tannins and tannic acid in white wine. They found that monomeric phenolic compounds were rated more bitter than astringent, while polymeric compounds were rated more astringent than bitter. The duration of aftertaste increased with the increasing concentration of test substances. Sucrose decreased both the maximum intensity and the aftertaste duration in red wine. Tartaric acid, on contrary, increased the astringency (Oberholster, Francis et al. 2009).

The pH of wine generally ranges from pH 3.2 to 3.8 and this difference is sufficient to elicit changes in astringency. Lowering the pH of wine and model wine solutions has been shown to increase the intensity of astringency as well as increase the association of tannins with proteins. This effect is more significant than increasing the concentration of individual organic acids such as malic, lactic and tartaric acid, however greater organic acid concentrations combined with greater acidity have been shown to contribute to the chalky characteristics of red wine. A combination of low pH and high organic acid concentration was also shown to be responsible for increasing the astringency of fermented coconut sap. Tannins have been shown to bind to residual proteins or polysaccharides in the wine matrix, thereby reducing the concentration available for salivary protein interaction and thus reducing astringency. This has been demonstrated in fruit, with the decrease in astringency of ripening fruit attributed to an increase in polysaccharides rather than a decrease in tannin concentration (McRae and Kennedy 2011). In other study (Jones, Gawel et al. 2008) ethanol and glycerol were the only factors with an apparent main effect on ‘bitterness’ although they were also implicated in a higher order interaction involving various combinations of polysaccharides, protein and volatiles. In general, ethanol enhanced ‘bitterness’ while glycerol suppressed it. Bitterness is one of the four basic tastes that the tongue is able to experience. The other three are sourness, sweetness and saltiness. The mouth's taste receptors that

take particular note of bitterness, are situated at the back of the tongue and on the hard palate. Various components have a bitter taste, inter alia phenols, certain ions, amino acids, peptides, alcaloids, acilated sugars, glycocides, nitrogen components and thiocarbamates. Astringency, as opposed to bitterness, is a tactile sensation that may also be ascribed to the occurrence of phenols. Astringency is also described as a puckering, drying out sensation in the mouth (Noble 1994).Higher ethanol resulted in increased palate 'dryness'. Samples higher in ethanol were perceived to produce a rougher palate sensation (Jones, Gawel et al. 2008).

The concentration of phenols in a wine has a direct influence on the bitterness, astringency and ageing potential of that wine. Factors that influence the phenol concentration of grapes (and therefore eventually the wine), are i.a. grape cultivar, region (cooler regions have higher phenol concentrations) and degree of ripeness of the grapes. If the stems are removed and the seeds are not damaged during the crushing process, phenols are extracted mainly from the skins. The total phenol concentration of red wines usually ranges between 1000 and 3500 mg/l. The incorporation of oxygen during fermentation and maturation accelerates the polymerisation of phenols. During maturation (a slow process of oxidation) polymerisation of phenols occurs, eventually resulting in precipitation of the polymers. Young red wines described as "hard" (bitter and astringent), benefit from the polymerisation process in that the bitter, lower molecular mass polymerises phenols during maturation to phenols with a higher molecular mass. Such wines are "softer" (less bitter and mainly astringent) during maturation (Noble 1994). The total phenol concentration of white wines, vinified with minimal skin contact, is between 100 and 250 mg/l. Phenols cause both an astringent and a bitter sensation in the taster. The influence of astringency therefore perplexes the observation of bitterness in the judges and there is also confusion about the two tastes. These factors confound research on bitterness. All phenol fractions are bitter as well as astringent. If the phenol fractions do not contribute independently to bitterness in wine, they might give rise to bitterness by synergistic action. The interaction between bitterness and astringency complicates the sensorial evaluation of bitterness, as well as the study of the effect of vinification techniques on phenols and the occurrence of bitterness. Not only do tasters differ physiologically in their ability to experience bitterness, bitterness is also influenced by the degree of sweetness and the alcohol concentration of the product (Louw 2001).

2.3.7 Type of panel: consumers versus trained professionals or experts

Peynaud warns against the indiscriminate use of the entire wine vocabulary available to us. He admits to there being, of the thousand-odd wine descriptors now available, around 470 words "which refer to taste characteristics". Again, he succumbs to the temptation to classify, distinguishing three discourse communities:

"the professional taster's vocabulary, the amateur presenting a wine to guests at a dinner tasting, (and) […] a wine journalist writing for the readers of a wine magazine."

He goes on to discuss “several ways of talking about the taste of wine depending on circumstances, training and the taster’s state of mind. The expert: seeks clarity and precision above all in his expression. His style is strict and economical but his comments are reasoned; his conciseness is not due to a lack of imagination but to a choice of the most precise words, and in his reports he only uses terms with an accepted and agreed meaning. In spite of his skill his language should be simple and intelligible to all. Where technical terms are concerned he will refrain from defining smells by analogy with little known chemical substances.”

Of “the more occasional taster” and “the informed amateur”, Peynaud has much less to say. They “do not always express themselves precisely. Their vocabulary is more limited, their style more full of imagery but less precise. They speak in metaphors and allusions, and not always in the best of taste. The inventiveness of their vocabulary conceals its vagueness.”

In his chapter on the vocabulary of taste Peynaud isolates a section on “the metaphorical language of taste”, his most interesting metalinguistic joust with the complexities of the language of taste. “Tasters’ language is made up of precise terms for concrete sensations: sweetness, acidity, bitterness, the smell of ethyl acetate, for example; and for more subtle sensations it consists of imprecise, but conventional, terms which attempt to define a balance of flavours. In the first case the word fits the perception well and is intelligible. In the second case, by trying to clarify the blurred image of their sensations, tasters are led to juggle with words.” Peynaud speaks positively of precise terms and concrete sensations, equating them with the scientific, with chemical compounds.(Bruce 1999)

One of the biggest challenges in consumer research is the clarification of consumer language. Consumers may use terms that are ambiguous, have multiple meanings, are associated with “good” or “bad”, or are combinations of several terms. These integrated terms, such as creamy”, are often used by consumers to represent a combination of positive attributes (Drake 2002).

In fact, for more than 50 years, the rule in sensory evaluation has been that a test must always be performed by a certain number of people. If it is already difficult to understand the meaning of one persons discourse, it is obvious that this difficulty increases when several speeches from different people must be interpreted and summarized. The ISO (5492:1992) defines ‘‘expert’’ as follows: In the general sense, a person who, through knowledge or experience, has competence to give an opinion in the fields about which he/she is consulted.

Nine wine experts tasted in replicate six Chardonnay wines that had been aged in oak barrels from different forests and/or species. They freely gave their descriptions in writing; the only instruction given was to underline three words or expressions that best characterized each tasted wine. The texts were submitted to an objective lexical analysis that quantified the important variation among the experts.The preceding results demonstrate that there are, among the experts, considerable variations and that these variations structure the corpus. This finding was expected: the differences among literary critics concerning the same book or among film critics regarding the same film are common examples. We did not think, however, that these differences would be so large. Additionally, the within-expert variations

are very large. The following discussion will examine to what extent the experimental conditions adopted for this experiment might explain this second conclusion (Sauvageot, Urdapilleta et al. 2006).

The aim of a recent american study was to investigate the concept of complexity in wine as a function of domain-specific expertise. Thirty-nine wine professionals and 30 wine consumers participated in interviews aimed at inducing verbal responses concerning their representations of (i) wine complexity in general, (ii) wine complexity in relation to white wine with perceived ageing ability, and (iii) wine complexity in relation to red wine with perceived ageing ability. The verbal data were analysed with the textual data analysis software ALCESTE. Results showed that wine professionals as a group tended to represent complexity in wine in terms of extrinsic factors such as oenological processes (e.g., lees stirring; use of oak) and terroir variables (e.g., soil). On the other hand, wine consumers' representations of wine complexity were dominated by intrinsic factors relating to their experience of consuming wine (e.g., smell and taste of wines) and were personalised and subjective (e.g., about their own enjoyment and pleasure) (Parr, Mouret et al. 2011).

Perrin (2008) performed napping methodologies in several experiments. Napping can be considered as a variation of a sorting task. Assessors were asked to place samples on a large sheet of paper, according to their similarities and differences between the samples. Perrin concluded that this technique gives a global sensory image and most important dimensions. Its repeatability has to be checked, as it was checked in her experiments and not achieved in all of them. The panellists were asked to describe the groups of wines they have sorted and they generated a lot of items. The wine map issued from this ultra-flash profile was interpretable and the main dimensions were close to those obtained with a sensory profile. Napping results were better linked to typical evaluation than the other methods (sensory profile and ultra-flash profile). Globally, the study demonstrated that the more freedom of the methods; the more the agreement is difficult to reach (Perrin, Symoneaux et al. 2008).

Tasting should be organized by a third party in an appropriate tasting room, wines should be served blind, tasters should not be informed of the purpose of the test, and individual tasting data and comments should be collected independently before any group discussion (Lesschaeve 2007).

Experienced winemakers, wine judges, and wine writers are considered wine experts by the public and by their peers. Moreover, the public views wine experts as people who can help them choose the right wine for the perfect occasion. Thomas and Pickering (2003) surveyed New Zealand wine consumers on the importance of information displayed on wine bottle labels. They found that when consumers examined wine labels to determine their purchase decisions, they first look for winery, then for brand name, and then for opinions of wine experts and awards and medals. But what is a wine expert? An expert is defined by American Society of Testing Materials as someone (often operating alone) with extensive experience in a product category who performs perceptual evaluations to draw conclusions about the effects of variations in raw materials, processing, storage, aging, and so on (ASTM 2005). However, it is expected that an expert would have a superior sensory acuity. Can wine experts make repeatable sensory assessments, assuming they would perform sensory tests according to established

standardized procedures? The literature is scarce on the repeatability of wine expert ratings. Trade publications do not report these data. Data from this author suggest that wine experts are likely to provide repeatable evaluations; however, their quality assessments are rarely aligned with other wine expert ratings (Lesschaeve, unpublished data). Wine experts tend to be more repeatable than novices in the vocabulary they use to describe wine, likely because of a superior olfactory memory performance (Parr, White et al. 2004). Wine experts would rely on prototypic description of wine ("I smell gooseberry therefore it is a Sauvignon blanc and I should also smell grapefruit and cat urine") instead of relying on their sensory perceptions at the time of the tasting (Lesschaeve and Noble 2010).

Sensory evaluation by expert wine tasters is used to distinguish wines of great diversity that do not conform to reference groups, defines as quality wines produced in a specified wine region as given in the EU legislation (Sivertsen, Holen et al. 1999).

CHAPTER 3: MATERIALS AND METHODS

The sensory characterization of the 12 Geographical Indications of Mainland Portugal deals poorly with operative methodologies that are based on physical evidence of wine samples. As shown in the literature chapter studies which result in recent publications are based on a limited basis to a few wine samples thus the sensory characterization of wide geographic areas, such as Designations of Origin or Geographical Indications, lack a statistical robust support. In this research, sensory outputs through the action of assessors in a tasting room were ruled out from the experimental design.

3.1 Experimental design

Maybe with innovative usage and, therefore, lacking more studies with similar methodologies, the experimental design was based on the application of extensive sensory profiling questionnaires, assessed by renowned winemakers and referenced scholars, opinion leaders, buyers and experts from the Portuguese wine industry. The debate about the differences between an expert panel and a consumer panel is well described in the previous literature chapter. The decision to invite a panel of experts is justified by the possibility of getting from these individuals a more complete and extensive cognitive knowledge about the sensory profile of certificate white and red wines in each of the 12 Geographical Indications of Mainland Portugal.

Invitations were made to 40 national referenced experts that during the months of May and June 2012 should individually answer to 24 sensory questionnaires, whose models for whites and reds certified as a Protected Geographical Indication (also called Regional Wines), were formulated on the basis of the literature cited above.

Within the scope of this thesis only the data for red wines was analyzed and results as well as conclusions were showed.

The default scale for sensory evaluation of the majority of descriptors assessed was 0 (corresponding to inexistent perceived intensity) to 10 (corresponding to full perception or intensity). Only in less than 10% of the questions was used a different scale, sometimes justified by literature (as in the question about the hue of the wine), other times by methodological issues (as in the question about the place of residence of each expert). Where used for statistical purposes the effect of different scales, despite very limited, has been taken into consideration.

Both questionnaires begin with three questions of self-control. The first refers to the region of residence of the taster or expert, while the second aims to assess the expert's level of knowledge regarding the scrutinized region (in the case of the most renowned experts, maximum or close-by scores would be expected). The third question seeks assessment of sensory panelists about the differentiation between certified wines with Protected Geographical Indication level and those certified to the level of Protected Designation of Origin, both within the scrutinized region.

The questionnaire was designed according to the approved International Organization of Vine and Wine method for sensory assessment of wines, thus it is divided in 3 blocks: visual sensations (COLOUR), the aromatic sensations (AROMA) and the gustatory and tactile sensations (TASTE). Adressing exclusively the possible upcoming of the academic work in this area of research, the survey ends with 6 questions that relate the profile of the scrutinized wines to their match with various types of meat, fish and traditional dishes.

The color was assessed in its intensity and in its tonality, with color patterns of red wines according to the latest studies cited in the literature chapter.

Aroma was evaluated for red wines with 1 overall measure for intensity and 18 aromatic descriptors tended to summarize significant amount of scientific research mentioned above, many of which already used in the form of aroma wheels (Fischer 1999).

The Taste of red wines, measured via tactile and gustatory sensations and cognitively memorized by the panel of experts was evaluated under 14 descriptors, including the classical essential tastes (sour, sweet, salty, bitter), and adding the result of recent work focused on the tactile sensations resulting from various types of bitterness and astringency and the sensations caused by caustic and drying alcohol sensations (Gawel 2000; Gawel, Iland et al. 2001).

The model questionnaire is showned in Annex 2.

3.2 About the Expert Panel

50% of responses were received, meaning 24 fully completed questionnaires per each Geographical Indication by 20 experts. The number of respondents is higher than the number of sample wines used in various studies cited in the literature review. The quality and expertise of the specialists are well expressed in the small and very undersized presentation of each panel expert, to whom the author deeply appreciates and thanks:

ANDRÉ MAGALHÃES	Leader of the Slow Food movement in Portugal, food&wine writer and wine judge at the Concours Mondial Bruxelles, restaurateur and wine manager.
ANTÓNIO BRAGA	Assistant Winemaker at Sogrape Vinhos, Portuguese Leading Wine Producer, doing wines in several wine regions.
ANTÓNIO MAÇANITA	Owner and Chief Winemaker at Fitapreta Vinhos, Consultant Winemaker doing wines in several portuguese wine regions.
ANTÓNIO VENTURA	Senior Consultant Winemaker doing wines in several portuguese wine regions.
FRANCISCO FIGUEIREDO	Chief Winemaker at Adega Regional de Colares. Consultant Winemaker doing wines in several portuguese wine regions.
FREDERICO VILAR GOMES	Co-Owner of Montecascas Vinhos, Consultant Winemaker doing wines in several portuguese wine regions.
HÉLDER CUNHA	Co-Owner of Montecascas Vinhos, Consultant Winemaker doing wines in several portuguese wine regions.
JOÃO CORREIA	Senior Winemaker at Companhia das Quintas, doing wines in several portuguese wine regions.
JOÃO PAULO GOUVEIA	Teacher at Viseu Viticultural School. Co-owner of Vines e Wines Consultants, doing wines in several portuguese wine regions.
JORGE RICARDO DA SILVA	PhD Professor at Instituto Superior de Agronomia, Lisboa. Chairman of the Portuguese Association of Oenology. Panel chairman in several international wine competitions.
LUÍS RAMOS LOPES	Director of Revista de Vinhos, the leading portuguese wine magazine.
LUÍS SOTTOMAYOR	Senior Winemaker at Sogrape Vinhos, Portuguese Leading Wine Producer, doing wines in several wine regions.
MANUEL MALFEITO	PhD Professor at Instituto Superior de Agronomia, Lisboa. Consultant Winemaker doing wines in several portuguese wine regions.
MÁRIO ANDRADE	Senior Consultant Winemaker doing wines in several portuguese wine regions.
MIGUEL GRIJÓ	Owner of IVIN, a distribution company working with wines from all portuguese wine regions.
MIGUEL PESSANHA	Chief Winemaker at Sogrape Vinhos, Portuguese Leading Wine Producer, doing wines in several wine regions.
NUNO CANCELA DE ABREU	Co-Owner and Chief Winemaker at Sociedade Boas Quintas. Senior Consultant Winemaker doing wines in several portuguese wine regions.
OSVALDO AMADO	Chief Winemaker at Dão Sul – Global wines, one of the biggest portuguese wine producers, doing wines in several wine regions.
PAULO LAUREANO	Owner and Chief Winemaker at Paulo Laureano Vinhos. Senior Consultant Winemaker doing wines in several portuguese wine regions.
RAFAEL NEUPARTH	Consultant Winemaker doing wines in several portuguese wine regions.
VIRGÍLIO LOUREIRO	PhD and retired Professor at Instituto Superior de Agronomia, Lisboa. Senior Consultant Winemaker doing wines in several portuguese wine regions.

3.3 Data Analysis

Over 20000 database entries were retrieved, placed in an EXCEL worksheet and subsequently analyzed using SPSS (Statistical Package for Social Sciences). SPSS is among the most widely used programs for statistical analysis in social science, and its main added value lies in the diversity of methods of data analysis it provides.

Univariate and bivariate analysis were performed in order to compare the characteristics of the twelve regions for the various sensory descriptors, followed by the completion of principal components analysis with varimax rotation, sought to explore the possibility of reducing the extended initial space of sensory descriptors on fewer dimensions - the main components. Based on the results achieved, new variables (indexes) that summarize the mean scores of the former highly correlated variables included in each component were built. The number of retained components was based on the Kaiser test (according to which the components with an eigenvalue greater than or equal to 1 are retained), and occasionally, the following component was still retained. This occurred when increasing the number of components considerably improved interpretability of those components, but only if the eigenvalue of the additional component to be retained was close to 1.

After reducing the initial space variables a new comparison of the 12 regions was made.

Given that the central hypothesis of this study has to do with the proximity of some regions in relation to sensory profiles, global research of this proximity was assessed by clustering. The cluster analysis is a group of multivariate techniques whose primary purpose is to assemble objects (in this case, IG red wines represented by each region) based on the (sensory) characteristics that they possess. Cluster analysis classifies objects so that each object is similar to others in the cluster with respect to a predetermined selection criterion. The resulting clusters of objects should then exhibit high internal (within-cluster) homogeneity and high external (between-cluster) heterogeneity. Hierarchical Cluster Analysis was applied in this research. Such method involves the construction the construction of a hierarchy of a treelike structure. Each object or observation starts out as its own cluster. In subsequent steps, the two closest objects are combined into a new aggregate cluster, thus reducing the number of clusters by one in each step. The process ends when all cases are grouped in a single cluster. It is up to the researcher to identify the best solution, ie what should be the final number of clusters retained (Grimm 2004). For this purpose, it is necessary to analyze the characteristics of the clusters during the various stages to decide when an interpretable solution or a solution containing a reasonable number of homogeneous clusters is reached. Because its application is more of an art than a science, however, it can easily be abused or misapplied by researchers. Different interobject measures and different algorithms can and do affect the results. Two of the most used grouping algorithms were tested: the "furthest neighbour" and "Ward", which led virtually to the same cluster solutions. Since not all the attributes or scales were identical, the author chose to standardize the input values.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Main research question or hypothesis

The starting point for this dissertation was the author's (published) statement that the red wines coming from 12 Protected Geographical Indications of Mainland Portugal didn't correspond to 12 different sensory, one for each Geographical Indication. On the contrary, and in agreement with the thought previously published by the author, sensory characterization of those 12 GI or Regional red wines could be grouped into three major macro-zonings that originate a much broader territorial reading. The author has published several Portuguese wine guides and, through those books and lectures, has tried to set an intermediate stage of three macro-regions that would encompass all Portuguese wine regions, generating three Portuguese wine profiles: the ***Atlantic wines***, born and raised in coastal fresh and humid climates; the ***Valley (or Mountain) wines***, from continental inland mountains, naturally concentrated and balanced; and the ***Southern wines***, typical round and sweet Mediterranean juices.

After a simple application of a qualitative content analysis of 3 editions of The People´s Wine Guide (Coutinho 2009; Coutinho 2010; Coutinho 2011), the author proposed a typical sensory characterization expressed in Chapter 1 as this research's hypothesis.

4.2 Degree of knowledge regarding the Geographical Indications

The level of knowledge and experimental validity of the panelists have been demonstrated previously, and the coming results will attest the robustness of the methodology and its usefulness in future studies. However, the answer to the question "To what extent do you know the sensory profile of wines from this IG?" raises questions which should be carefully considered by the wine industry, Universities and public administration.

Out of the 12 Geographical Indications of Mainland Portugal, 3 GIs, and in particular one of them, were considered unknown by a surprising number of tasters.

Due to a low mean of less than 4 (3.8/10) for the IG Terras de Cister regarding the panelist ability to produce a founded sensory assessment of its red wines, the author chose to withdraw the responses of experts who have declared a level of knowledge equal or lower than 3/10, for any Geographical Indication. In the case of IG Terras de Cister, respective means and all the data analysis considered only 10 valid surveys for red wines.

Considering the higher level of expertise gathered around this panel of wine professionals, results have showed a surprisingly low cognitive knowledge about 1 particular Geographical Indication: the smaller GI Terras de Cister and some focal distance regarding GI Algarve down on the extreme south and IG Transmontano up on the northern border. For IG Terras de Cister does not showcase its certified IG wines on any big or medium Portuguese retailer. However IG Algarve has s scarce number of listed

wines/producers nationwide and IG Transmontano wines stands midway from the previous regions. The future development of such small and unknown GIs should be discussed by the industry.

GI		KNOWLEDGE
AG	Mean	6,63
	N (Valid Surveys)	16
	Std. Deviation	1,893
AL	Mean	8,15
	N (Valid Surveys)	20
	Std. Deviation	1,348
BA	Mean	6,95
	N (Valid Surveys)	20
	Std. Deviation	2,235
D	Mean	7,90
	N (Valid Surveys)	20
	Std. Deviation	1,119
L	Mean	7,47
	N (Valid Surveys)	17
	Std. Deviation	1,068
M	Mean	6,79
	N (Valid Surveys)	19
	Std. Deviation	1,619
PS	Mean	7,82
	N (Valid Surveys)	17
	Std. Deviation	1,334
T	Mean	7,32
	N (Valid Surveys)	19
	Std. Deviation	1,529
TB	Mean	6,74
	N (Valid Surveys)	19
	Std. Deviation	1,821
TC	Mean	6,30
	N (Valid Surveys)	10
	Std. Deviation	1,418
TD	Mean	7,95
	N (Valid Surveys)	20
	Std. Deviation	1,468
TM	Mean	6,62
	N (Valid Surveys)	16
	Std. Deviation	1,204
Total	Mean	7,28
	N (Valid Surveys)	213
	Std. Deviation	1,620

Table 6: Univariate Statistics regarding answer about Experts knowledge on IGs Red Wines

4.3 Differences between GI (regional) and DO wines, on sensory profiles

Several studies cited in Chapter 2 confirm the close relationship of Designations of Origin with the notion of typicality. While the PDO and the PGI each bear a distinctive relationship to the place of production, each differs in the character of that relationship. The requirements for a protected designation (or appellation) of origin (PDO) are more stringent in so far as the product must not only originate in the place but its quality must be exclusively due to a particular geographical environment with its inherent natural and human factors. To qualify for a PDO, the product must be produced within

the specified geographical area, and the product's quality or characteristics must be 'essentially due to that area'. By comparison, the protected geographical indication (PGI) is broadly enough defined for most locally-based products to take advantage of its protection. The PGI requires the product to be produced, processed, or prepared in the geographical area, and the quality, reputation, or other characteristics to be generally 'attributable' rather than 'essentially due' to that area (Evans 2010). The international market and the majority of the key opinion leaders based its action on positive differentiation of wines certified as Designation of Origin. Appellations such as Bordeaux, Burgundy, Ribera del Duero, Rioja, Chianti have perceived value by consumers and deserve a premium regarding its price point. There was no evidence of scientific studies that relate this difference in prestige between the wines of Protected Designation of Origin (PDO) and wines of Protected Geographical Indication (PGI), known in Portugal as regional wines, and differentiation of their respective sensory profile One of the initial questions of the survey was seeking answers to a predicted differentiation between sensory profiles of wines of Protected Designation of Origin (PDO) and wines of Protected Geographical Indication (PGI), known in Portugal as Regional wines. In other words, considering that the geographical boundaries of a given Protected Designation of Origin (being more or less extensive) is always inserted in a determined Geographical Indication (eg. the Geographical Indication Lisbon includes, within its boundaries, smaller areas where wine production is allowed to label according to the most exclusive status of Designations of Origin, such as Colares or Bucelas), the answer to the question "Do the sensory profiles of DO wines found within this GI have a different characterization other than the one you will give to the IG or Regional wines?" may present clues as to the current state of typicality within mainland Portuguese wine regions and to the possibility of clustering or macro-zoning. The scale used followed the pattern of most sensory descriptors, with a score of 0 for the answer "Nothing Different" and a gradient up to the score of 10 for the response "Very Different".

The global means, by region and wine colour (including red and whites) deserve a closer look.

Geographical Indications	Main Designations of Origin	Whites Mean	Reds Mean
Algarve (AG)	Lagoa	1,50	1,25
Alentejano (AL)	Alentejo	1,95	1,90
Beira Atlântico (BA)	Bairrada	2,30	2,70
Duriense (D)	Douro	2.60	3,45
Lisboa (L)	Bucelas, Colares, Alenquer	4,32	2,82
Minho (M)	Vinho Verde	2,05	2,42
Península de Setúbal (PS)	Palmela	2,16	2,94
Tejo (T)	Do Tejo	1,63	1,16
Terras da Beira (TB)	Beira Interior	1,75	2,21
Terras de Cister (TC)	Távora - Varosa	1,69	1,50
Terras do Dão (TD)	Dão	2,21	2,50
Transmontano (TM)	Trás-os-Montes	1,29	1,81
Total 12 GIs		**2,17**	**2,27**

Table 7: Mean regarding DO vs IG wines different sensorial profile

The expert panel's assessment showed a significant similarity between the sensory profile of wines certified as Protected Geographical Indication (or Regional) and those certified as Protected Designation of Origin. The regions that scored higher in typicality of their Designations of Origin in relation to GI (or Regional) wines have, in general, a much limited number of DO authorized or dominant grape varieties. Perhaps this factor may justify the panel's assessment and inspire a broad national debate on the current position and future of Designations of Origin in Mainland Portugal.

4.4 Sensory characterization of red wines coming from all 12 Geographical Indications of Mainland Portugal

4.4.1 Evaluating the colour of red wines

Regarding the colour assessment parameters of GI (or Regional) wines, tonality (or hue) and intensity were evaluated. Being only two, those parameters were excluded from the principal components analysis and stood alone at that stage. Regarding the colour tonality, based on recent studies (Hernandez, Saenz et al. 2009) particular names of certain tonalities shift across wine countries. The Expert Panel was asked to choose one of four colour description as the most typical for the assessed region: Violet/Purple – corresponding to coding score 1; Purple/Ruby - corresponding to coding score 2; Ruby/Garnet - corresponding to coding score 3; Garnet/Brick Red - corresponding to coding score 4. As to colour intensity, it was assessed with the typical and most used scale 0-10 on this sensory survey. The different amplitude on both scales was taken into consideration during the application of all statistical data analysis techniques.

GI		Hypothesys	COR Ton	Tonality	COR intens
M (Minho)	Mean	Atlantic	1,11	Violet/Purple	8,58
D (Duriense)	Mean	Valleys	1,65	Purple/Ruby	7,55
L (Lisboa)	Mean	Atlantic	1,82	Purple/Ruby	6,35
BA (Beira Atlântico)	Mean	Atlantic	2	Purple/Ruby	5,65
TD (Terras do Dão)	Mean	Valleys	2	Purple/Ruby	6,6
TB (Terras da Beira)	Mean	Valleys	2,32	Purple/Ruby	6,16
TM (Transmontano)	Mean	Valleys	2,38	Purple/Ruby	6,25
TC (Terras de Cister)	Mean	Valleys	2,6	Ruby/Garnet	5,1
AL (Alentejo)	Mean	South	2,7	Ruby/Garnet	7,3
PS (Península de Setúbal)	Mean	South	2,76	Ruby/Garnet	6,24
T (Tejo)	Mean	South	2,84	Ruby/Garnet	6,32
AG (Algarve)	Mean	South	3	Ruby/Garnet	6,19

Table 8: Red Wine Colour Tonality and Intensity Means per Geographical Indication

In terms of colour evaluation, the expert panel confirms the clustering hypothesis in respect to hue or tonality. As most outstanding discrepancies, there is a very characteristic profile of GI Minho, certainly due to the presence of the dominant Vinhão inky red cultivar that gives a clear leadership in color

intensity. It is also the only region with a distinctive Violet/Purple assessment, associated with lower pH regions (Fernandes 2010; Kontoudakis, Gonzalez et al. 2011) and very young wines. The two remaining Atlantic regions (Beira Atlântico and Lisboa) were characterized by a Purple/Ruby hue, the same as all Central and Northern Portugal (except the small and unknown region of Terras de Cister), which confirms the aforementioned relationship of pH with tonality. The southern regions of Portugal, all characterized by a Ruby/Garnet tonality, confirming the increase of yellowish chalcone form anthocyanins in higher pH regions (Kontoudakis, Gonzalez et al. 2011), thus fitting the research hypothesis of macro-zoning and confirming not only the aforementioned relationships with higher pH and low acidity but also correlate with regions of higher temperatures (Miele, Rizzon et al. 2010).

4.4.2 Evaluating the aroma of red wines

Principal components factor analysis was carried out for the various sensory parameters that constituted the aroma characterization survey of red wines, in accordance with the most up-to-date bibliography. The results of this analysis suggest that several parameters can be grouped, since their variation is directly (or inversely) proportional, among them. Thus, the array of principal components can explain a statistically significant value of discrimination scored by the expert panel only with the proposed 5 groups, whose meaning and coherence with the sensory evaluation is explained after the table showing the inverted matrix of principal component analysis for aroma descriptors:

Rotated Component Matrix[a]

	Component				
	1	2	3	4	5
NOSE woody	**,814**	,054	,085	,151	,111
NOSE spice	**,674**	,020	,236	,154	,206
NOSE red	**,644**	,139	,088	-,253	,346
NOSE pastry	**,595**	,185	,012	,426	,040
NOSE caramel	**,492**	,442	,083	,433	-,219
NOSE black	,058	**,846**	-,131	-,140	,249
NOSE stone	-,027	**,809**	,054	,167	,048
NOSE raisin	,251	**,717**	-,092	,351	-,230
NOSE jam	,513	**,650**	-,200	,203	-,086
NOSE chemical	-,036	,064	**,757**	-,026	-,095
NOSE veg	,292	-,192	**,742**	-,157	,177
NOSE animal	-,012	-,024	**,733**	,307	,109
NOSE herbal	,231	-,160	**,709**	,094	,243
NOSE dry flor	,157	,058	,189	**,763**	,234
NOSE dry	,118	,206	-,009	**,691**	,216
NOSE flor	,304	,046	-,079	,077	**,784**
NOSE mineral	,110	-,091	,218	,208	**,697**
NOSE citrus	-,001	,177	,381	,290	**,574**

Table 9: Rotated Component Matrix regarding Red Wine Variables on Aroma

Group 1 includes the following aromatic descriptors: *Woody, Red (Fruits), Spice, Pastry and Caramel*, which may be grouped under the so called WOODY & SPICY profile. The 2nd Group joins the descriptors *Black (White), Stone (Fruits), Raisin, Jam*, and may be assigned to the RIPE FRUIT profile. Group 3 joins *Chemical, Veg (Vegetable or Green), Animal, Herbal* all included in the GREEN & OFF FLAVOUR profile. Group gathers just *Dried Fruits* and *Dry flower* easily recognized as members of the OVERRIPE AROMA profile. The 5th aggregate UNOAKED FRESH & MINERAL profile includes *Floral, Citrus (Fruits) and*

Mineral. The Author treated the intensity descriptor (NOSE intense) separately and chose to isolate it at this stage of the experimental design. Discriminative strength of the sensorial characterization results on the aroma, assessed by the Expert Panel and measured by the percentage of variance explained accumulates a value of 66.7% when the 5 main principal components are considered.

Total Variance Explained

Component		Initial Eigenvalues			Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**WOODY & SPICY**	4,8	26,5	26,5	2,7	15,2	15,2
2	**RIPE FRUIT**	3,2	17,9	44,4	2,7	15,1	30,3
3	**GREEN & OFF FLAVOUR**	1,5	8,5	52,9	2,5	14,1	44,5
4	**OVERRIPE AROMA**	1,3	7,4	60,3	2,0	11,2	55,6
5	**UNOAKED FRESH & MINERAL**	1,1	6,4	66,7	2,0	11,1	66,7

Table 10: Total Variance Explained by 5 Principle Components on Red Wine Aroma

These principal components are aligned with the methodologies used in various universities with expertise in wine sensory analysis and can be grouped according to a Cartesian system of dichotomous assessment of sensory profile:

X-axis GREEN & OFF FLAVOUR-RIPE FRUIT-OVERRIPE AROMA

Y-axis UNOAKED & FRESH MINERAL-WOODY & SPICY

4.4.3 Evaluating the taste of red wines

Principal components factor analysis was carried out for the various sensory parameters that constituted the taste characterization survey of red wines, in accordance with the most up-to-date bibliography. The results of this analysis suggest that several parameters can be grouped, since their variation is directly (or inversely) proportional, among them. Thus, the array of principal components can explain a statistically significant value of discrimination scored by the expert panel only with the proposed 4 groups, whose meaning and coherence with the sensory evaluation is explained after the table showing the inverted matrix of principal component analysis for taste descriptors:

Rotated Component Matrix[a]

	Component			
	1	2	3	4
TASTE grain	**0,879**	-0,073	0,071	0,122
TASTE rough	**0,862**	-0,216	0,154	0,075
TASTE astringent	**0,812**	-0,341	0,186	0,165
TASTE dry	**0,787**	-0,045	0,247	-0,186
TASTE sweet	-0,071	**0,886**	0,071	-0,092
TASTE alcohol	-0,299	**0,799**	-0,113	0,168
TASTE smooth	-0,163	**0,787**	-0,045	0,206
TASTE oily	0,044	**0,622**	-0,166	0,583
TASTE acid	0,492	**-0,621**	0,363	0,187
TASTE salt	0,084	0,025	**0,864**	0,009
TASTE bitter	0,393	-0,011	**0,715**	0,053
TASTE bubbly	0,167	-0,395	**0,572**	-0,209
TASTE length	0,188	-0,107	0,077	**0,862**
TASTE full body	-0,078	0,466	-0,1	**0,714**

Table 11: Rotated Component Matrix regarding Red Wine Variables on Taste

Group 1 adds Grain, Rough, Astringent and Dry taste, encompassing the evaluation of a rough sensations profile designated by DRY & ASTRINGENT. The 2nd Group joins the tastes Sweet, Alcohol, Smooth, Oily and (the inverted assessment corresponding to) Acid, and may be referred to as SWEET & VISCOUS. Group 3 includes Salt, Bitter and Bubbly to express the COASTAL & FRESH profile. Group 4 is composed only by Length and Full Body easily recognized as members of the PERSISTENT profile. The inverse assessment between acidity and the other SWEET & VISCOUS profile descriptors should be underlined, meaning that the experts panel sensory discrimination is inversely proportional with regard to sweet and sour tastes, i. e. when the Panel considers that a particular region is characterized by a high level of sweet taste, then the evaluation of the sour taste is proportionally lower in that region. The ability to discriminate the results of sensory characterization of taste expressed by the expert panel,

measured by the percentage of variance explained accumulates a value of 75.0% when considering the 4 main components.

Total Variance Explained

Component		Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**DRY & ASTRINGENT**	**5,4**	**38,4**	**38,4**	**3,4**	**24,2**	**24,2**
2	**SWEET & VISCOUS**	**2,7**	**18,9**	**57,3**	**3,4**	**24,1**	**48,3**
3	**COASTAL & FRESH**	**1,4**	**10,4**	**67,7**	**1,9**	**13,6**	**61,9**
4	**PERSISTENT**	**1,0**	**7,3**	**75,0**	**1,8**	**13,1**	**75,0**

Table 12: Total Variance Explained by 4 Principle Components on Red Wine Taste

These components reflect dichotomies that are aligned with the methodologies used in various universities with expertise in sensory analysis of wine, e.g. SWEET & VISCOUS vs. COASTAL & FRESH. On such groupings validated by this statistical technique some characteristics that may be related with the applied methodology were showed:

a) Despite the latest sensory studies, which led to discriminating and grouping sensory work presented in the form of wheels of taste (Gawel 2000; Pickering and Demiglio 2008), or by intensity lists with discriminating descriptors (Vieira-de-Moura 2007), the experts panel assessment tend to group the tactile sensations related to the rougher astringency in the same principal component DRY & ASTRINGENT, interestingly the more discriminating one, so those descriptors were answered, for each region, in the most proportional way.

b) The second principal component SWEET & VISCOUS aggregates the sweet taste as well as the tactile sensations related to a velvety astringency. In this research a more approachable and simple bi notation-scoring system was found to express the experts panel assessment on astringency - Rough vs. Velvety - which compare with the graduated and highly discriminating scales already cited and presented in the previous chapters.

c) The bitter taste was included amongst the principal component COASTAL & FRESH descriptors. Despite the significant contribution for the eigenvalues of the main components DRY & ASTRINGENT and SWEET & VISCOUS, bitter taste was assessed differently from astringent sensations, which might be perhaps something unexpected taking into account that the experimental design did not include a prior calibration phase of essential tastes and tactile sensations.

d) The absence of a prior phase of calibration to level the experts' cognitive assessment in relation to essential tastes and various tactile sensations of astringency may explain the dual assessment of astringency - Rough vs. Velvety - which resulted from data analysis of scores. Despite the logistical impossibility to set a calibration pre-stage to a panel that includes the

most distinguished and busy winemakers and opinion leaders of Portugal, a reflection envisaging the methodological enlargement will take place during the preparation of the next stages related to this area of research.

e) Looking to these resulting simplified assessment groupings, the academic world might consider evaluating new ways to relate sensory research and literature, chiefly the most applied for industrial and wine making use, with practical and efficient communication and feasibility skills, bearing in mind the limited availability or allocation of all sorts of resources.

4.4.4 Regional cluster composition of red wines according to assessed sensory profiles

On the basis of the statistical analysis earlier which resulted in aggregation of different initial sensory descriptors in principal components whose explanation can be found in the former sub-chapters and whose statistical validity was confirmed by the good results of the index of robustness designated by Cronbach's Alpha, always with values higher than 0.7, the table of means of all sensory variables that will be worked in a multivariate clusters analysis is presented in Annex 3.

The evaluation of sensory proximity of various Geographical Indications of Mainland Portugal was tested with the aid of multivariate statistical analysis, now applying the technique of clusters analysis. In the scope of this thesis, the validation of starting hypothesis was tested with the demanding participation of all the sensorial descriptors that resulted after the application of the principal components analysis. This ambitious mode should be considered with caution and merely exploratory, considering the encouraging results. In subsequent phases of research new data which will analyze partial and deeply the close relations between certain individualized and/or aggregates descriptors for the whole of Geographical Indications of Mainland Portugal will be detailed.

With the participation of all the sensorial descriptors that characterize the assessment of the wines of 12 Geographical Indications studied, structured in the main frame of the analysis of color, aroma and taste of the wine by a panel of specialists, we can see the graphic results in the form of dendrogram. The dendrogram is a graph in the form of tree where we can observe changes in the levels of similarity in successive clustering stages. The horizontal axis represents the level of similarity between wines from the different Geographical Indications and the vertical axis indicates each object of evaluation, i.e. the GI red wine profile.

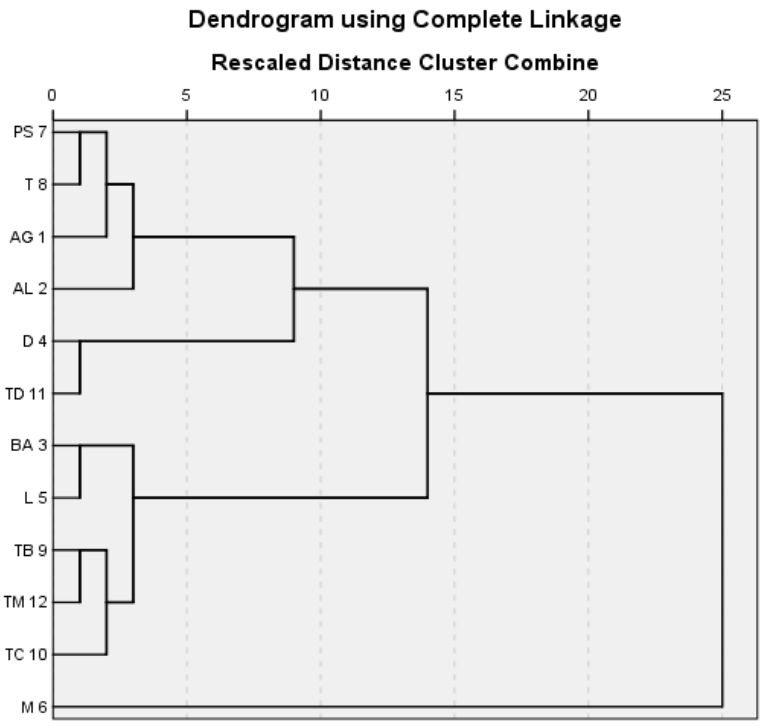

Figure 23: Red Wines Cluster Analysis Dendogram

The results show a first cluster of 4 Geographical Indications of Southern Portugal: Tejo, Península de Setúbal, Alentejano and Algarve. This data is encouraging and is aligned with the hypotheses of this dissertation. Regarding the discrimination between wines from the Atlantic regions and Mountain (or Valleys) wines the results of the aggregation do not confirm this distinction immediately. There is, however, one Atlantic region that shows a stand alone position amongst all GIs, reinforcing its extreme typicality: Minho and, according to the results in chapter 4.4.2., inner Designation of Origin Vinho Verde. For an accurate profiling based in 4 clusters, according to multivariate analysis proceedings, means by cluster are showed below:

	Sul de Portugal		Vales Centrais		Atlântico Temperado + Vales Periféricos		Atlântico Super Húmido		Total	
	Tejo Pen. Setúbal Alentejo Algarve		Duriense Terras do Dão		Beira Atlântico Lisboa + Terras da Beira Transmontano Terras de Cister		Minho		Total	
	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
COR_ton_mean	2,83	4	1,83	2	2,22	5	1,11	1	2,26	12
COR_intens_mean	6,51	4	7,08	2	5,90	5	8,58	1	6,52	12
NOSE_intens_mean	6,36	4	6,93	2	5,39	5	5,84	1	6,01	12
NOSE_youngwoody_mean	4,71	4	4,64	2	4,03	5	2,93	1	4,27	12
NOSE_overripe_mean	3,30	4	3,55	2	3,13	5	1,89	1	3,16	12
NOSE_freshmineral_mean	3,11	4	5,00	2	3,88	5	3,35	1	3,76	12
NOSE_ripefruit_mean	5,82	4	5,11	2	3,99	5	3,24	1	4,73	12
NOSE_greenoffflavour_mean	3,52	4	3,88	2	4,17	5	5,26	1	3,99	12
TASTE_dry_astringent_mean	3,67	4	4,82	2	5,12	5	6,43	1	4,70	12
TASTE_sweetviscous_mean	6,11	4	5,09	2	4,12	5	2,43	1	4,80	12
TASTE_persistent_mean	5,59	4	6,88	2	5,72	5	5,03	1	5,81	12
TASTE_coastalfresh_mean	1,80	4	1,75	2	2,35	5	3,79	1	2,19	12

Table 13: Red Wine Sensory Descriptor Means and number of regions (N) per immediate cluster

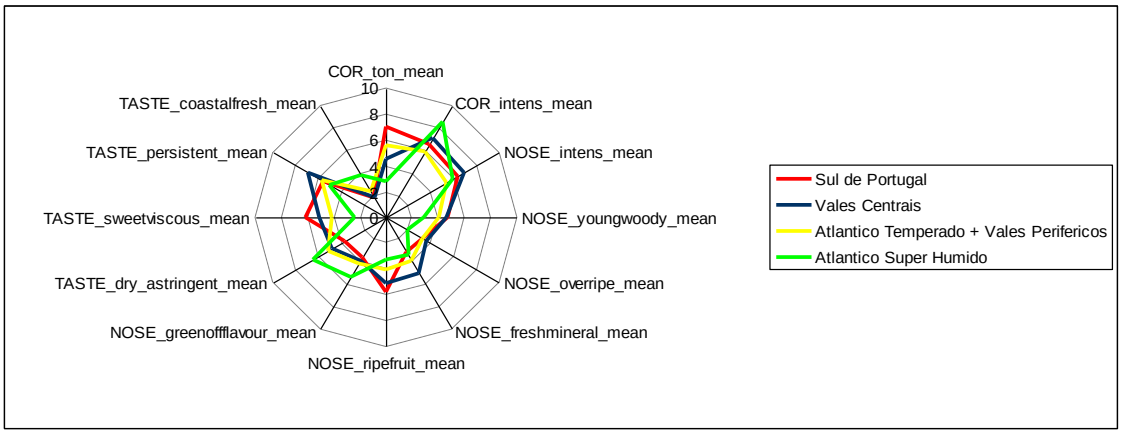

Figure 24: Web representation of Red Wine Sensory Descriptor Means per immediate cluster

It is interesting to compare the regions grouped by sensorial descriptors with the literature on bioclimatic characterization of Continental Portugal (Magalhães 1995; Costa 1998; Fernandes 2005). There seems to be a scenario of three major influences but, according to the aggregation sequences, with some sub-segments already referred to in chapter 2.1.3. It is justifiable to begin the analysis of sensory aggregation by the stand alone GI Minho, very interesting and of typical relevance amongst all

the regions of mainland Portugal. In fact, according to the expert's assessment, the red wines (GI Minho and DO Vinho Verde, on the basis of sensory similarity declared by the respondents) of Minho present, since the demanding and discriminating initial phase of statistical measurements on all sensorial descriptors, a separation line that guarantees a unique character and typicality amongst all Geographical Indications. This result is aligned with bioclimatic research studies (Magalhães 1995) that confirm the extreme maritime influence and justify the territorial description of GI Minho as ATLÂNTICO SUPER HÚMIDO (the cited author calls Coastal Super Humid). Following the initial upper aggregation of the 4 regions of the SUL DE PORTUGAL (Península de Setubal with Tejo; both with Algarve and the three with Alentejano) the next cluster segment puts together the 2 most well-known GIs from the continental Valleys mountainous zoning (Douro with Terras do Dão). This sub-segment was called VALES CENTRAIS (Central Valleys). The close relations between the former six regions standing together in decision tree at interim clustering stages are, certainly, supported by more than one sensory factor. The dendogram shows a first sensory cleavage between the 6 previous regions and the remaining. The first group that appears on the lower half of the diagram includes 2 Atlantic regions (IG Beira Atlântico and IG Lisboa). Based on bioclimatic cited research, this segment will be named ATLÂNTICO TEMPERADO. The 3 last regions from the mountainous inland Valleys (Terras da Beira with Transmontano and both with Terras de Cister) join together in a sort of peripheral undiscovered inner GIs (considering the specialists lower cognitive level (Knowledge <=3)) and shall be named VALES PERIFÉRICOS. To test the proposed sensory and territorial segmentation, lower central cluster was split into 2 sub-segments: ATLÂNTICO TEMPERADO + VALES PERIFÉRICOS.

	Sul de Portugal		Vales Centrais		Vales Periféricos		Atlântico Temperado		Atlântico Super Húmido	
	Tejo Pen. Setúbal Alentejo Algarve		Duriense Terras do Dão		Terras da Beira Transmontano Terras de Cister		Beira Atlântico Lisboa		Minho	
	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N
COR_ton_mean	2,83	4	1,83	2	2,43	3	1,91	2	1,11	1
COR_intens_mean	6,51	4	7,08	2	5,84	3	6,00	2	8,58	1
NOSE_intens_mean	6,36	4	6,93	2	5,44	3	5,33	2	5,84	1
NOSE_youngwoody_mean	4,71	4	4,64	2	3,95	3	4,16	2	2,93	1
NOSE_overripe_mean	3,30	4	3,55	2	3,15	3	3,12	2	1,89	1
NOSE_freshmineral_mean	3,11	4	5,00	2	4,00	3	3,70	2	3,35	1
NOSE_ripefruit_mean	5,82	4	5,11	2	4,19	3	3,70	2	3,24	1
NOSE_greenoffflavour_mean	3,52	4	3,88	2	3,86	3	4,62	2	5,26	1
TASTE_dry_astringent_mean	3,67	4	4,82	2	4,91	3	5,45	2	6,43	1
TASTE_sweetviscous_mean	6,11	4	5,09	2	4,39	3	3,71	2	2,43	1
TASTE_persistent_mean	5,59	4	6,88	2	5,88	3	5,48	2	5,03	1
TASTE_coastalfresh_mean	1,80	4	1,75	2	2,01	3	2,87	2	3,79	1

Table 14: Red Wine Sensory Descriptor Means and number of regions (N) per justified cluster

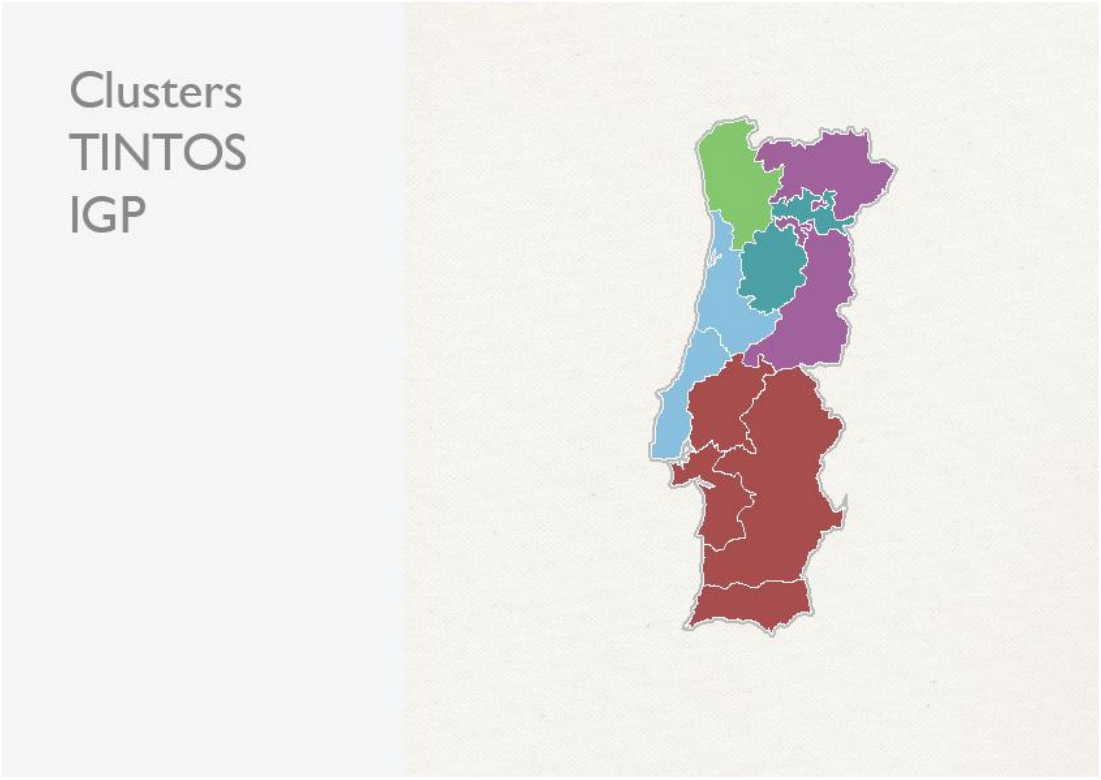

Figure 25: Portugal Map with Red Wines IG Cluster representation by colour

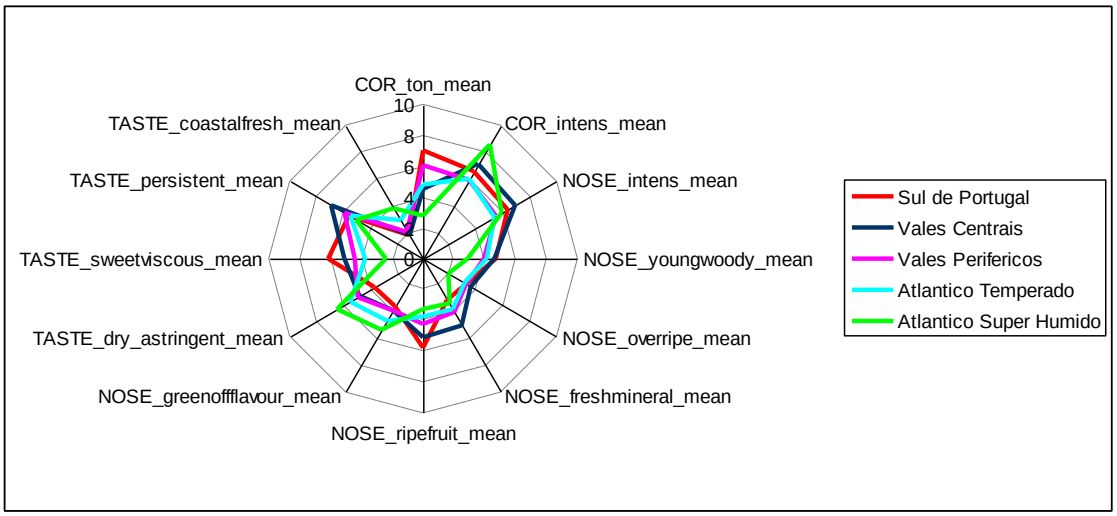

Figure 26: Web representation of Red Wine Sensory Descriptor Means per immediate cluster

Means by aggregate descriptor reveal some characteristics that sustain the fast clustering dynamics encompassing the 4 **SUL DE PORTUGAL** IGs and help envisaging a typical sensory profile:

a) Color tonality is fully inclined to the Ruby/Garnet choice, related to warm climate viticultural regions, namely semi-arid mediterranean (Magalhães 1995; Fernandes 2010).

b) The aroma profile shows na intense raisiny and jammy black and stone fruit character (NOSE_ripefruit_mean= 5,82) opposite to a low mineral, floral and citrus fruit presence (NOSE_freshmineral_mean= 3,11). Higher in aromatic intensity (NOSE_intens_mean= 6,36) and welcoming frequent woody, spicy and young yeasty red fruit notes (NOSE_youngwoody_mean= 4,71).

c) Taste characterization shows clear typicality on sweet and oily intensive textures, higher alcohol driven tactile sensations, weekness of fresh acidic taste and tannin smoothness (TASTE_sweetviscous_mean= 6,11). Lowest levels of dry, astringent, rough and grain tannin-related mouthfeel are frequent (TASTE_dry_astringent_mean=3,67) in these medium bodied and fairly persistent southern red wines (TASTE_persistent_mean= 5,58), showing one of the lowest levels (TASTE_coastalfresh_mean= 1,80) of salty, bitter and bubbly sensations (thus, a good example of what Portuguese consumers generally call *Vinhos Maduros (ripe wines)*).

Initial hypothesis of a single sensory profile covering the mountain or **VALES DE PORTUGAL** red wines did not find confirmation from the experimental design results. Instead 2 geographically neighbour sub-segments did show sensory proximity as explained below. Therefore sensory profiles of **VALES CENTRAIS** (Duriense and Terras do Dão) and **VALES PERIFÉRICOS** (Terras da Beira, Transmontano and Terras de Cister) will be described.

VALES CENTRAIS macro-zoning was presented as an immediate clustering output. According to the cluster analysis method, and referring to the related aggregate means, sensory profile may be explained with the following characterization:

a) Color tonality is typically Purple/Ruby (COR_ton_mean= 1,83), which is characteristic of fresh/cool climate continental regions, with extreme thermal amplitudes (Fernandes 2010), explaining one of the highest color intensities (COR_intens_mean= 7,08).

b) Red wine aromatic intensity reaches the highest peak in VALES CENTRAIS (NOSE_intens_mean= 6,93). Also the mineral character, as well as floral and citrus fruit notes, maybe related with Touriga Nacional cultivar (Terras do Dão e Duriense) and Touriga Franca cultivar (Duriense), show maximum heights (NOSE_freshmineral_mean= 5,00). Average, but leading, presence of dried fruits and flowers (NOSE_overripe_mean= 3,55) point out to a heterogeneous mountain side with significant gaps in altitude and semi-arid locations near the Spanish border (Magalhães 1995), which may explain similitude with the Southern regions, as witnessed in the clustering dendogram (Fig. 23). Other proximities with the South occur on higher raisiny and jammy black and stone fruit aromas (NOSE_ripefruit_mean= 5,11) frequent woody, spicy and young yeasty red fruit notes (NOSE_youngwoody_mean= 4,64).

c) Taste characterization shows clear typicality based on the extremely long mouthfeel persistence, which relates with the highest assessment on the body dimension of these rock-solid concentrated reds from VALES CENTRAIS (TASTE_persistent_mean= 6,88), matching closely the neighbouring peripheral valleys. Average sweet and oily textures, levelled with alcohol driven tactile sensations and medium fresh acidic taste and tannin smoothness (TASTE_sweetviscous_mean= 5,09) are also comparable to the neighbouring peripheral valleys, and the same applies to dry, astringent, rough and grain tannin-related medium (TASTE_dry_astringent_mean= 4,82). Linking with southern reds, wines from VALES CENTRAIS, showed one of the lowest levels (TASTE_coastalfresh_mean= 1,75) of salty, bitter and bubbly sensations (thus, a good example of what Portuguese consumers generally call *Vinhos Maduros (ripe wines)*).

VALES PERIFÉRICOS macro-zoning was presented as a sub-segment of an immediate clustering output. According to the cluster analysis method, and referring to the related aggregate means, sensory profile may be explained with the following characterization:

a) Color tonality of red wines was assessed in an interim level between Purple/Ruby and Ruby/Garnet (COR_ton_mean= 2,43), halfway from fresh regions and warm regions typical hues. In fact, this peripheral setting includes a vast macro-zoning border which may explain bigger color amplitude. Also color intensity (COR_intens_mean= 5,84) got the lowest score. Color evaluation, with all the subjectivity that a shortened scale and the absence of a prior phase of calibration encompass, sets a significant difference between the VALES PERIFÉRICOS wine profile and neighbouring central valleys.

b) Aromatic intensity of VALES PERIFÉRICOS red wines is one of the lowest amongst all macro-zonings (NOSE_intens_mean= 6,44), setting another difference with neighbouring central valleys and proximity relations with the Atlantic regions, although scoring means don't show

enough discrimination. A global mountainous character, matching the neighbouring central valleys was found on the medium-high mineral, floral and citrus fruit assessments (NOSE_freshmineral_mean= 4,00). Aggregate descriptors referring to medium low ripe aromas (NOSE_overripe_mean= 3,15), (NOSE_ripefruit_mean= 4,19) and moderate woody, spicy and young yeasty red fruit notes (NOSE_youngwoody_mean= 3,95) may be considered interim values between neighbouring mountain regions and coastal Atlantic fresher profile, giving room to mountainous profile with even bigger presence of fresh aromas and lower fruit ripeness.

c) Taste characterization shows clear typicality based on the extremely long mouthfeel persistence, which relates with the second highest assessment on the body dimension of these medium-high concentrated reds from VALES PERIFÉRICOS (TASTE_persistent_mean= 5,88), matching closely the neighbouring cenral valleys. Average sweet and oily textures, levelled with alcohol driven tactile sensations and medium fresh acidic taste and tannin smoothness (TASTE_sweetviscous_mean= 4,39) are also comparable to the neighbouring central valleys, and the same applies to dry, astringent, rough and grain tannin-related medium (TASTE_dry_astringent_mean= 4,91). Low levels (TASTE_coastalfresh_mean= 2,01) of salty, bitter and bubbly taste are close enough to the global profile from the aggregate valleys but the slight increase suggests a fresh link towards the Atlantic regions, and some typicality on the acid-fresh mountainous sensory profile.

Initial hypothesis of a single sensory profile covering the coastal or **ATLÂNTICO DE PORTUGAL** red wines did not find confirmation from the experimental design results. Instead 2 geographically neighbour sub-segments did show sensory proximity as explained below. Therefore sensory profiles of **ATLÂNTICO TEMPERADO** (Beira Atlântico e Lisboa) and **ATLÂNTICO SUPER HÚMIDO** (Minho) will be described.

ATLANTICO TEMPERADO macro-zoning was presented as a sub-segment of an immediate clustering output. According to the cluster analysis method, and referring to the related aggregate means, sensory profile may be explained with the following characterization:

a) Color tonality is typically Purple/Ruby (COR_ton_mean= 1,91), which is characteristic of fresh/temperate climate humid regions, with low to mild amplitudes (Fernandes 2010), thus the color intensity shows one of its lowest results (COR_intens_mean= 6,00), despite its average score.

b) The aromatic profile encompasses several similar characteristics which are common to both Atlantic sub-segments. Its overall intensity (NOSE_intens_mean= 5,33) is significantly decreasing, reaching the lowest point in the ATLÂNTICO TEMPERADO profile. Going down are all ripe and jammy fruit notes (NOSE_ripefruit_mean= 3,70) as well as dried fruits and flowers (NOSE_overripe_mean= 3,12). Mineral, floral and citrus fruit aromas are also in loss (NOSE_freshmineral_mean= 3,70) but these fresher notes are merely second to the profiles from the valleys. Also the unoaked drive (until the next Atlantic sub-segment) was found on the

moderate woody, spicy and young yeasty red fruit notes (NOSE_youngwoody_mean= 4,16) and increasing leadership of green, vegetable and herbal aromas, possibly related to fresh and timid ripeness, as well as chemical and animal notes (NOSE_greenoffflavour_mean= 4,62).

c) Along the transitional path that will drive us to the extreme northwest Atlantic, the ATLÂNTICO TEMPERADO reds present typical gustatory characteristics such as medium to high intensity (TASTE_dry_astringent_mean= 5,45) of dry, astringent, rough and grain tannin mouthfeel related to greener ripeness (Sun 2001). The freshness profile is magnified by the higher presence of salty, bitter and bubbly (carbonic gas) sensations. (TASTE_coastalfresh_mean= 2,87). In the opposite way, decreasing of persistence and thiner body evaluation (TASTE_persistent_mean= 5,48) and, chiefly, the loss of sweet and oily textures, lower alcohol driven tactile sensations and reduction of tannin smoothness (TASTE_sweetviscous_mean= 3,71). With the former aggregate measure, significant increase of fresh acidic taste, which is included in the inverted way, is also typical of the ATLÂNTICO TEMPERADO profile.

ATLÂNTICO SUPER HÚMIDO, as stated previously, presented the highest primary typicality assessments, according to the cluster analysis results, isolating the unique GI Minho and its strongly correlated inner DO Vinho Verde. Means by aggregate measure reveal some characteristics that sustain the fast clustering dynamics and help envisaging a typical sensory profile:

a) Minho typicality shows immediately by the color characterization. A extreme young Violet/Purple hue (COR_ton_mean= 1,11), is heavily related with fresh/cool climate regions (Magalhães 1995). What seems extremely typical is the unforeseen highest color intensity amongst all Geographical Indications (COR_intens_mean= 8,58), certainly due to the presence of the dominant Vinhão inky red local cultivar. Color evaluation encompasses a significant typicality that isolates the ATLÂNTICO SUPER HÚMIDO profile from all others.

b) The aromatic profile encompasses several similar characteristics which are common to both Atlantic sub-segments, but more extreme. After an average overall intensity assessment (NOSE_intens_mean= 5,84), extreme lows are found in ripe and jammy fruit notes (NOSE_ripefruit_mean= 3,24) and dried fruits and flowers almost are inexistent (NOSE_overripe_mean= 1,89). Red wines seem to go unoaked, with extreme low presence of woody, spicy and young yeasty red fruit notes (NOSE_youngwoody_mean= 2,93). Average presence of mineral, floral and citrus fruits notes are aligned with neighbouring Atlantic regions (NOSE_freshmineral_mean= 3,35). Highest peak of green, vegetable, herbal, week ripeness related aromas and strong chemical and animal note are to be found (NOSE_greenoffflavour_mean= 5,26).

c) Located on the extreme Northwest corner of Mainland Portugal, the ATLÂNTICO SUPER HÚMIDO sensory profile presents typical gustatory characteristics such as the highest intensity (TASTE_dry_astringent_mean= 6,43) of dry, astringent, rough and grain tannin mouthfeel

related to greener ripeness (Sun 2001). The freshness profile is magnified to its peak by the highest presence of salty, bitter and bubbly (carbonic gas) sensations. (TASTE_coastalfresh_mean= 3,79). Inversely, light bodied wines with average persistence also show typicality (TASTE_persistent_mean= 5,03) as well as the lowest assessment on sweet and oily textures, lower alcohol driven tactile sensations and reduction of tannin smoothness (TASTE_sweetviscous_mean= 2,43). With the former aggregate measure, maximum increase of fresh acidic taste, which is included in the inverted way, is also typical of the ATLÂNTICO SUPER HÚMIDO profile.

CHAPTER 5: CONCLUSIONS AND FUTURE RESEARCH

5.1 Conclusions

Production and trading of wine is secular in Portugal. Since the beginning of Portuguese cartography there has been a concern for geographical definition of viticultural and wine producing regions. Subsequent boundaries or limits were drawn and changed on the basis of public-private interests, not without the loss of an accurate timeline and documented evidences, giving the amount of entities involved, since the monarchy, through the republican revolution and new-state dictatorship, until the young democracy and the communal supra-national policies within the European Union.

Today, there are 12 Protected Geographical Wine Indications in Mainland Portugal. This means that consumers have a potential access to a overall wine shelf encompassing 12 white wines and 12 red wines from different regional upbringing, labelled as VINHO REGIONAL and certified as INDICAÇÃO GEOGRÁFICA PROTEGIDA (PGI). Matching the European wine architure, there are, within those extended wine producing regions, smaller demarcations that, on the basis of self-explanatory and long history of local art of making outstanding wines with unique methods, cultivars, viticultural handcraft work, may produce exclusive wines certified as DENOMINAÇÃO DE ORIGEM PROTEGIDA (PDO).

In such a small country as Portugal, does the actual range of 12 GI or REGIONAL wines correspond to a decision making process based on 12 unique and typical wine sensory profiles, so different one another that clearly fit alone on the cognitive memory – in opposition to the emotional or affective one – in the consumers mind?

The starting point for this dissertation was the author's (published) statement that the red wines coming from 12 Protected Geographical Indications of Mainland Portugal didn't correspond to 12 different sensory profiles, one for each Geographical Indication. On the contrary, and in agreement with the thought previously published by the author, sensory characterization of those 12 GI or Regional red wines could be grouped into three major macro-zonings that originate a much broader territorial reading. The author has published several Portuguese wine guides and, through those books and lectures, has tried to set an intermediate stage of three macro-zonings that would encompass all Portuguese wine regions, generating three Portuguese wine profiles: the ***Atlantic wines***, born and raised in coastal fresh and humid climates; the ***Valley (or Mountain) wines***, from continental inland mountains, naturally concentrated and balanced; and the ***Southern wines***, typical round and sweet Mediterranean juices.

Sensory characterization of each profile was condensed from thousands of descriptive tasting notes that were statistically grouped by the MAXDictio program, which enabled word counting according to its frequency.

Maybe with innovative usage and, therefore, lacking more studies with similar methodologies, the experimental design was based on the application of extensive sensory profiling questionnaires, assessed by 20 renowned winemakers and referenced scholars, opinion leaders, buyers and experts from the Portuguese wine industry.

Within the scope of this thesis only the data for red wines was analyzed and results as well as conclusions were showed.

Over 20000 database entries were retrieved, placed in an EXCEL worksheet and subsequently analyzed using SPSS (Statistical Package for Social Sciences). After the application of various statistical techniques the results support some conclusions that seem to indicate a valid and until now little explored field of research. Among various conclusive findings, the following may worth some attention:

a) Certainly justified by the Portuguese secular art of making and trading wine and the long path filled with public-private interests regarding the delimitation of mainland Portugal wine regions, the present boundaries of the 12 Geographical Indications, assessed by the typicality of their 12 REGIONAL wines were sensory validated once all GIs showed differences with significant statistical meaning (at least in 1 descriptor) which was verified by the ANOVA method, considering one fixed factor – the Geographical Indication – and considering data regarding all 40 descriptor queries. Evidence was found, however, of proximities, some extremely strong, which multivariate statistical methods will validate and due results will sustain the existence of sensory aggregations between GIs and extended geographical clusters or macro-zonings with similar sensory profile.

b) Considering the higher level of expertise gathered around this panel of wine professionals, results have showed a surprisingly low cognitive knowledge about 1 particular Geographical Indication: the smaller GI Terras de Cister and some focal distance regarding GI Algarve down on the extreme south and IG Transmontano up on the northern border. For IG Terras de Cister does not showcase its certified IG wines on any big or medium Portuguese retailer. However IG Algarve has s scarce number of listed wines/producers nationwide and IG Transmontano wines stands midway from the previous regions. The future development of such small and unknown GIs should be discussed by the industry.

c) The expert panel's assessment showed a significant similarity between the sensory profile of wines certified as Protected Geographical Indication (or Regional) and those certified as Protected Designation of Origin. The regions that scored higher in typicality of their Designations of Origin in relation to GI (or Regional) wines have, in general, a much limited number of DO authorized or dominant grape varieties. Perhaps this factor may justify the panel’s assessment and inspire a broad national debate on the current position and future of Designations of Origin in Mainland Portugal.

d) The application of Multivariate Principal Components Analysis to a vast majority of the survey descriptors aimed to characterize the aroma of red wines, thus compiled according to the most

recent studies reviewed in the literature chapter, showed a significant simplification of discriminating measures that was found sufficient for the panel specialists and represent an important aggregation of sensations which, a priori, the scientific community tend to discriminate. In the case of red wine, the aromatic intensity (NOSE_intens_mean), which does not respond qualitatively, rather quantitatively, was kept isolated from the 18 initial aroma descriptors, finally grouped into five main components: **NOSE_overripe_mean, NOSE_youngwoody_mean; NOSE_greenoffflavour_mean, and NOSE_freshmineral_mean NOSE_ripefruit_mean**.

With small rearrangements, explained in the previous chapter of Results, it was possible to find an aggregate sensory measurement that resulted coherent and significantly discriminating. The simplification procedure was based on the panelists' assessments and should deserve a closer look and debate by the scientific community regarding the use of highly specific and less obvious sensory descriptors unable to find a proper understanding and extended use by the industry. This concern is finding increasing support within the scholar world itself (Quandt 2007; Loureiro 2012).

e) The application of Multivariate Principal Components Analysis to a vast majority of the survey descriptors aimed to characterize the gustatory and tactile taste of red wines, thus compiled according to the most recent studies reviewed in the literature chapter, showed a significant simplification of discriminating measures that was found sufficient for the panel specialists and represent an important aggregation of sensations which, a priori, the scientific community tend to discriminate. In the case of red wine the 14 initial taste descriptors were finally grouped into four main components: **TASTE_dryastringent_mean; TASTE_sweetviscous_mean; TASTE_coastalfresh_mean e TASTE_persistent_mean.**

With small rearrangements, explained in the previous chapter of Results, it was possible to find an aggregate sensory measurement that resulted coherent and significantly discriminating. In the next sub-chapter attention will be given to the absence of a pre-stage calibration test. However the simplification procedure was based on the experts' assessments and should deserve a closer look and debate by the scientific community regarding the use of highly specific and less obvious sensory descriptors unable to find a proper understanding and extended use by the industry, chiefly on tannins tactile range of descriptors.

f) The application of multivariate cluster analysis to the whole array of single and aggregate sensory measures has confirmed the existence of macro-zoning sensory proximities which, partly, confirmes this research initial hypothesis and, more important, validated the scope of the present assay confirming a valid investigation line. The REGIONAL red wines in mainland Portugal results led to a sensory aggregation around 4 clusters, which explanatory sensory characterization may be found in chapter 4: SUL DE PORTUGAL (IG Península de Setúbal + IG Tejo, IG Alentejano, IG Algarve); VALES CENTRAIS (IG Duriense + IG Terras do Dão); ATLÂNTICO

TEMPERADO (IG Beira Atlântico + IG Lisboa) grouped with VALES PERIFÉRICOS (IG Terras da Beira, IG Transmontano, IG Terras de Cister); ATLÂNTICO SUPER HÚMIDO (IG Minho).

Sub-segments of the central cluster were segregate in ATLÂNTICO TEMPERADO and VALES PERIFÉRICOS with discriminating and significant results, mainly on the color evaluation and the taste assessment. Sensory description of referred 5 profiles found scientifical support on literature review of various specific areas of sensory, viticultural, oenological and bio-climatic knowledge.

Such results, although more refined, show promising similitude with the initial research hypothesis.

g) Regarding the color evaluation, the expert panel's judgement was fully related to the final aggregations of several Geographical Indications in fewer clusters. According to the most recent studies on wine color, the following table illustrates the proven dominant pairings between tonality and color intensity and the resulting sensory profiles.

Geographical Indication		Hypothesys	COR Ton	Tonality	COR intens	Perfis
M (Minho)	Mean	Atlantic	1,11	Violet/Purple	8,58	ATLÂNTICO SUPER HÚMIDO
L (Lisboa)	Mean	Atlantic	1,82	Purple/Ruby	6,35	ATLÂNTICO TEMPERADO
BA (Beira Atlântico)	Mean	Atlantic	2	Purple/Ruby	5,65	
D (Duriense)	Mean	Valleys	1,65	Purple/Ruby	7,55	VALES CENTRAIS
TD (Terras do Dão)	Mean	Valleys	2	Purple/Ruby	6,6	
TB (Terras da Beira)	Mean	Valleys	2,32	Purple/Ruby	6,16	VALES PERIFÉRICOS
TM (Transmontano)	Mean	Valleys	2,38	Purple/Ruby	6,25	
TC (Terras de Cister)	Mean	Valleys	2,6	Ruby/Garnet	5,1	
AL (Alentejo)	Mean	South	2,7	Ruby/Garnet	7,3	SUL DE PORTUGAL
PS (Península de Setúbal)	Mean	South	2,76	Ruby/Garnet	6,24	
T (Tejo)	Mean	South	2,84	Ruby/Garnet	6,32	
AG (Algarve)	Mean	South	3	Ruby/Garnet	6,19	

Table 15: Red Wine ColourDescriptor Means per GI in relation to justified cluster

h) In a small country such as Portugal, encompassing a low yield viticulture and a dominance of old vines in small parcels owned by even smaller producers, scientific research studies on macro-zoning, namely on sensory profiles of GI or REGIONAL certified wines, may be considered of value added and may contribute to the debate of scale factors that might result in significant gains in areas such as wine certification (3 to 5 certification boards instead of 12), admission of trans-regional wine certification for high volume brands (ATLÂNTICO PT, VALES PT and SUL PT) and a better and clearer communication and marketing that would reach a higher group of consumers with less information.

5.2 Limitations and future research

Although the results might be considered encouraging regarding forward research within this unexplored sensory profiling line of investigation, several hazards and limitations must be stated and discussed:

a) For experimental designs which deal with physical wine samples, assessed in an adequate tasting room, several studies agree that the application of sensory surveys including a significant array of color, aroma and taste measurements must be preceded by a calibration pre-phase applied to all tasters. In the present research and related experimental design the tasters were asked to assess and reply to sensory questionnaires on the basis of their ample and referenced cognitive knowledge. The Expert panel encompasses leading Professionals that produce, assess, trade and study wines from several Portuguese wine regions in a daily basis. Methodological questions over efficacy and validity of this research results, based on the pretext that a calibration pre-stage was mandatory, are accepted not without a sense of impracticability considering the expert panel timeline. Such dilemma will be discussed in subsequent stages of this research.

b) The application of a survey to evaluate the sensory profile of wines certified as Protected Geographical Indication may be considered innovative as much as adventurously bold, considering the territorial extension of some GIs and the enormous amount of wines, cultivars, producers and winemakers. João Paulo Martins, one of the leading wine critics in Portugal, refused to integrate the Expert panel "because" he wrote "there isn't just one style of red and white wine in each region, therefore I do not know what should be my average assessment on aroma, taste or food pairing". However, macro-zoning sensory profiling must be designed with ample and grouping innovative techniques once the tasting room discriminating methods always work on the basis of no more than a few wines, thus lacking territorial validity, as was stated by several research teams (Vaudour 2005).

c) 50% of responses were received, meaning 24 fully completed questionnaires per each Geographical Indication by 20 experts. The number of respondents is higher than the number of sample wines used in various studies cited in the literature review. However, the Expert panel will be increased considering the coming research new steps.

d) In this research, sensory profiling validity and results where found on the basis of an overall global and most demanding input of the whole array of descriptors regarding COLOR, AROMA and TASTE. Discussion of segmented results regarding dual sensations (COLOR vs. AROMA or AROMA vs. PALATE) or single descriptors (TASTE_Astringent vs. TASTE_Bitter) will be presented during the following stages of this research.

e) The sensory questionnaires included 6 questions regarding food and wine pairing. Those surveys ended with 6 questions about the scrutinized GI wine and its match with several types of meat, fish and traditional local food. The issue may seem inadequate considering the

standard thresholds, but the close relation of food and wine pairing in a cultural eat-with-wine country such as Portugal deserves a thorough study.

f) In the next step of this research, the experimental design used to profile GI or REGIONAL red wines from mainland Portugal will be replicated for white wines and results will be showed and discussed accordingly.

The current moment of Portugal and its Wines should be seen as a mere photograph placed on a secular diary filled with transcendent memories that crossed generations and all Portuguese families. Diary's coming events will be of enormous added value for Portugal's wealth and living quality standard. This dissertation, like a photograph, may be an open window through which the Portuguese wine industry may foresee new research and working processes.

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ANNEX 1

Word frequency

Word	Word length	Frequency	%	AT MINHO TINTO CASTAS	AT LISBOA TINTO CASTAS	AT BBAIRRADINAS TINTO CASTAS
lote	4	36	31,58	3	18	15
baga	4	20	17,54	0	0	20
touriga-nacional	16	18	15,79	0	11	7
syrah	5	10	8,77	0	8	2
castelão	8	9	7,9	0	8	1
cabernet-sauvignon	18	8	7,02	0	7	1
merlot	6	4	3,51	0	3	1
aragonez	8	4	3,51	0	3	1
vinhão	6	3	2,63	3	0	0

Word frequency

Word	Word length	Frequency	%	VM DAO BEIRAO TINTO CASTAS	VM TDOURO TINTO CASTAS
lote	4	149	44,61	52	97
touriga-nacional	16	91	27,25	51	40
aragonez	8	45	13,47	10	35
touriga-franca	14	25	7,49	0	25
trincadeira	11	7	2,1	1	6
tinta-barroca	13	7	2,1	0	7
alfrocheiro	11	4	1,2	4	0
vinhas-velhas	13	2	0,6	0	2

Word frequency

Word	Word length	Frequency	%	SO ALENTEJO TINTO CASTAS	SO TEJO TINTO CASTAS	SO ALGARVE TINTO CASTAS	SO PSETUBAL TINTO CASTAS
lote	4	253	38,16	173	45	6	29
aragonez	8	121	18,25	102	9	4	6
trincadeira	11	69	10,41	57	6	1	5
touriga-nacional	16	61	9,2	31	20	1	9
castelão	8	54	8,15	4	18	1	31
syrah	5	41	6,18	27	7	1	6
cabernet-sauvignon	18	30	4,53	8	12	1	9
alicante-bouschet	17	19	2,87	12	3	0	4

Word frequency

Word	Word length	Frequency	%	AT BBAIRRADINAS TINTO DESCRITORES	AT LISBOA TINTO DESCRITORES	AT MINHO TINTO DESCRITORES
frutos-vermelhos	16	44	5,72	16	25	3
granada-médio	13	25	3,25	14	11	0
fresco	6	22	2,86	9	12	1
elegante	8	16	2,08	12	4	0
ameixa	6	16	2,08	5	11	0
taninos	7	15	1,95	6	9	0
madeira-doce	12	11	1,43	4	7	0
cereja	6	11	1,43	7	4	0
granada-intenso-violáceo	24	10	1,3	2	8	0
fresca	6	10	1,3	6	4	0
baunilha	8	9	1,17	1	8	0
granada-médio-violáceo	22	9	1,17	0	9	0
madeira	7	9	1,17	2	7	0
densidade-mínima	16	8	1,04	2	6	0
taninos-rústicos	16	8	1,04	6	2	0
simples	7	8	1,04	2	6	0
média-densidade	15	8	1,04	1	6	1

Word frequency

Word	Word length	Frequency	%	VM DAO BEIRAO TINTO DESCRITORES	VM TDOURO TINTO DESCRITORES
frutos-vermelhos	16	71	3,75	21	50
elegante	8	49	2,59	20	29
granada-médio-violáceo	22	45	2,38	14	31
ameixa	6	40	2,11	9	31
granada-médio-carmim	20	38	2,01	5	33
fresco	6	35	1,85	16	19
granada-intenso-violáceo	24	31	1,64	10	21
granada-médio	13	28	1,48	14	14
bergamota	9	26	1,37	10	16
madeira	7	26	1,37	13	13
sucroso	7	25	1,32	5	20
longo	5	25	1,32	9	16
madeira-fresca	14	24	1,27	7	17
taninos-concentrados	20	22	1,16	9	13
cereja	6	21	1,11	8	13
madeira-doce	12	20	1,06	6	14
arqueado	8	18	0,95	4	14
taninos-de-guarda	17	18	0,95	13	5
redondo	7	17	0,9	4	13
granada-intenso-carmim	22	17	0,9	12	5
cativante	9	17	0,9	5	12
amplo	5	16	0,85	2	14
antes	5	16	0,85	4	12
corpo-médio	11	15	0,79	7	8

Word frequency

Word	Word length	Frequency	%	SU ALENTEJO TINTO DESCRITORES	SU ALGARVE TINTO DESCRITORES	SU PSETUBAL TINTO DESCRITORES	SU TEJO TINTO DESCRITORES
frutos-vermelhos	16	205	5,03	119	5	36	45
granada-médio	13	84	2,06	59	2	12	11
granada-médio-violáceo	22	74	1,81	49	1	8	16
elegante	8	71	1,74	44	2	10	15
fresco	6	70	1,72	38	0	16	16
expressivo	10	65	1,59	44	1	4	16
granada-médio-carmim	20	58	1,42	39	2	6	11
ameixa	6	57	1,4	44	0	9	4
longo	5	54	1,32	38	0	12	4
granada-intenso-violáceo	24	51	1,25	22	0	18	11
madeira	7	46	1,13	27	4	9	6
redondo	7	42	1,03	23	3	6	10
baunilha	8	42	1,03	24	2	13	3
ameixa-preta	12	41	1,01	30	1	2	8
simples	7	41	1,01	22	0	12	7
madeira-doce	12	40	0,98	22	0	6	12
sucroso	7	38	0,93	21	2	8	7
agridoce	8	37	0,91	20	0	6	11
arqueado	8	36	0,88	20	1	9	6
tosta	5	36	0,88	22	0	7	7
granada-intenso	15	32	0,78	18	1	8	5
densidade-média	15	31	0,76	16	0	9	6
madeira-fresca	14	31	0,76	13	0	10	8
granada-intenso-carmim	22	30	0,74	21	0	3	6
tanino-macio	12	29	0,71	29	0	0	0
tostados	8	29	0,71	18	1	6	4
média	5	26	0,64	16	0	5	5
especiaria	10	26	0,64	12	1	5	8

ANNEX 2

VINHOS TINTOS JOVENS REGIONAIS

IG

POR FAVOR RESPONDA A TODAS AS PERGUNTAS COLOCANDO UMA CRUZ NA RESPOSTA OU NÍVEL DE INTENSIDADE DESEJADOS.

TEM RESIDÊNCIA NESTA REGIÃO? SIM ☐ NÃO ☐

RESPONDA COM SINCERIDADE: ATÉ QUE PONTO CONHECE O PERFIL SENSORIAL DOS VINHOS DESTA IG?

NULO (COLOQUE UMA CRUZ)											INTENSO
	0	1	2	3	4	5	6	7	8	9	10

RESPONDA COM SINCERIDADE: CONSIDERA QUE OS PERFIS SENSORIAIS DOS VINHOS DOC QUE SE ENCONTRAM NESTA IG TÊM UMA CARACTERIZAÇÃO DIFERENTE DA QUE VAI DAR PARA OS VINHOS REGIONAIS ?

NADA DIFERENTE (COLOQUE UMA CRUZ)											MUITO DIFERENTE
	0	1	2	3	4	5	6	7	8	9	10

CARACTERIZAÇÃO GENÉRICA DA **COR** (ESCOLHA APENAS UMA DAS QUATRO CORES DE BASE E AVALIE A RESPECTIVA INTENSIDADE CORANTE)

VIOLETA - PÚRPURA	☐
PÚRPURA - RUBI	☐
RUBI - GRANADA	☐
GRANADA - TIJOLO	☐

EM RELAÇÃO À COR BASE QUE ESCOLHEU PARA OS VINHOS DESTA REGIÃO, PONHA UM (X) SOBRE A ESCALA DE INTENSIDADE QUE MEDE A RESPECTIVA INTENSIDADE CORANTE

COR AGUADA (COLOQUE UMA CRUZ)											COR INTENSA
	0	1	2	3	4	5	6	7	8	9	10

SE ACHAR CONVENIENTE, PODE COMPLETAR A SUA CARACTERIZAÇÃO VISUAL, POR EXTENSO

CARACTERIZAÇÃO GENÉRICA DO **AROMA** (RESPONDA A TODAS AS ESCALAS, AINDA QUE, EM VÁRIOS GRUPOS AROMÁTICOS, TENHA QUE MARCAR O (X) NO INÍCIO DA ESCALA DE INTENSIDADE, POR CONSIDERAR ESTE GRUPO AROMÁTICO AUSENTE DO PERFIL AROMÁTICO DA REGIÃO.

INTENSIDADE AROMÁTICA Intensidade Global do Aroma

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS FLORAIS Intensidade dos aromas de rosa, flor de laranjeira, violeta, cravo

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DE FLORES SECAS Intensidade dos aromas de feno, rosa velha, camomila

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS HERBAIS Intensidade dos aromas de mentas, tomilho, relva cortada, chás, anisados, mato mediterrânico

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS VEGETAIS Intensidade de aromas pungentes de pimentos verde ou vermelho, azeitonas

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS MINERAIS Intensidade dos aromas de xisto seco, terra, fumo mineral, água mineral, apetrolados

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DE FRUTOS CÍTRICOS Intensidade dos aromas de laranja, limão, bergamota, toranja

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DE FRUTOS VERMELHOS Intensidade dos aromas de morango, framboesa, groselha

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DE FRUTOS PRETOS Intensidade dos aromas de amora, arando, mirtilo

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DE FRUTA DE CAROÇO Intensidade dos aromas de ameixa preta, abrunho, cereja

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS FRUTOS DESIDRATADOS Intensidade dos aromas de passa de uva, passa de ameixa, figo, banana

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DE FRUTOS SECOS Intensidade dos aromas de amendoa, avelã, noz, pinhão

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DE FRUTA COMPOTADA Intensidade dos aromas de compotas de frutos vermelhos ou pretos, alicorados

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS ALIMENTARES E PASTELARIA Intensidade dos aromas de manteiga, pão, chocolate de leite, baunilha, ovo

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DE ESPECIARIA Intensidade dos aromas de pimenta, cravinho, noz moscada, canela, cacau, café

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS CARAMELIZADOS Intensidade dos aromas de caramelo, fruto caramelizado, mel, polen, alcaçuz

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS DA MADEIRA Intensidade dos aromas frescos (eucalipto, cedro, resina, madeira verde), queimados e fumados

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS QUÍMICOS Intensidade de aromas de dentífrico, cola, metal, redução, fermento, fruta artificial (sem ser defeito)

INTENSIDADE NULA FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AROMAS ANIMAIS Intensidade dos aromas de couro, carne, bacon, musk/ginete, cão molhado (sem ser defeito)

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

SE ACHAR CONVENIENTE, PODE COMPLETAR A SUA CARACTERIZAÇÃO AROMÁTICA, POR EXTENSO

CARACTERIZAÇÃO GENÉRICA DO **GOSTO** (RESPONDA A TODAS AS ESCALAS, AINDA QUE, EM VÁRIAS SENSAÇÕES GUSTATIVAS, TENHA QUE MARCAR O (X) NO INÍCIO DA ESCALA DE INTENSIDADE, POR CONSIDERAR DETERMINADA SENSAÇÃO AUSENTE DO PERFIL GUSTATIVO DA REGIÃO.

BORBULHA Intensidade da sensação gasosa, carbonatada, na boca

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

DOCE Intensidade do gosto doce, sucroso

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

ACIDEZ Intensidade do gosto ácido, como sumo de limão, fresco e arrepiante

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

SALGADO Intensidade do gosto salgado

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

AMARGO Intensidade do gosto amargo (não avalie como adstringência. Amargo é o gosto ágrio, como café ou chicória)

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

SECURA (TÁCTIL) Intensidade das sensações de secura na boca. Falta de lubrificação ou de humidade na boca.

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

TEXTURA SUAVE Intensidade das texturas suaves na boca

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

TEXTURA RUGOSA — Intensidade das texturas rugosas, aguçadas na boca

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

TEXTURA GRANULADA — Intensidade das texturas granuladas na boca

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

ADSTRINGÊNCIA GLOBAL — Intensidade conjunta da secura, textura superficial e das sensações dinâmicas na boca

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

CORPO CHEIO — Intensidade do peso volúmico, extrato seco e viscosidade

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

ÁLCOOL — Intensidade das sensações resultantes da presença do álcool, quentes e cáusticas

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

COBERTURA DE BOCA — Intensidade da sensação final oleosa na boca

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

COMPRIMENTO/PERSISTÊNCIA — Intensidade da persistência do vinho na boca

INTENSIDADE NULA — FORTE INTENSIDADE

0	1	2	3	4	5	6	7	8	9	10

SE ACHAR CONVENIENTE, PODE COMPLETAR A SUA CARACTERIZAÇÃO GUSTATIVA, POR EXTENSO

CARACTERIZAÇÃO GENÉRICA DAS **MARIDAGENS** COM PRATOS PRINCIPAIS (RESPONDA A TODAS AS ESCALAS, AINDA QUE TENHA QUE MARCAR O (X) NO INÍCIO DA ESCALA DE INTENSIDADE, POR CONSIDERAR DETERMINADA MARIDAGEM INADEQUADA AO PERFIL DA REGIÃO.

CARNE BRANCA (grelhada) Aves domésticas e Coelho

MÁ MARIDAGEM BOA MARIDAGEM

0	1	2	3	4	5	6	7	8	9	10

CAÇA PEQUENA/ASAS (grelhada) Lebre, Perdiz

MÁ MARIDAGEM BOA MARIDAGEM

0	1	2	3	4	5	6	7	8	9	10

PORCO (grelhada)

MÁ MARIDAGEM BOA MARIDAGEM

0	1	2	3	4	5	6	7	8	9	10

CARNE VERMELHA (grelhada) Vaca, Cabrito, Cordeiro

MÁ MARIDAGEM BOA MARIDAGEM

0	1	2	3	4	5	6	7	8	9	10

CAÇA GROSSA (grelhada) Javali, Veado

MÁ MARIDAGEM BOA MARIDAGEM

0	1	2	3	4	5	6	7	8	9	10

PRATOS TRADICIONAIS DA REGIÃO EM ESTUDO

MÁ MARIDAGEM BOA MARIDAGEM

0	1	2	3	4	5	6	7	8	9	10

SE ACHAR CONVENIENTE, PODE COMPLETAR A SUA NOTA DE HARMONIZAÇÃO COM COMIDA, POR EXTENSO

POR FAVOR REVEJA AS SUAS RESPOSTAS, SOBRETUDO QUANTO AO GRAU DE CONHECIMENTO PESSOAL SOBRE O PERFIL SENSORIAL DOS VINHOS QUE ESTÁ A AVALIAR.

OBRIGADO PELA SUA COLABORAÇÃO.

ANNEX 3

Bi-Variate Statistics for RED WINES final PCA

GI		KNOWLEDGE	IG vs DO	COR Ton	COR intens	NOSE intens	COMPUTE Nose_youngwoody=MEAN(NOSEwoody, NOSEred, NOSEspice, NOSEpastry, NOSEcaramel)	COMPUTE Nose_overripe=MEAN(NOSEdryflor, NOSEdry)	COMPUTE Nose_freshmineral=MEAN(NOSEflor, NOSEmineral, NOSEcitrus)	COMPUTE Nose_ripefruit=MEAN(NOSEblack, NOSEstone, NOSEraisin, NOSEjam)	COMPUTE Nose_greenoffflavour=MEAN(NOSEchemical, NOSEveg, NOSEanimal, NOSEherbal)	Taste_dry_astringent	Taste_sweetviscous	Taste_persistent	Taste_coastalfresh
AG	Mean	6,63	1,25	3,00	6,19	6,13	4,5000	2,8438	2,7708	5,7656	2,7969	3,3125	6,4750	5,3750	1,5417
	N	16	16	16	16	16	16	16	16	16	16	16	16	16	16
	S.D.	1,893	2,266	,365	,981	1,025	1,69234	1,60954	1,34835	1,51786	1,17693	1,57982	,55558	,84656	,98036
AL	Mean	8,15	1,90	2,70	7,30	7,15	4,7900	3,8500	2,8667	6,9500	3,4750	3,4250	6,6800	6,0000	1,5667
	N	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	S.D.	1,348	1,651	,470	,733	,875	1,45454	1,89945	1,05631	1,09904	1,30762	1,04850	,72082	1,03872	,96791
BA	Mean	6,95	2,70	2,00	5,65	5,30	4,0700	3,3250	3,8000	3,2750	4,9250	5,7250	3,2400	5,6000	3,1167
	N	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	S.D.	2,235	2,386	,459	1,387	1,081	1,12629	1,39807	1,25377	1,21909	1,51114	1,34238	,62778	,95422	1,43178
D	Mean	7,90	3,45	1,65	7,55	6,95	4,7100	3,4750	4,7667	6,0375	3,8125	4,6125	5,6600	7,0500	1,5833
	N	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	S.D.	1,119	2,259	,587	,999	,887	1,34317	1,35214	1,62617	1,15358	1,48429	1,26042	,80551	,80948	1,08620
L	Mean	7,47	2,82	1,82	6,35	5,35	4,2471	2,9118	3,6078	4,1324	4,3088	5,1765	4,1765	5,3529	2,6275
	N	17	17	17	17	17	17	17	17	17	17	17	17	17	17
	S.D.	1,068	2,298	,636	1,455	,786	1,36296	1,27764	1,57778	1,16632	1,25477	1,12418	,88567	,70189	1,04670
M	Mean	6,79	2,42	1,11	8,58	5,84	2,9263	1,8947	3,3509	3,2368	5,2632	6,4342	2,4316	5,0263	3,7895
	N	19	19	19	19	19	19	19	19	19	19	19	19	19	19
	S.D.	1,619	2,479	,315	1,644	1,708	1,18549	1,13748	1,80696	1,39312	1,73100	1,43334	,86990	1,52273	1,44534
PS	Mean	7,82	2,94	2,76	6,24	6,12	4,8353	3,5588	3,4706	5,4559	3,8676	3,6618	5,9294	5,5000	2,3137
	N	17	17	17	17	17	17	17	17	17	17	17	17	17	17
	S.D.	1,334	3,191	,437	,903	,857	1,37702	1,69450	1,72827	1,44221	1,53378	1,33153	,68899	,84779	1,48824
T	Mean	7,32	1,16	2,84	6,32	6,05	4,7263	2,9474	3,3158	5,0921	3,9474	4,2632	5,3684	5,4737	1,7895
	N	19	19	19	19	19	19	19	19	19	19	19	19	19	19
	S.D.	1,529	1,463	,375	,582	,911	1,34860	1,61499	1,67580	,91746	1,47568	1,63824	,62277	,75413	1,25320
TB	Mean	6,74	2,21	2,32	6,16	5,74	4,1263	3,0789	4,3860	4,2105	3,9605	5,0658	4,5158	6,0789	1,9474
	N	19	19	19	19	19	19	19	19	19	19	19	19	19	19
	S.D.	1,821	1,653	,671	1,167	,933	1,21694	1,55691	1,42406	1,13426	1,57291	1,27976	,75518	,69248	1,21850
TC	Mean	6,30	1,50	2,60	5,10	5,20	3,7400	2,7000	3,7667	3,4500	3,7250	5,0250	3,9400	5,5500	2,2000
	N	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	S.D.	1,418	1,650	,516	,994	1,033	1,19276	,97753	1,23778	1,14139	1,07658	1,41642	,66700	,76194	1,04468
TD	Mean	7,95	2,50	2,00	6,60	6,90	4,5700	3,6250	5,2333	4,1875	3,9375	5,0250	4,5200	6,7000	1,9167
	N	20	20	20	20	20	20	20	20	20	20	20	20	20	20
	S.D.	1,468	2,524	,459	1,095	1,021	1,47438	1,63735	1,62257	1,56414	1,30252	1,10888	,73241	,83351	1,17913
TM	Mean	6,63	1,81	2,38	6,25	5,38	3,9750	3,6563	3,8333	4,9063	3,9063	4,6250	4,7125	6,0000	1,8750
	N	16	16	16	16	16	16	16	16	16	16	16	16	16	16
	S.D.	1,204	1,642	,500	,856	,806	1,45121	1,70996	1,50062	1,18980	1,41973	1,19722	,76583	,89443	1,06022
Total	Mean	7,28	2,27	2,23	6,60	6,07	4,2911	3,1784	3,7887	4,7676	4,0223	4,7077	4,8178	5,8404	2,1941
	N	213	213	213	213	213	213	213	213	213	213	213	213	213	213
	S.D.	1,620	2,240	,728	1,382	1,196	1,42900	1,57774	1,64123	1,68021	1,52275	1,56953	1,43890	1,07298	1,35745