Overall conceptual characterization of aged dry white wines using a mental descriptive questionnaire

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Abstract

The purpose of the present study was to understand the overall concept of an aged dry white wine using a mental descriptive questionnaire. A total of 680 worldwide participants, grouped according to their expertise, replied to an online questionnaire in order to characterize the sensory analytical and synthetic descriptors of an aged dry white wine. The descriptors were selected using a Check-All-That-Apply (CATA) approach concerning wine colour, aroma, taste and mouthfeel sensations, and global appreciation.

The responses checked by at least 20% of the participants included the following number of descriptors: (a) 5, for the colour; (b) 7, for the aromas; (c) 6, for the taste and the mouthfeel sensations; and (d) 10, for the global appreciation.

The expertise level did not influence the overall sensory description of aged dry white wine concerning the most frequent descriptors. As a result, these wines were characterized by a deep yellow to deep gold colours and aromas of dried fruit, honey, caramel, oak and beeswax. The taste and mouthfeel sensations were dominated by body, length, viscosity, smoothness, dryness and acidity. The global appreciation included terms such as complex, persistent, rich, concentrated and developed. This overall sensory space is consistent with the metaphorical concept of “mellowed by age” wines.

Keywords: Aged dry white wine, Conceptual characterization, Expertise level, Tasting scripts, Mellowed wines.

Resumo

O objetivo do presente estudo foi compreender o conceito geral de um vinho branco envelhecido por meio de um questionário descritivo mental. Um total de 680 participantes, de todo o mundo, agrupados de acordo com sua experiência, responderam a um questionário *online* a fim de caracterizar os descritores sensoriais analíticos e sintéticos de um vinho branco envelhecido. Os descritores foram selecionados usando uma abordagem *Check-All-That-Apply* (CATA) em relação à cor do vinho, aroma, sabor e sensações de boca, e apreciação global.

As respostas assinaladas por pelo menos 20% dos participantes incluíram o seguinte número de descritores: (a) 5, para a cor; (b) 7, para os aromas; (c) 6, para as sensações de boca e gosto; e (d) 10, para valorização global.

O nível de experiência não influenciou a descrição sensorial global de um vinho branco envelhecido, tendo em conta os descritores mais frequentes. Desta forma, podemos dizer que estes vinhos são caracterizados por cores de amarelo profundo a dourado profundo e aromas de frutas secas, mel, caramelo, carvalho e cera de abelha. O gosto e as sensações de boca foram dominadas por corpo, duração, viscosidade, suavidade, secura e acidez. A apreciação global incluiu termos como complexo, persistente, rico, concentrado e evoluído. Este espaço sensorial é consistente com o conceito metafórico de vinhos “mellowed by age”.

Palavras-Chave: Vinho branco envelhecido, Caracterização conceptual, Nível de expertise, Guiões de prova, “mellowed by age”.

Resumo Alargado

O potencial de envelhecimento é uma das características importantes para os vinhos brancos de alta qualidade. No entanto, poucos são capazes de preservar a acidez de um vinho branco jovem e, ao mesmo tempo, desenvolver aromas específicos de evolução.

Geralmente, o espaço sensorial de um vinho branco envelhecido é caracterizado por um aumento da harmonia, diminuição da aspereza e aumento da complexidade, bem como a diminuição da sensação de frescura, o desenvolvimento de aromas de fruta madura e compotas bem como nuances aromáticas de mel ou nozes.

No entanto, sobre a temática de vinhos brancos envelhecidos, prevalecem estudos sobre a identificação das principais moléculas odoríferas relacionadas com o processo de envelhecimento e a sua implicação nas características sensoriais, mas não a definição do que é um vinho branco envelhecido.

Desta forma, este trabalho de investigação abriu um novo capítulo no estudo de vinhos brancos envelhecidos, propondo uma caracterização conceptual de um vinho branco envelhecido por meio de um questionário que permitirá a descrição conceptual baseada na imagem mental de cada participante.

A metodologia, sem recurso a prova, utilizada neste trabalho é baseada no conceito *Mental Imagery*, que mais não é do que a capacidade de criar uma imagem mental na ausência de um estímulo externo. Neste contexto, e na representação de conhecimento, está estudado que *Experts* e *Novices* têm processos distintos: *top-down* e *bottom-up*, respetivamente. No primeiro cenário, associado a um maior nível de *expertise*, a resposta sensorial é influenciada por experiências prévias e conhecimento adquirido, i.e., a informação conceptual influencia a resposta, nem sempre o que é descrito é percecionado. De forma oposta, o processo de *bottom-up* implica a tomada de decisão usando a informação percecionada pelo estimulo, i.e., a informação sensorial determina a resposta.

Os dados para este estudo foram recolhidos através de um questionário online, num total de 680 respostas, utilizando uma adaptação da metodologia CATA, a fim de uniformizar os descritores para cada parâmetro, com o objetivo de compreender as perceções e preferências dos participantes sobre o envelhecimento dos vinhos brancos, bem como obter uma caracterização conceptual de um vinho branco envelhecido. As respostas ao questionário foram posteriormente analisadas, recorrendo a métodos estatísticos, para aferir os atributos mais relevantes escolhidos pelos participantes. Esta análise teve como base a frequência de citação de cada atributo, por categoria, avaliada através de testes de Qui-quadrado (χ^2) e comparações através do procedimento de Marascuilo (95%), para determinar diferenças significativas entre os diferentes atributos, por categoria. Apenas foram considerados para análise estatística atributos mencionados por mais do que 20% dos participantes.

Decorrente do tratamento dos dados, foi pertinente a divisão dos participantes em dois grupos (*Experts* e *Novices*) com base em duas perguntas do questionário. E assim permitir o estudo da dependência/independência do grau de *expertise* e do conceito do que é um vinho branco envelhecido.

Em termos da perceção de idade, cerca de 50% dos participantes acredita que entre os 6 a 10 anos, um vinho branco pode ser considerado "velho". Já para o intervalo de idade superior, 21 – 40 anos, são os *Experts* que mais se fazem representar nesta escolha. Já apenas 12% do total dos participantes considera que um vinho branco envelhece melhor que um vinho tinto. O fator determinante para a escolha de "21 – 40 anos" ou "Melhor" é o grau de interesse dos participantes, i.e., ser muito interessado condiciona esta escolha.

Um total de 28 descritores, categorizados em quatro categorias principais: *Cores*, *Aromas*, *Gosto e Sensações de Boca* e *Apreciação Global*, foram mencionados por mais de 20% dos participantes. Estes descritores distribuíram-se pelas categorias da seguinte forma: (a) 5, para a cor; (b) 7, para os aromas; (c) 6, para as sensações de boca e gosto; e (d) 10, para valorização global.

Os participantes caracterizam estes vinhos como tendo uma cor amarela profunda a dourada profunda e aromas de frutas secas, mel, caramelo, carvalho e cera de abelha. O gosto e as sensações de boca foram dominadas por corpo, duração, viscosidade, suavidade, secura e acidez. A apreciação global incluiu termos como complexo, persistente, rico, concentrado e evoluído.

Descritores como, petróleo/querosene, pedra molhada ou salgado são usados pelos *Experts* com mais frequência do que pelos *Novices* devido à elevada especificidade ou dificuldade em defini-los. As nuances entre as caracterizações de *Experts* e *Novices* baseiam-se, principalmente, na utilização de vocabulário mais específico e na diversidade de termos utilizados, o que revela que *Experts* possuem mais recursos cognitivos e de memória para a realização deste tipo de descrições sem recurso a prova que os *Novices*. No entanto, a maior diversidade e especificidade de vocabulário dos *Experts* não resulta numa caracterização altamente diferenciada, apresentando-se similar à caracterização dos *Novices*.

Além da caracterização sensorial, inferiu-se também os sentimentos que os participantes associam a um vinho branco envelhecido e as ocasiões em que escolheriam um vinho destes. Elegante e Interessante foram, assim, os adjetivos mais usados por ambos os segmentos, bem como o consumo destes associado a uma ocasião especial.

Acreditamos também que os participantes neste tipo de estudos têm, *a priori,* interesse no tema e possuem algum conhecimento, o que limita a existência de *true Novices* e poderá de alguma forma ter condicionado os resultados, diminuindo a disparidade entres os dois grupos. Esta crença resulta do facto de estes participantes escolherem participar voluntariamente no estudo.

A escolha dos descritores nas diferentes categorias permitiu definir o espaço sensorial que, perante a conotação negativa do adjetivo *velho*, pode ser caracterizado pela expressão inglesa de *Mellow wines* ou *Mellowed by aging,* que quando traduzido para português se refere a algo amadurecido, evoluído, em que os vinhos se tornam mais suaves, evoluídos, adocicados, ricos e agradáveis.

Foi também interessante perceber se o país de origem dos participantes influenciou a escolha das regiões associadas à produção de vinhos brancos envelhecidos. Os participantes foram agrupados como tendo origem em países do "Novo Mundo" ou do "Velho Mundo". Quando considerada a totalidade dos participantes os resultados foram influenciados pelo elevado número de portugueses, e assim, as região de Colares e Dão foram uma escolha preferencial, apesar da Borgonha ter sido a mais escolhida. Na exclusão dos portugueses do grupo do "Velho Mundo", as regiões portuguesas são penalizadas, demonstrando algum etnocentrismo dos participantes estrangeiros e desconhecimento dos vinhos e regiões portuguesas. Mostrando-se ser uma limitação do nosso trabalho, a predominância de portugueses.

Os resultados desta abordagem, sem recurso a prova, suportam a existência de uma imagem mental, associada a um vinho branco envelhecido e a um espaço sensorial bem definido sem a influência do nível de experiência dos participantes, no conceito geral destes vinhos.

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Abbreviations

TDN - 1,1,6,-trimethyl-1,2-dihydronapthalene

QDA™ - Quantitative Descriptive Analysis™

DA - Descriptive Analysis

CATA - Check-all-that-apply

PGI - Protected Geographical Indication

VWIQ - Vividness of Wine Imagery Questionnaire

PF - Percentage Frequency

PSP – Polarized Sensory Positioning

1 Introduction

1.1 Problem Statement

With this thesis, we performed research in order to be able to answer the following question: *Is there an overall concept that defines the sensory image of an aged dry white wine?*

The present research aims to provide reliable information about the aged dry white wine concept by using a non-tasting mental descriptive task, based on the perception of experts and non-experts.

Besides the overall conceptual characterization of an aged dry white wine, another goal was to understand what is the influence of expertise on the delimitation of the sensory image without tasting, since different studies reveal that experts have more cognitive and memory resources to perform this task than non-experts [1], [2].

2 Literature Review

2.1 Ageing of White Wines

2.1.1 Historical Context

The preference for wines with different styles is a function of diet, climate, commerce, social preferences and technologies [3]. For many authors sweetness, or the degree of sweetness, is the oldest styling parameter of wine. This may explain why consumers' tastes and preferences changed along with the history of wine consumption.

The evolution of winemaking's style has been linked to the problem of wine preservation, especially for wines traded and consumed outside their area of origin [4]. The earliest wine vessels, found in Iran, showed evidences of wine sweetened with honey and high-sugar fruits. Roman texts dated from the 3rd and 2nd centuries BC described a winemaking process where the sweet wine was a result of the incomplete fermentations of the dried grapes, which contribute to more intense and complex flavours in wine, as well as natural stability [3], [4]. In the Common Era, many techniques for achieving sweetness were documented, such as, the addition of honey in large quantities, boiling unfermented juice to be added to the wines and fermentation in closed vats, creating an anaerobic atmosphere for the alcoholic conversion [3]. Some of these techniques persisted for many centuries and they are spread all over the Mediterranean. For example, dried-grape winemaking is still practiced in Jerez and Valpolicella [4]. Since the beginning, dry or sweetish wine has been made alongside with the sweet wines, confirmed by the residues without any exogenous sweeteners in many amphorae [5].

The modern era of wine trade begun between the 15th and 18th centuries where it was transformed from an agricultural, regional and perishable product into a commercial and durable product. Contrary to Antiquity, during this period, "old" wine was cheaper than the "new" wine which was the wine from the most recent harvest. The "old" one was the wine from the previous harvest. The fact that the "new" wine was higher priced than the "old" contributes to the rational that the "old" wine did not age well [3]. This picture changed when wine producers became wine exporters and importers, in long-distance trade, and they had the need to make the wine more stable during long periods. *Élevage* appeared as a technique to develop a wine from "childhood" to "adulthood" in wood casks for long periods, where the lees are gradually eliminated by clarification and racking [3]. Wines produced with this technique were characterized as "less fresh and fruity but more polished and evolved" [3].

The appreciation for sweet wines might be explained by the diet transformation in Germany in the beginning of the 19th century, when this country was the world's largest beet sugar producer, and the abundant supply of cane sugar imported from West Indian colonies to England between 1650 and 1850 [6]. Late in the 20th century, across Europe, dry wines gradually emerged enhanced by the Brut Champagne style, which became mainstream at that time, and English consumers seemed to decreased their preferences for sweet wines [7]. Currently, a preference for dry wines might be justified by the prevalence of dietetic habits, focused on lower calories, that are commonly associated with this type of wine.

2.1.2 Aging Types and Sensory Characteristics

Aging potential is one of the important features for high quality white wines. Some white table wines are capable of developing a desirable bottle *bouquet*. However, the ideal aging does not occur in every wine, most of them are not able to preserve the nuances of a young white wine and, at the same time, develop specific aromas [8], [9]. According to Schneider [9], aromatic changes in old white wines begin before any kind of colour change, reflecting deep alterations in taste and aroma. Additionally, Loscos et al. [10], affirmed that varietal differences increase with aging.

Generally, the colour of an old white wine is deeper, varying from straw to amber. An increased harmoniousness, decreased harshness, increased complexity can be verified [11]. This intrinsic complexity might divert the preferences of consumers for young white wines or the need of a more trained palate to appreciate these features.

In young white wines, the fruity aroma depends on the grape content in terpenes in association with acetates and mono and dicarboxylic acid ethyl esters which appear during the fermentation process [12]. According to Pérez-Coell et al. [12], the loss of freshness and increase in spiciness and overripe fruit aromas might be justified by the concentration's decrease in esters and acetates, mainly by hydrolyzation. These authors justified the increase in the intensity of the spicy and overripe fruit by the increase of ethyl lactate and 5-ethoxymethylfurfural. These compounds are characterized by a cinnamon and dry fruit aroma and can be formed without oxygen during bottle storage [13]. Schneider [9], refers the degradation of grape-derived terpenols and norisoprenoids responsible for fruity-floral, accelerated by the oxygen uptake.

Other molecules can be considered as aging markers for whites wines, such as, phenylacetaldehyde and methional (Strecker aldehydes), aliphatic aldehydes (trans-2-nonenal), sotolon, 1,1,6,-trimethyl-1,2-dihydronapthalene (TDN), *cis*- and *trans*- dioxanes and dioxolanes and the formation/deterioration of certain sulfur-containing compounds [14].

The oxidative phenomena is the most typical form of aging in white wines (oxidative aging) with a known sensory pattern (formation of off-flavours and the loss of fruity notes), revealed by oxidative aroma degradation with the development of aromatic nuances of honey, beeswax, straw, hay or nuts [15]. Reaction of caramelization, mainly Maillard type, involving sugars and amino acids can also be part of the odour-active compounds formation during aging [16].

The sporadic nature of the oxidative phenomena occurring during bottle storage can have a major cause, which is the bottle closure, mainly the natural cork stoppers. This type of closures are responsible for a heterogenous permeability of the oxygen which is higher in the first month and decreases during storage time [14].

Finally and according to Schneider [9], an atypical aging in white wines is related to the accumulation of molecules that induce the character of old wines in young ones. The 2-aminoacetophenone is one of the molecules, whose the defective deviations from normal wine maturation is characterized by flavours of mothball, soap, rotten eggs, garlic or cooked vegetables [9]. The ability to recognize the type of evolution and its character justifies the need of further research in the topic, since some evolution patterns might be considered as an intrinsic terroir expression or assumed as a fault in some countries.

2.1.3 White Wines that Age Well

Typically, dry white wines do not age as long as red wines, unless we bring to the discussion fortified dessert wines or botrytized white wines. Fermentation without grape skins and lack of acidity are, usually, the main reasons for white wines' aging potential reduction. Therefore, odour-less varieties and high fixed acidity are the key factors for a wine to age well.

Some grape varieties can improve the ability of a dry white wine to age well and some of them are listed below, based on the information provided in [11] and [17]:

- **Chardonnay**, is the most well-known of the age-worthy whites. Its ability to age comes from the combination of high acidity and oak barrel aging. As the time passes tropical fruits, vanilla and butter notes will appear.
- **Sémillon**, famous with blend of Bordeaux when blended with Sauvignon Blanc. Even if the acidity is not so high has been shown to age gracefully and develop interesting nutty flavors over time.
- **Rkatsiteli**, a rare find outside of Eastern Europe, this grape has all the features of a great white to age with beeswax and nuttiness on the palate.
- **Riesling**, as it ages, Riesling becomes a rich yellow colour with surprising aromas of petrol caused by an unique aroma compound called TDN.
- **Viura**, also known as Rioja Blanca, the young wines from this variety start with citrus and mineral flavours and become increasingly rich and flavourful as they age.

- **Chenin Blanc**, famous the sweet ones from the Loire Valley and with increasing value in South Africa. With a wide range of styles the flavours can range from yellow apple to chamomile and honey.
- **Savatiano**, the most planted white grape in Greece, capable of evolving into an exotic, nutty, and grassy white with age.
- **Arinto**, is produced in a wide range of styles, the best wines have lean, mineral, and citrus notes that open up into rich, honeyed, beeswax, and melon flavours with time.

The popular press emphasizes the role of the variety in the aging potential apparently neglecting the influence of climate, grape growing decisions and winemaking techniques. These factors probably explain the wide range of years in the aging aging chart for a few white wines displayed in in **Figure 2.1**.. Interestingly, the “shorter life” of Moscato and Gewürztraminer is recognised in this chart, in accordance with the usual high aromatic intensity of these wines when young.

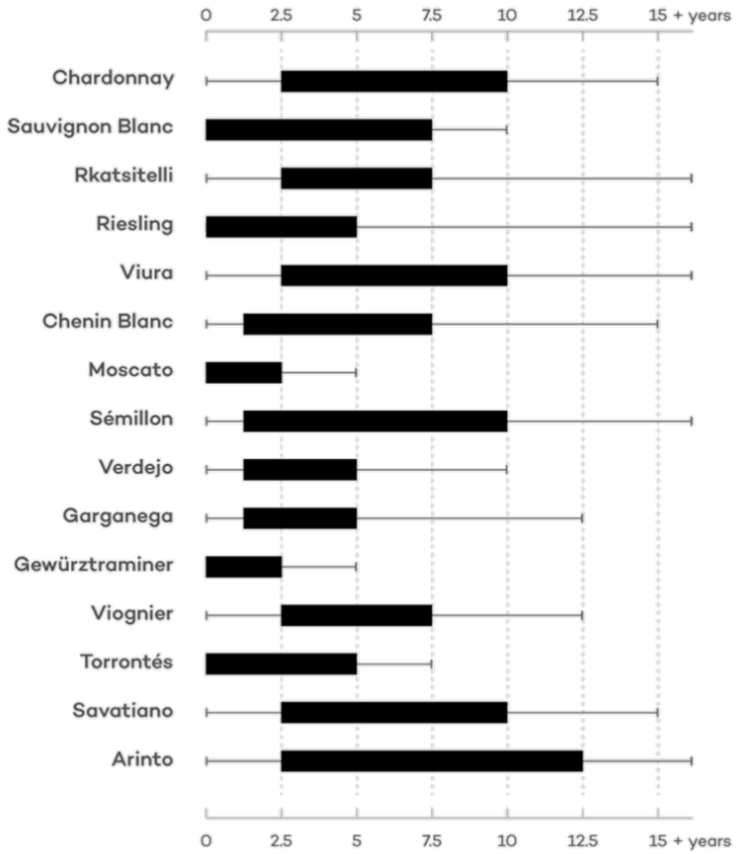

Figure 2.1. Aging Chart for White Wines. Source: Adapted from [17].

2.2 Multisensory Wine Perception

Tasting wine is a multisensory experience, involving the simultaneously stimulation of the vision, smell, taste and touch senses influencing as a whole the wine perception. The multi-modality of wine perception is derived from the neurons response to inputs from different sensory receptors [18].

2.2.1 Colour

Colour is a component of the visual sensations associated to sensory perception involved in wine assessment, complementary with clarity, viscosity, effervescence and tears [19]. It is a visual attribute of the wine dependent on how the visible radiation is transmitted, absorbed and reflected by the wine. The colour perception is complex and usually there is no simple relationship between the human perception and the spectrophotometric measurements [20]. Skin contact duration, grape pigmentation, wine age and the presence or absence of wine faults might have an influence in the colour of wine. This association has limited precision and must be used with caution in order to avoid unjustly influencing and biasing a wine's perceived quality. To overcome this, wine may be sampled in black glasses or under red lights [19]. Several studies were conducted to validate the influence of colour on the quality perception and assessment. According to Andrea et al. [21], in an investigation developed with rosé wines, when in a blind taste, the preferred wines were the least preferred when the colour was visible. Parr et al. [22] showed that the colour's influence is less impactful with experienced tasters than with novice tasters when a significant difference between colour and other attributes was evident. However, when the colour influence was eliminated (black glasses) both experts and novices behaved equally [19]. Another false relationship is the colour's depth and the perceived odour intensity, this connection is much more related to life experiences than with flavour intensity. This biased association between wine colour and flavour can strongly influence taste and odour perception.

Focusing on the dry white wines, the colour of the young ones ranges from colourless to pale straw. The yellow, gold and amber tones are associated with long pre-fermentative maceration, due to the carotenoids and phenolics uptake from the skins; maturation in oak allowing the phenolics extraction and oxidation phenomena; or age, resulting in structural changes and different pigments' generation [19].

2.2.2 Aroma Perception

It is common to think and characterize aroma, flavour and taste as interchangeable meanings. Essentially, aroma is related to the sense of smell, taste refers to the senses inside the mouth (taste and mouthfeel) and flavour is when aroma and taste converge.

Aroma is possibly the most important factor in wine quality control and quality assurance in white wines. Combined with taste, aroma is responsible for the wine's enjoyment and pleasurable experience. Aroma is a pleasant word to describe odour, which is the sensation perceived by the sensory organ when sniffing a volatile substance [23]. The ability to sense an odour can be done by two different ways. One is through nostrils (orthonasal), where the volatile compounds reach the olfactory epithelium directly, and the other is the indirect one, through the back of the throat and into the retronasal cavity [24]. Limbic system is also involved in the sense of smell and it is a part of our brain that also deals with emotion, behaviour, motivation and long-term memory [25].

Wine aroma can be characterized as a complex balance of more than 800 volatile compounds with different origins: from grapes (varietal aroma), from alcoholic fermentation under anaerobic conditions (fermentative aroma) and the *bouquet*, resulting from the transformation of the aroma during aging [26].

According to Ferreira et al. [27], aroma compound can be classified according the role they play in wine:

- I**mpact or highly active compounds**, can effectively transmit their specific or primary aroma nuance to a wine without the need of the support of more aroma chemicals. Sotolon is a good examples of this group.
- **Impact groups of compounds**, families of compounds usually having similar chemical structures, with similar odour properties and that can impact the aroma of a wine with specific notes of the family. An example in this group are the ethyl esters of fatty acids, responsible for the fruity notes of some white wines.
- **Subtle compounds**, are the compounds which fail to transmit their specific aroma nuances to the wine but contribute decisively to the development in wine of some secondary-generic aroma nuance, such as fruit or sweet.
- **Compounds forming the base of wine aroma**, the compounds present in all wines at concentrations above their corresponding odour thresholds which are no longer perceived as single entities because their aromas are fully integrated to form the complex concept of wine aroma.
- **Off-flavour compounds**, whose presence brings a decrease in the overall aroma quality of wine.

2.2.3 Taste, Mouthfeel and Flavour

“Sensations perceived by the taste organ when stimulated by certain soluble substances” is the definition for taste, while mouthfeel is “mixed experience derived from sensations in the mouth that relate to physical or chemical properties of a stimulus”, provided by International Standard Sensory Analysis Vocabulary (ISO 5492:2008) [23].

Taste receptors, usually named taste buds, located all over the tongue, are responsible for the gustatory sensations of sweet, salty, bitter, sour and umami. Metallic perception is commonly mentioned as a wine taste, but there is no evidence of if it is as a true taste, a flavour (combination of textures and tastes) or a misinterpreted olfactory sensation [19]. This type of confusion between taste and smell is very common, besides the fact that taste is perceived in the oral cavity and smell is perceived ortho and retronasally, the latter is most of the time mislocalized [28].

Mouthfeel sensations could be divided into physical sensations as texture properties and chemical sensations as flavour properties [23]. Mouthfeel is sensed by free nerve endings of the trigeminal nerve all over the inside of the mouth and tongue. Astringency, viscosity, bitterness, burning or prickling among others are perceptions derived from the stimulation of at least one of the trigeminal receptors: mechanoreceptors (touch), thermoreceptors (heat and cold), nocireceptors (pain), and proprioreceptors (movement and position) [19].

Based on International Standard Sensory Analysis Vocabulary (ISO 5492:2008) [23], flavour is the combination of gustatory, olfactory and trigeminal sensations. It is how the brain synthesizes the aromas, taste and mouthfeel into an overall impression and experience of the wine [25].

Fruit flavours are the first flavours that the consumers learn to identify, justified by the gratifying feeling they promote [25]. On the other hand, off-flavours are quickly judged by consumers because some of them are less pleasant, sometimes weird and require an acquired taste [29]. Since aroma perceptions are highly individual, it is important to mention that the perception and appreciation of an off-flavour is completely dependent on the consumer.

2.3 Sensory Image

Each individual has its own "sensory fingerprints", which can be defined as a personal sensory perception influenced by genetic, environment and cultural aspects. Having different receptors in the eyes, nose and mouth, each person forms a different "sensory image" in the cerebral cortex when confronted with a given stimulus [30]. This justifies how difficult it is to communicate a sensory experience.

Additionally, we know that the central nervous system is able to distinguish as many flavours as there are molecules to taste and not only the traditional four sensations: sweet,

salty, sour and bitter [30]. The problem is that our vocabulary is more limited than the sensory perception and we cannot describe the sensation with words. Sensory training may diminish this difficulty and increase the fluency in wine description, having in mind that this ability may just be a matter of practice and not sensory acuity [31].

2.3.1 Mental Imagery and Expertise Influence on Sensory Analysis

"Seeing with the mind's eye" or "hearing with the mind's ear" could represent the definition of the "Mental Imagery", which is the ability to create an image in the absence of an external stimuli, and can result as a sensory reconstruction from past experiences [32]. Considering perception as the registered information obtained from the senses, mental images can be the modification and combination of the stored perceptual information originating new objects and not only a recall of a previously perceived object [33]. This definition allows us to understand why experts and novices could have different wine mental imagery in addition to the fact that wine tasting is a multisensory experience.

Comparing panels made of experts and panels made of non-experts is a widely used method to understand the influence of knowledge on sensory sensitivity and preferences. According to Honoré-Chedozeau et al. [34], the development of skills and conceptual knowledge seems to be acquired through both exposure and intensive formal training.

The comparison between experts and novices may be focused on the knowledge representation where we can have two processes: bottom-up and top-down, the way how these processes are used depends on the level expertise [35]. The first one corresponding to the cases where the decision is made using the information perceived by the stimuli, i.e., the sensory information determined the response (novices strategy) [36]. The top-down process uses prior knowledge and personal experience in response to a stimuli, i.e., the conceptual information influences the sensory responses (experts strategy). Based on this, many studies showed that experts had conceptual-based knowledge representations (abstract information) and novices had surface-based knowledge representations made from concrete information perceived by personal experience [34]. Wine tasting processes/scripts and linguistic prototypes could be the resources used by experts to describe a wine if they know what they are drinking. Using these tools, experts identify and describe wine's characteristics by comparing those features with previous models deriving from their wine experience [31], [1]. This type of cognitive resources gives experts the ability to describe what they are perceiving even if sometimes the description is not actually perceived [2].

2.3.2 Sensory Analysis

Sensory science emerged in the 1940s and since the beginning it was applicable to wine as a technique with the ability to collect wine characteristics in a least biased way, which is the main advantage when comparing with the traditional wine tasting method [37]. This is guaranteed by the implementation of standardized and controlled protocols, decreasing the physiological and psychological factors and the application of statistics principles with accurate, precise, repeatable and reproducible data [38].

Sensory analysis science is an interdisciplinary field that comprises the measurement, interpretation and understanding of human responses to external and internal stimuli perceived by the senses, originating the perception. Which is the act of becoming aware of a stimulus and its quality, through the sensations that are sensed by us and the interpretation of those sensations based on previous experiences [39].

This multiplicity of physic and chemical stimulus from the exterior and internal ones, such as memory or previous experiences, results in a vast number of possible responses. Although human senses turn out to be the most accurate instrument for sensory evaluation, it structurally incorporates an amount of uncertainty and imprecision in the work data, since different tasters perceive, prefer and rank the sensory attributes of a given product differently, it is therefore essential to reduce the variability of the data [40].

The use of sensory science in the wine sector is a way to support the research efforts in viticulture and oenology, ensuring wine production quality (quality control), as a tool for product and market development, as well as in the commercial field providing information on consumers' wine preferences based on sensory attributes identification. Knowing which styles of wine appeal to a specific target group of consumers may lead to a competitive advantage [37].

2.3.3 Sensory Analysis Methods

Based on Heymann et al. [39], sensory analysis methods can be divided in two main groups: the Analytical methods, that includes the Discrimination and Descriptive tests, and the Affective methods.

Affective methods, also known as Hedonic methods, are able to assess consumers acceptance, overall linking and the aim is to establish the hierarchy of those included in a specific set of samples, according to the desire or preference [40]. Paired Preference Test, Ranking Test and Hedonic Test are commonly used as Affective methods, which are able to be performed by consumers since these tests are simple and easy to understand.

As part of Analytical Methods, the Discrimination (or Difference) tests are a simple way to indicate whether the wine samples are perceived as different by human senses, usually performed by experienced panellists. According to Lesschaeve et al. [37], Discrimination tests include:

- **Threshold Tests**, performed to determine the sensitivity of the panellists to a specific compound or to estimate the contribution of the compound to flavour;
- **Intensity Ranking Tests**, panellists need to use their short-term memory and make multiple paired comparison tests in order to rank the samples by intensity of a specific attribute;
- **Intensity Tests**, use different type of scales and scaling procedures to measure the intensity of a specific wine attribute, rated by experienced panellists.

On the other hand, the Descriptive tests are more similar to chemical analysis. That is, they aim to identify and measure the 'composition' of the products, or to determine the presence or intensity of a particular feature.

The objective of the Descriptive methods is to quantify the specific sensory differences between two samples in the set and this information can be achieved using different approaches, such as Flavour Profile, Texture Profile, Quantitative Descriptive Analysis™ (QDA™), Sensory Spectrum™ and Quantitative Flavour Profiling [41]. Here we can also include what some authors called "Conventional/Generic Descriptive Analysis" (DA), which is a mixed approach of the different ideas of the mentioned methods, mainly QDA™ and Sensory Spectrum™[42]. This technique allows the correlation between the products' sensory profile and the consumers preferences or perceived quality [43].

However, according to Prescott [44], perception is multidimensional, meaning that it is the integration of sensory signals elicited by different sensory dimensions (visual, olfactory, taste, tactile) rather than a sum of individual signals measured by DA, i.e., DA measures monodimensional attributes in order to identify the differences between the products. This is one of the limitations of DA when used in complex products, such as wine, as well as the need of having a highly specialized and trained panel (cost) and also the assumption that the trained panel and the consumers have the same perception (difficult to link DA to hedonic data), those are reasons why in the last decade alternative techniques have emerged [43].

Alternative techniques are in general less time consuming, faster, flexible and good alternatives to the classic methods, both in terms of timing and training requirements. The training time can be reduced or eliminated, since the participants are the consumers and the discrepancy between consumers' perception (hedonic ratings) and trained panellists (sensory profile) is also reduced [42], [43].

According to Varela et al. [42] and Valentin et al. [45], alternative methods are based on different approaches, such as, the evaluation of individual attributes also known as Verbal-based methods (Check-all-that-apply - CATA, Flash Profiling), these methods generate a direct description of the products, like DA; evaluation of global differences or Similarity-based methods (Free Sorting Task, Napping®); comparison with product references, named also as Referenced-based methods (Polarized Sensory Positioning - PSP) and based on Free Global evolution (open-ended questions).

All these methods are complementary to DA, which cannot be replaced when an accurate description is needed. They act as a tool to obtain the product description and feedback, directly from the consumers.

Tasting-based approaches are limited to samples that are previously selected and during the tasting section the participants might be affected by fatigue, which is mainly associated to the accumulation of astringency and bitterness. Therefore, and based on the results achieved by Jose-Coutinho et al. [46] and Sáenz-Navajas et al. [43], the cognitive-based descriptive methodology can be a promising tool to conduct large scale sensory studies and at the same time overcome the drawbacks of based-tasting approaches.

2.4 Memory and Questionnaire Based Methodology Applications

As mentioned in the previous section, an ill-defined sensory concept by a long-term memory-based strategy was used by Sáenz-Navajas et al. [43] to access the characterization of green red wine for Spanish experts. The mentioned study was based on a free description task evoking the last green wine that participants had tasted, appealing to their memory. Using an open question, such as “Could you describe the last green wine you tasted?”, the researchers obtained a wide range of responses and those responses allowed researchers to obtain a theoretical green red wine prototype for Spanish experts. A “wine tasting script” was clearly used by participants following the structure: colour, aroma, taste and mouthfeel, global multimodal descriptors and finally an hedonic judgment.

Jose-Coutinho et al. [46] also developed a study to describe white wine sensory profile of all 12 Protected Geographical Indications (PGIs) of mainland Portugal using only experts’ memory, without wine tasting samples. One more time the uses of a long-term memory characterize the expert’s prototype of a typical white wine from a specific PGI. The main question that experts were expected to answer was “How would you define a typical young commercial white wine from this particular PGI and score each sensory attribute accordingly?” and this answer was obtained using a survey designed according to the three-tier sensory method assessment: colour, aroma and taste/mouthfeel sensations. Colour was assessed in its intensity (0 for extremely diluted to 10 for extremely intense) and tonality, with only 3 options: yellow green, straw yellow, yellow gold. The aroma was evaluated using 17 aromatic

categories, referenced in the literature and used in the form of aroma wheels. The taste was evaluated using 13 measures, including sour, sweet, salty and bitter tastes, as well as mouthfeel categories, such as dryness, roughness, astringency or body. For each category the participant needed to check, in an integer value scale, if the given variable was no trace (0) or extremely intense (10). The achieved results found three macro-zonings, clustering all 12 Portugal PGIs, with typicality differences, statistically validated and sensorially described.

The Vividness of Wine Imagery Questionnaire (VWIQ) developed by Croijmans et al. [32] measures mental imagery of wine in the visual, olfactory and taste modalities and was designed to explore individual mental imagery, track the development of expertise as well as an evolutive tool in wine education. This questionnaire focused on the senses that are accessible to novices and experts alike, excluding those components which might require specific training, such as mouthfeel and aftertaste. Generically, the questionnaire is based on a scenario description (e.g., “You have tasted several wines, and the hostess presents the last wines for the tasting.”) and three sentences presented related to the colour, odour and taste of wine in each scenario (e.g., “The colour of a white wine, a Chardonnay, that she gives you to try; The smell of the next red wine you try, a Pinot Noir; The taste of this red wine (Pinot Noir) when you try and taste the wine”) each one rated by the participants on the following scale: 1 - No image at all (only “knowing” that you are thinking of the object); 2 - Vague and dim; 3 - Moderately clear and vivid; 4 - Clear and reasonably vivid; 5 - Perfectly clear and as vivid as the real situation.). The results obtained for validation with this methodology support that the mental imagery is modality-specific, i.e., the imagery is not general but a separate construct of visual, olfactory and taste imagery. However, the study revealed a strong vividness of imagery of wine using visual modality, i.e., dominance of vision in mental imagery.

Besides long-term memory and mental imagery studies, questionnaire-based studies are very common in wine sector, mainly to understand consumers’ wine preferences, to estimate consumers’ willingness-to-pay or to know market tendencies.

Sellers [47] and Di Vita et al. [48] developed, separately, studies on sustainable and organic wines and the consumers’ willingness-to-pay in Spain and Italy, respectively. In both cases, qualitative and quantitative information about attitudes and purchase behaviour with respect to the topic were collected. Questions such as “Are you willing to pay more for a sustainable wine with respect to a conventional wine with similar characteristics?” or “How much are you willing to pay for an organic wine?” are examples of what was asked to the participants. The overall results showed that Spanish consumers are willing to pay a premium price for a sustainable wine if it has the same characteristics than a conventional one. On the other hand, the Italian consumers are willing to pay an additional price for organic wines compared to conventional ones.

Mehta and Bhanja [49] used in-depth interview as methodology to identify the attributes of primary importance in the wine selection process for young Indian wine drinkers. The interview included questions about general preferences, consumption and motivation behaviour as well as occasions for consumption and how the choice of wine is made. The highest importance was given to price followed by type of wine. Attributes as brand, taste, origin were referred as other important factors but with minor differences in importance.

This summarized review of some non-tasting studies supports the problem statement and the research methods presented in this research by validating that non-tasting mental descriptive methodologies have been used with successful and interesting results in previous research.

3 Research Methods

3.1 Online Survey

The online survey was conducted using the Google Forms platform with the goal of understanding the perceptions and preferences of participants about aging wines, especially dry white wines. Besides demographic questions, such as age and country of origin, the intent was to collect information regarding the concept of what should be an aged white wine, its descriptors, complexity, associated emotions and potential of aging when in comparison with red and dessert wines. Distribution of the survey occurred mainly through students' and professors' mailing lists, as well as personal contacts in the wine sector and social networks.

All responses were anonymous and the participants were informed that the data would only be used for academic purposes and would not be shared with any other entity.

The survey was composed of 24 questions spread between 4 sections: Introduction, Demographic and Wine Habits, Overall Wine Preferences and Aged Dry White Wines Attributes, and was written in an attempt to take no more than 10 to 15 minutes to complete. The Appendix I, include the questionnaire details.

Concerning the sensory descriptors, an adaptation of CATA methodology was applied in order to uniform the descriptors for each parameter, reducing the ambiguity and overcome the use of the "everyday language", which is associated to the individual and previous experience, commonly used by consumers.

3.1.1 Procedure Limitations

The following non-predicted limitations were encountered regarding the online questionnaire:

- Google Forms platform did not allow the participants located in China to easily participate, since all Google products are forbidden in that country;
- English language was a barrier for some non-native English speakers, which might justify the smaller number of participants from Spain. This barrier was solved for some Portuguese speakers with a Portuguese version, delivered in Brazil;
- Some participants faced a couple of issues if they were using a mobile phone to reply to the survey;
- When the participants were asked to rank the styles of wine by preferences, using a Likert scale, the question was not very clear as well as the error message and some participants reported problems in moving forward;

- The question "Years of wine industry experience" raised some doubts among the participants because those that said that they did not work in the sector, instead of choosing "Not Applicable" option, selected a range of years of experience.

3.1.2 Data Analysis

In order to identify the most relevant attributes chosen by the participants, a citation frequency method was used based on the Percentage Frequency (PF) parameter represented by the formula PF = FN / N, where FN is the number of times a descriptor has been chosen by participants and N is the total number of participants. This parameter (with the same formula) has been used in Picard et al. [50] and has been validated by Barbe et al. [51] as a way to obtain significant and representative results given that it is applied on a sample bigger than or around 30 participants. In the following results (i.e. tables) PF will be described as “frequency of citation (expressed in %)”.

The effect of expertise and country of origin on the frequency of citation of terms by category was assessed by means of Chi-square (χ^2) per cell analysis and Marascuilo post-hoc pairwise comparisons (95%) were carried out for significant effects, identifying the source of variation of the Global Chi-square tests. Only terms mentioned by at least 20% of the participants, in at least one group, were included in the analysis. The total results can be found in Appendix II. Analysis were carried out using XLSTAT software (version 2021.3.1.1135, Addinsoft, New York, USA).

4 Results and Discussion

4.1 Participants Characterization

In total, 680 participants answered the survey between 22/02/2021 and 31/03/2021. The majority of the responses were from Europe (72.8%), followed by 16.8% from South America (mainly from Brazil), Asia with 6.0%, 3.8% from North America, 0.4% and 0.1% from Oceania and Africa, respectively. From all the participants, 45.1% of them were from Portugal and 16.6% from Brazil, followed by Italy (9.4%) and France (7.4%), with other countries, with smaller representations, between 0.1% to 3.4%.

A majority of participants (76.8%) come from countries which we would include in the “Old World”, while 23.2% come from countries represented as “New World”, such as Brazil. This difference is mainly geographic, “Old World” refers to the traditional winegrowing regions of Europe or their surroundings and “New World” refers to everything else.

Since one of the objectives of this work is to understand what is the influence of expertise on the delimitation of the sensory image without tasting, it is important to define (**Table 4.1**)

and characterize the two groups: Novices and Experts. **Table 4.1** defines Novices and Experts based on two survey questions. We defined Novices as participants who do not work in the wine sector and tasting wine is not part of their job. In opposition, an Expert can be a participant who works in wine sector or tasting is part of the job, or both.

This division intends to clearly separate those who are not associated with the wine business, with the aim to have two groups defined by real functions and not dependent on self-reported or high or low involvement.

Table 4.1. Novices' and Experts' definition based on two survey questions.

	Do you work in the wine sector?	Is wine tasting part of your job?
Novices	✗	✗
	✗	✓
Experts	✓	✗
	✓	✓

Novices represented 46.9% of the total participants and they were mainly from Portugal (48.0%) and Brazil (26.3%), with an interesting participation from Armenia (6.6%) and Italy (6.0%). **Table 4.2** shows an homogeneous age distribution and the Novices participants characterize themselves as having an interest or being highly interested in wine but, as expected, with an unassuming position regarding their knowledge.

Experts represented 53.1% of the total of the participants and the demographic information, as well as the wine consumption frequency, wine knowledge and interests are shown In **Table 4.2**.

Portugal, following the overall geographic distribution, was also the country with the higher participation of Experts (42.7%), although France appeared as the second country with more Experts (13.3%), followed by Italy (12.5%).

It is interesting to notice the tendency of the age distribution to the younger groups (18 - 29 and 30 - 39) in the Experts segment. Even without statistical analysis, it seems that a higher level of education in wines amongst younger generations was present, by comparison with the distribution from Novices. Experts characterized themselves as knowledgeable and highly knowledgeable with 49.0% and 45.4%, respectively. Nevertheless, it is important to mention that one expert selected the "No knowledge" option, reflected in **Table 4.2**. Without surprise the option most picked by the Experts to characterize their wine interest was "Highly interested".

In both groups, Novices and Experts, the option "2 to 3 times per week" was the one with higher percentages for wine consumption frequency, 32.9% for Novices and 48.8% for Experts.

Table 4.2. Demographic characterisation of online survey participants.

	Group	Total (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)
Countries[1]	"Old World"	76.8	82.8	70.2
	Portugal	45.1	42.7	48.0
	"New World"	23.2	17.4	29.7
	Brazil	16.6	8.0	26.3
Age	18- 29	30.6	37.1	23.2
	30 - 39	26.9	28.8	24.8
	40 - 49	18.5	15.2	22.3
	50 - 59	15.3	11.4	19.7
	> 60	8.7	7.5	10.0
Wine Interest	No interest	1.5	0.0	3.1
	Limited interest	10.3	1.1	20.7
	Interested	24.0	11.4	38.2
	Highly interested	64.3	87.5	37.9
Wine Knowledge	No knowledge	3.4	0.3	6.9
	Limited knowledge	26.6	5.3	50.8
	Knowledgeable	44.4	49.0	39.2
	Highly knowledgeable	25.6	45.4	3.1
Consumption Frequency	Daily	25.3	33.0	16.6
	2 to 3 times a week	41.3	48.8	32.9
	1 time per week	14.6	11.6	17.9
	1 to 3 times per month	8.7	3.9	14.1
	Occasionally	10.1	2.8	18.5

Before going further in the analysis it is interesting to see the average number of descriptors used/checked by each segment (Experts and Novices) in each category. **Table 4.3** shows that Experts checked in average more descriptors than Novices, this suggests that Experts have more developed vocabulary than Novices. Furthermore, Experts might also have tasted different aged dry white wines with different profiles leading to different associations, when compared to Novices. Another interpretation might be that Experts select more of the available options in order to guarantee a correct answer. These results will be further

[1] Countries from "Old World" included: Armenia, Austria, Belgium, Denmark, France, Georgia, Germany, Greece Italy, Netherlands, Norway, Poland, Romania, Russia, Portugal, Turkey, Scotland, Spain, United Kingdom, Switzerland, Ireland, Ukraine. Countries from "New World" were: Brazil, USA, China, South Africa, South Korea, Canada, Colombia, Australia.

supported when analysing individual (Experts and Novices) hierarchical characterization (**Figure 4.6** and **Figure 4.7**).

Table 4.3. Average number of descriptors checked by Experts and Novices regarding each category.

	Experts	Novices	Number of descriptors
Colours	2.5	2.0	7
Aromas	5.5	3.6	20
Taste and Mouthfeel sensations	4.0	3.1	12
Global Appreciation	5.6	3.9	20
Occasions	4.2	3.6	11
Feelings	4.4	3.2	16

4.2 Aging Perception

Regarding the old wine perception section (**Table 4.3**), 62.8% of the participants said that the Red Wine was the older type of wine they enjoyed the most, followed by White Wine with 21.9% and Dessert Wine with 15.3%. 50.3% of the participants believed that a White Wine should be regarded as old if the wine has 6 to 10 years, a Red Wine is considered old for 48.1% if it has 11 to 20 years and 34.7% said that an old Dessert Wine might be 11 to 20 years old. Finally, 50.7% said that a white wine aged worse when compared to a red wine.

Table 4.4. Frequency of answer (expressed in %) for each segment (Experts and Novices) regarding the survey questions about old perception. Significance (P) calculated from chi-square test (ns: non- significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Survey Question	Group	All (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)	*p*
Which type of older wine did you enjoy the most?	**Red Wine**	**62.8**	**55.1**	**71.5**	****
	White Wine	**21.9**	**27.4**	**15.7**	****
	Dessert Wine	15.3	17.5	12.9	*
From what age is a dry white wine considered old?	**2 - 5 years**	**25.9**	**18.3**	**34.5**	****
	6 - 10years	**50.3**	**54.8**	**45.1**	**
	11 - 20 years	20.9	23.3	18.2	ns
	21 - 40 years	2.6	3.6	1.6	*
	> 40 years	0.3	0.0	0.6	ns
From what age is a red wine considered old?	**2 - 5 years**	**4.3**	**2.2**	**6.6**	***
	6 - 10 years	**34.0**	**26.3**	**42.6**	****
	11 - 20 years	**48.1**	**54.8**	**40.4**	****
	21 - 40 years	**13.1**	**16.3**	**9.4**	***
	> 40 years	0.6	0.3	0.9	ns
From what age is a dessert wine considered old?	**2 - 5 years**	**12.9**	**7.2**	**19.4**	****
	6 - 10 years	20.1	17.7	22.9	*
	11 - 20 years	34.7	34.3	35.1	ns
	21 - 40 years	**24.4**	**30.2**	**17.9**	****
	> 40 years	**7.8**	**10.5**	**4.7**	***
How do you believe that a dry white wine ages in comparison to a red wine?	**Better**	**12.2**	**8.0**	**16.9**	****
	Worse	50.7	51.9	50.5	ns
	Same	**37.1**	**41.0**	**32.6**	**

Besides the percentages of answers for each category regarding old wine perception or from what age a dry white wine is considered old, it is interesting to know who were the participants that believe that a dry white wine is old from 21 - 40 years (**Table 4.5**).

We can see that among the people who chose the range 21 – 40 years from what age a dry white wine is considered old, Experts are over represented compared to the Novices even if this difference is considered to not be significant (p-value (0.105) > 0.05). So, it is easy to accept that the higher percentages regarding the wine knowledge belong to the "Knowledgeable" and "Highly knowledgeable", with 38.9% and 50%, respectively, even if those

percentages do not mean a correspondence between the knowledge and the choice of the range 21 – 40 years (p-value > 0.05). In opposition, it was noticed that being highly interested is linked to the range choice because the p-value (0.004) for this category is inferior to the significance level of 5% (0.05).

Table 4.5. Characterization of the participants who believe that a dry white wine is old from 21-40 years and who believe that a dry white wine ages better in comparison to a red wine expressed in % and the p-value for a significance level of 5%, marked in bold the p-values < 0.05.

	Group	21 – 40 years		Better	
		% (n=18)	*p*-value	% (n=83)	p-value
Expertise Level	Expert	72.2	0.105	**34.9**	**<0.001**
	Novices	27.8	0.105	**65.1**	**<0.001**
Age	18 - 29	22.2	0.459	**20.5**	**0.030**
	30 - 39	33.3	0.533	19.3	0.091
	40 - 49	22.2	0.663	**28.9**	**0.014**
	50 - 59	11.1	0.674	20.5	0.173
	> 60	11.1	0.673	10.8	0.452
Wine Interest	No interest	0.0	0.763	2.4	0.462
	Limited interest	0.0	0.138	**20.5**	**0.003**
	Interested	5.6	0.053	30.1	0.169
	Highly interested	**94.4**	**0.004**	**47.0**	**0.001**
Wine Knowledge	No knowledge	0.0	0.534	3.6	0.853
	Limited knowledge	11.1	0.129	**43.4**	**<0.001**
	Knowledgeable	50.0	0.635	39.4	0.064
	Highly knowledgeable	38.9	0.212	18.1	0.090
Consumption Frequency	Daily	44.4	0.077	26.5	0.777
	2 to 3 times a week	50.0	0.459	34.9	0.209
	1 time per week	5.6	0.292	15.7	0.744
	1 to 3 times per month	0.0	0.191	6.0	0.374
	Occasionally	0.0	0.142	**16.9**	**0.043**

It is also interesting to know who were the participants that believe that a dry white wine ages better in comparison to a red wine (**Table 4.5**). We can see that among the people who chose “Better” in the survey question “How do you believe that a dry white wine ages in comparison to a red wine?”, Novices were over represented (65.1%) compared to the Experts (34.9%). The ages distribution was quite homogeneous, although two groups (18 - 29 and 40 - 49) stand out, having statistical significance (p-value < 0.001). Concerning the wine interest, the higher percentage belongs to “Highly interested” with 47% and it is linked to the choice

because the p-value (0.001) for this category is inferior to the significance level of 5% (0.05). The “Limited interested” choice is also linked to the “Better” choice since p-value (0.003) < 0.005, which might be justified by the fact the participants are informed that the survey is about aged dry white wines, so they might have been biased to respond “Better” due to the aim of the survey. 43.4% who believe that a dry white wine ages better in comparison to a red wine considered themselves as having “Limited knowledge”. In terms of the consumption frequency only the participants who drink wine occasionally influenced the choice of the “Better” option (0.043 < 0.005).

Looking at **Table 4.5** we can infer an interesting, and perhaps expected, association: those that self-assess as having a higher interest in wine (i.e. “Highly interested”), and not necessarily a higher knowledge, are key differentiators for both answers. Furthermore, in **Table 4.5**, we notice that three of the statistically significant values (i.e. “Limited interest”, “Limited knowledge” and “Occasionally”) are self-assessments by participants and represent participants that are potentially less knowledgeable about wine. This might also be associated with, and help explain, why there’s an overrepresentation of Novices in **Table 4.5**, along with the explanations in the previous paragraph.

4.3 Effect of Expertise

4.3.1 Colours

Following the descriptors presented in **Table 4.6**, Deep Gold was the most cited colour for an aged dry white wine for both segments. This colour is usually associated to an aged white Rioja wine [11] which supports the Experts’ choice and the statistical difference between Experts and Novices, since Experts might be more familiar with these wines. Pale Brown, which is associated to the colour of Sherry wine or an aged dry white wine, revealed not to be statistical different between Experts and Novices. The colour less cited (Medium Yellow) was the one which was included on the survey as a colour of young white wines made from Sauvignon Blanc, Sémillon or Vermentino [11]. Although the frequency of citation appears very similar (17.5% for Experts and 20.1% for Novices) the pairwise comparison reveals that the proportion of Novices that mentions Medium Yellow is unexpectedly higher than the theoretical values.

Table 4.6. Frequency of citation (expressed in %) of terms associated to the characterization of aged dry white wines by colours and significance (P) calculated from chi-square test (ns: non- significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Colours	All (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)	*p*
Deep Gold	63.4	**76.5**	**48.6**	**
Pale Brown	45.6	52.9	37.3	ns
Deep Yellow	40.3	48.8	30.7	ns
Medium Amber	32.1	32.7	31.1	*
Deep Amber	21.2	21.9	20.4	ns
Medium Yellow	18.7	**17.5**	**20.1**	**

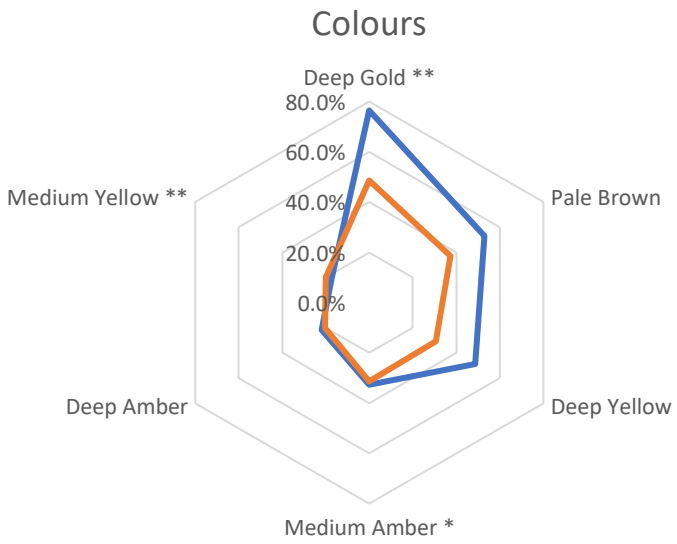

Figure 4.1. Visual representation of frequency of citation (%) of terms for colours associated to the characterization of an aged dry white wine, between Novices and Experts.

Figure 4.1 represents a clear trend for Experts to mention more the colours Deep Gold, Pale Brown and Deep Yellow, while Novices' distribution of selection seems more homogeneous.

4.3.2 Aromas

Regarding the aroma descriptors, represented in **Table 4.7**, Honey was the descriptor most cited by the Experts and Dried Fruit the one most picked by the Novices. The higher significances appeared in the Curry, Oak and Petroleum/Kerosene aromas, mainly higher percentages for the Experts which might be explained by the specificity of these terms.

Although, the choice of Bruised Apple, Spicy, Straw and Wet Stone as aromatic descriptors of an aged white wine was independent of the expertise level.

Table 4.7. Frequency of citation (expressed in %) of terms associated to the characterization of aged dry white wines by aroma and significance (P) calculated from chi-square test (ns: non- significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Aromas	All (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)	*p*
Dried Fruit	62.1	**70.4**	**52.7**	**
Honey	56.3	**77.0**	**32.9**	***
Caramel	46.2	53.2	38.2	*
Oak	45.4	**46.0**	**44.8**	****
Beeswax	33.4	**46.5**	**18.5**	***
Petroleum / Kerosene	32.1	**50.1**	**11.6**	****
Bruised Apple	29.7	38.0	20.4	ns
Earthy	19.6	**20.8**	**18.2**	**
Spicy	19.3	24.9	12.9	ns
Wet Stone / Flint Stone	19.3	25.5	12.2	ns
Straw	18.4	20.8	15.7	ns
Floral	17.4	**13.6**	**21.6**	****
Curry	13.7	**21.1**	**5.3**	****

Although Oak and Earthy present very similar frequency of citations, their statistical meaning is mostly derived from unexpectedly higher proportions of Novices selecting both these aromas. On the other hand, Bruised Apple, although having a different frequency of citation, appears as having similar proportions of selection between Experts and Novices, justifying the non-significance presented in **Table 4.7**. It is interesting to notice that Floral aroma is the only aroma where there's a frequency of citation higher in Novices rather than Experts.

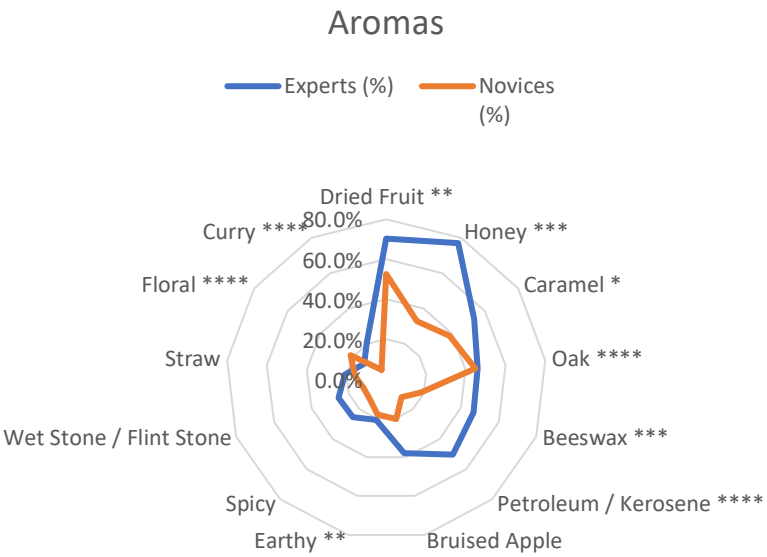

Figure 4.2. Visual representation of frequency of citation (%) of terms for aromas associated to the characterization of an aged dry white wine, between Novices and Experts.

Figure 4.2 represents a visualization of the contents of **Table 4.7** in which we can corroborate the idea that Experts have a wider range of descriptor selections, while, Novices seem to focus on a few descriptors that they identify as familiar in wine descriptions such as Oak, Dried Fruit and Floral.

4.3.3 Taste and Mouthfeel Sensations

Without surprise Body was the mouthfeel sensation most cited in both segments while the less cited by Experts was the Sweetness attribute and for Novices the Saltiness, see **Table 4.8**. Both attributes (Sweetness and Saltiness) are statistical different between both groups. Saltiness is a less know attribute by the ones with lower involvement in the sector, as well as, difficult to describe or identify in a tasting session. In this case Experts might have had the chance to taste a wine with saltiness taste and memorized the sensation and associate that to aged dry white wines. Sweetness has higher frequency of citation in Novices due to the common association to the dessert/fortified wines, which in most cases are aged wines.

Table 4.8. Frequency of citation (expressed in %) of terms associated to the characterization of aged dry white wines by Taste and Mouthfeel sensations and significance (P) calculated from chi-square test (ns: non- significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Taste and Mouthfeel Sensations	All (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)	*p*
Body	61.0	69.5	51.4	ns
Length	52.1	**66.8**	**35.4**	***
Viscosity	41.5	47.6	34.5	ns
Smoothness	38.8	45.7	31.0	ns
Dryness	36.9	39.6	33.9	*
Acidity	36.6	44.9	27.3	ns
Sweetness	17.6	**12.7**	**23.2**	****
Saltiness	16.5	**23.3**	**8.8**	***

Length is the descriptor that displays a higher discrepancy between Experts and Novices, which can be attributed to the fact that Length is a more technical descriptor and more difficult to define. Although Acidity has a different frequency of citation between segments (44.9% for Experts and 27.3% for Novices), this difference is not significant because of the similar proportions of selection between Experts and Novices.

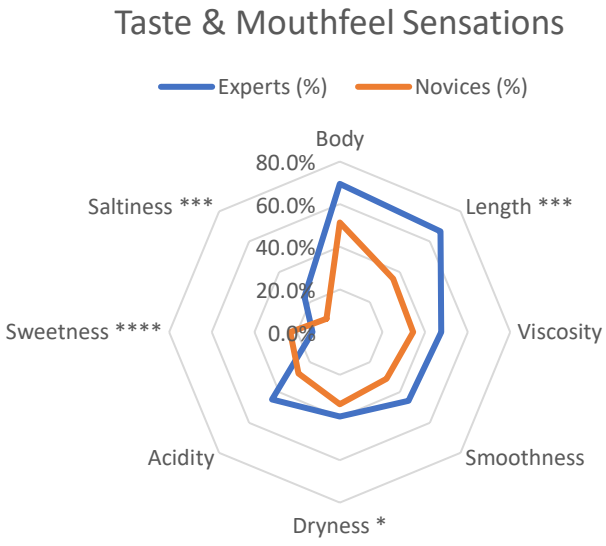

Figure 4.3. Visual representation of frequency of citation (%) of terms for taste and mouthfeel sensations associated to the characterization of an aged dry white wine, between Novices and Experts.

As mentioned before, Experts have a more focused characterization although each of them mentioned more descriptors. Novices have a frequency of citation mostly homogenous in most of the descriptors with the exception of body and saltiness, highlighted by the positive

and negative variation presented in **Figure 4.3**. **Figure 4.3** supports the idea explained above for length, acidity and saltiness in which the variation between Experts and Novices is totally different.

4.3.4 Global Appreciation

Table 4.9 shows that independently of the expertise level, both segments characterize an aged dry white wine as Complex and Persistent, with no significant differences. Besides the higher frequency of citation of Experts that cited Complex (85.9%), the proportions are very similar to the proportion of Novices who checked the same descriptor, justifying the non-significance. The effect of expertise in the global appreciation is mainly noticed in the choice of terms with more difficult definition, such as Durable Wine Fragrance (p-value < 0.001) and Concentrated in Flavours, Creamy and Round with p-value < 0.01.

Table 4.9. Frequency of citation (expressed in %) of terms associated to the characterization of aged dry white wines by global appreciation and significance (P) calculated from chi-square test (ns: non- significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Global Appreciation	All (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)	*p*
Complex	70.4	85.9	53.0	ns
Persistent	52.6	61.8	42.3	ns
Rich	45.9	59.6	30.4	*
Concentrated in Flavours	43.8	**46.0**	**41.4**	***
Evolution of the Wine in Glass	43.1	**57.6**	**26.6**	**
Concentrated in Mouth	41.3	**44.9**	**37.3**	**
Balanced	31.0	37.7	23.5	ns
Creamy	25.6	**36.0**	**13.8**	***
Durable Wine Fragrance	25.6	**23.3**	**28.2**	****
Round	22.4	**31.9**	**11.6**	***
Mineral	18.5	24.7	11.6	ns

Figure 4.4 corroborates the explanations above, where for the Novices an aged dry white wine is clearly described as: Complex, Concentrated in Flavours, Concentrated in Mouth and Durable Wine Fragrance, presented by the spikes. On the other hand, Experts have considered multiple descriptors as equally relevant for their characterization of an aged dry white wine.

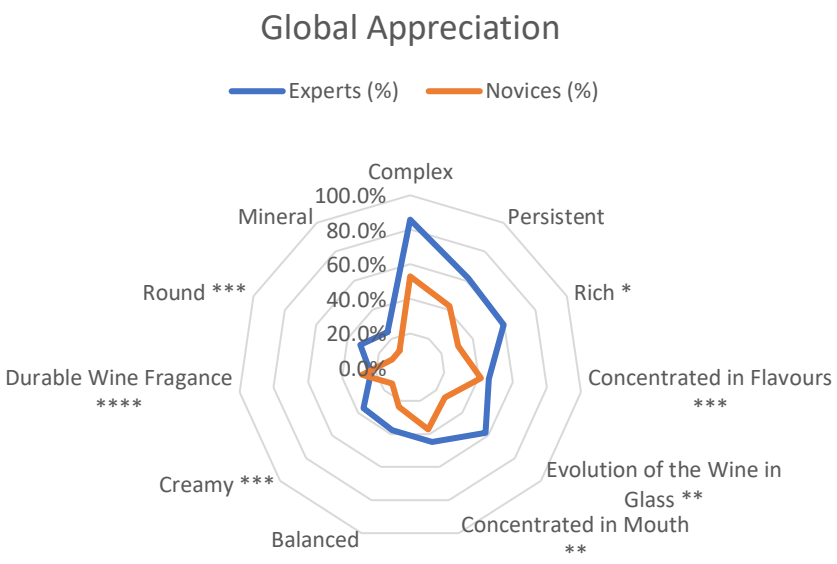

Figure 4.4. Visual representation of frequency of citation (%) of terms for global appreciation associated to the characterization of an aged dry white wine, between Novices and Experts.

4.3.5 Occasions & Feelings

In terms of occasions when aged dry white wine consumption occurs, there are three moments that are particularly statistically different between Experts and Novices, as described in **Table 4.10**: Restaurant Meal, Pre-meal Drink and Party. In the first situation – Restaurant Meal – there seems to be a prevalence tending for Experts. Experts have chosen this occasion considerably more than Novices. On the other hand, Pre-meal Drink and Party, seem to be two occasions where we have an unexpectedly high proportion of Novices claiming to consume aged dry white wine. These results seem to indicate that Novices consume aged dry white wine in occasions that are typically more relaxed, while Experts have a tendency to consume aged dry white wine in multiple occasions, without any special relevance towards relaxing occasions.

Table 4.10. Frequency of citation (expressed in %) of terms associated to the characterization of aged dry white wines by consumption occasions and significance (P) calculated from chi-square test (ns: non- significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Occasions	All (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)	*p*
Special Occasion	64.4	74.0	53.6	*
Restaurant Meal	52.9	**64.3**	**40.1**	***
Meeting with Friends	51.5	54.8	47.6	ns
Enjoy Wine by Myself	45.4	52.9	37.0	*
Romantic Meal	44.0	46.8	40.8	ns
End-of-day Drink at Home	30.6	29.9	31.3	ns
Business Event	30.4	31.6	29.2	ns
Causal Meal	23.5	22.4	24.8	ns
Pre-meal Drink	22.1	**19.4**	**25.1**	***
Party	16.3	**11.6**	**21.6**	****

In **Table 4.11** we can see results for feelings that are associated with an aged dry white wine. While Elegant and Interesting have been the top selections by total participants. From these results, three feelings stand-out by their statistical difference between Experts and Novices: Elegant, Memorable and Surprising. For Elegant, the statistical difference, although the frequency of citation is the same, can be explained by the fact that Novices have selected this feeling more in proportion to their overall selections.

Memorable and Surprising stand in the other opposite because Experts have selected it proportionally more than Novices, while also having a high frequency of citation. These feelings might be associated to the higher knowledge, or improved memory of Experts, due to the fact that they might have already tried different aged dry white wines, while Novices might have never had that chance.

Finally, Interesting has a very heterogeneous frequency of citation – much higher amongst Experts than Novices – but both segments have selected it in a similar proportion when considering all of their selections, which explains the fact that there's no statistical significance behind that difference.

Table 4.11. Frequency of citation (expressed in %) of terms associated to the characterization of aged dry white wines by feelings associated with these wines and significance (P) calculated from chi-square test (ns: non-significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Feelings	All (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)	*p*
Elegant	59.0	**60.4**	**57.4**	****
Interesting	58.4	70.6	44.5	ns
Memorable	53.1	**67.3**	**37.0**	**
Pleasant	42.5	47.4	37.0	ns
Harmony	42.4	47.1	37.0	ns
Surprising	41.6	**55.1**	**26.3**	***
Desirable	34.7	41.0	27.6	ns

4.4 Associated Regions

In this section, the aim is to understand how the country of origin of the participants influences the knowledge about the regions associated with aged dry white wine production. Comparing countries from “Old World” and the “New World” (mentioned in[1]), Burgundy in France is the most cited region associated to the production of aged dry white wine in both groups, without significance effect between them (**Table 4.12**). **Table 4.12** shows that the most significant difference between these two groups occurs in the citation of Colares in Portugal, with 41.4% versus 25.9%. This discrepancy might be biased by the Portuguese participants, since they are 45.1% of the total of the participants from countries from ”Old World”.

Table 4.12. Frequency of citation (expressed in %) of terms associated to the characterization of aged dry white wines by regions associated with production of these wines and significance (P) calculated from chi-square test (ns: non- significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Regions	"Old World" (%) (n=522)	"New World" (%) (n=158)	*p*
Burgundy, France	50.0	58.2	ns
Dão, Portugal	44.1	34.8	*
Colares, Portugal	**41.4**	**25.9**	***
Rhine Valley, Germany	35.8	40.5	ns
Bordeaux, France	35.2	39.9	ns
Rioja, Spain	21.6	30.4	*
California, USA	16.9	20.9	ns

Since the majority of the participants are from Portugal, it would be interesting to understand if the results showed in **Table 4.12** are biased by the Portuguese responses or not. **Table 4.13** shows that the Portuguese regions are less cited by the participants from "Old World" countries, if the Portuguese responses are not accounted for. Burgundy in France is also the most cited in both groups. Dão and Colares in Portugal have more frequency of citation in the "New World" countries than in "Old World" countries (without Portugal) and this behavior reflects the weight of participants from Brazil in the sample.

Table 4.13. Frequency of citation (expressed in %) of terms associated to the characterization of aged dry white wines by regions associated with production of these wines without Portuguese responses and significance (P) calculated from chi-square test (ns: non- significant; *P < 0.1; **P < 0.05; ***P < 0.01;****P < 0.001) with pairwise post-hoc comparison (95%) marked in bold.

Regions	"Old World" (without Portugal) (%) (n=215)	"New World" (%) (n=158)	*p*
Burgundy, France	63.7	58.2	ns
Rhine Valley, Germany	48.4	40.5	ns
Bordeaux, France	42.3	39.9	ns
Rioja, Spain	25.6	30.4	ns
California, USA	23.7	20.9	ns
Dão, Portugal	**23.3**	**34.8**	**
Colares, Portugal	17.2	25.9	*

With these results, we might infer that our sample reflects an association of France (specially Burgundy) and Germany (Rhine Valley) as regions associated with the production

of aged dry white wines. Rhine Valley has a great association to Riesling, which might explain the participants' association. Also, comparing the results from **Table 4.12** and **Table 4.13** it is possible to infer some ethnocentrism from the foreign participants and the lack of knowledge about Portuguese wines.

4.5 Sensory Conceptual Wheels

4.5.1 Hierarchical Characterization

Figure 4.5 illustrates the hierarchical classification of categories of descriptors most cited by participants when characterizing an aged white wine. A total of 28 descriptors have been mentioned by more than 20% of the participants and they have been categorized in four main categories: Colours, Aromas, Taste and Mouthfeel Sensations and Global Appreciation. These descriptors, and associated hierarchical classification, have been obtained by analysing the results of both Novices and Experts jointly.

In terms of colour, Deep Gold has been associated with aged white wines by most participants, with Pale Brown and Deep Yellow following. It is interesting to notice that Deep Gold and Deep Yellow, similar colours to untrained eyes, make up a large portion of the wheel in **Figure 4.5** regarding colours. 5 out of 7 possible colours (approx. 71%) were mentioned with Pale Straw and Medium Yellow not being regarded as much by participants as associated with aged white wines.

Figure 4.5. Sensory Wheel of common categories of descriptors, along with specific descriptors, cited by at least 20% of the participants, describing an aged dry white wine.

Dried Fruit, Honey, Caramel and Oak were the descriptors most associated with aged white wines, when thinking about aromas, by participants. Participants have also made relevant mentions to Beeswax, Petroleum/Kerosene and Bruised Apple. Only 7 aromas have made it into the wheel represented in **Figure 4.5** out of 20 possible aromas, approximately 35%.

Considering Taste and Mouthfeel sensations, participants have considered that Body and Length are the most associated with aged dry white wines, followed by Viscosity, Smoothness, Dryness and Acidity. Only 6 out of 12 (50%) taste and mouthfeel sensations have been associated enough to be counted for the hierarchical representation in **Figure 4.5**.

Finally, in terms of global appreciation, participants have considered Complexity as a defining descriptor for aged white wines. Persistent, Rich, Concentrated in Flavours/Mouth and Evolution of Wine in Glass have also been mentioned as closely associated with the concept of an aged white wine. 20 descriptors were mentioned and, of those, only 10 (50%) have been selected sufficiently to be included in the wheel represented in **Figure 4.5**.

Figure 4.5 provides a glimpse of how participants, both Novices and Experts, would characterize an aged white wine. Based on these findings, we can infer that these participants would characterize these wines as complex, full-bodied wines, tending to variations of yellow (Deep Gold and Deep Yellow) in terms of colour, with aromas ranging from Dried Fruit and Oak, to sweeter aromas such as Caramel and Honey.

4.5.2 Experts and Novices

Figure 4.6. Sensory Wheel of common categories of descriptors, along with specific descriptors, cited by at least 20% of the Experts, describing an aged dry white wine.

Figure 4.6 illustrates the hierarchical classification of categories of descriptors most cited by Experts when characterizing an aged white wine and in the same way **Figure 4.7** illustrates the characterization of an aged dry white wine by Novices.

A total of 35 terms have been mention by more than 20% of Experts while the total of terms checked by more than 20% of Novices was only 27.

In terms of colours, Experts mentioned 5 out of 7 possible colours, excluding Medium Yellow and Pale Straw options. On contrary, Novices believe that an aged dry white wine could have 6 colours out of the 7 available, only the Pale Straw option was rejected. Comparting both these wheels (**Figure 4.6** and **Figure 4.7**) with the one in **Figure 4.5**, it suggests that the conceptual characterization regarding the Colour for the total of the participants is more similar with the vision of the Experts. Medium Yellow is a descriptor that has some relevance for Novices but, at the same time, that descriptor wasn't mentioned by more than 20% of Experts.

Figure 4.7. Sensory Wheel of common categories of descriptors, along with specific descriptors, cited by at least 20% of the Novices, describing an aged dry white wine.

Honey, Dried Fruit and Caramel were the descriptors most picked by Experts, with a total of 12 terms out of 20 (60%). In Novices selection, Honey aroma was replaced by Oak aroma, as the 2nd one most cited (44.8%), in a total of 6 out of 20 descriptors (30%). Floral was the only aroma used by Novices which is not part of the aroma description made by the Experts. It is important to notice that Petroleum/Kerosene and Beeswax are aromas that exist mostly in the Experts' conceptual characterization and with enough relevance to also appear in the

overall characterization of both groups included, due to the weight that these descriptors carry amongst Experts. Aromas such as Wet Stone, Spice, Curry, Earthy and Straw also compose the Experts' aromatic characterization and are definitely associated to the semantic capability and trends in the wine sector. This information also corroborates what is displayed in **Table 4.3** where each Expert has selected an average of 5.5 aromatic descriptors, while each Novice selected an average of 3.6 aromatic descriptors.

Regarding the Taste and Mouthfeel sensations both Experts and Novices have considered that Body, Length and Viscosity are the most associated with an aged dry white wine. Although both segments used 7 out 12 terms in this category, Experts believe that an aged dry white wine could be salty and oppositely, for Novices, it could be sweet. Apart from Body, Length and Viscosity, the remaining descriptors, for both Novices and Experts, have similar selection proportions, although they appear in a different sequence of occurrence.

Finally, the main difference between the Experts and Novices on the global appreciation is the fact that Experts believe that an aged dry white wine is Round, Creamy and Mineral. Experts used more descriptors than Novices: 11 out of 20 for Experts and 8 out of 20 for Novices. This might be explained by the semantic and memory capability and also with the necessity of providing a "correct" answer.

4.6 Sensory Space Definition

The results presented and discussed above allowed us to propose a metaphorical concept to define the sensory space of an aged dry white wine, which is "Mellow wines" or "Wines mellowed by aging".

"Mellow" can be defined as soft and smooth as an adjective from flavours [52] or full-flavored from ripeness, as fruit; well-matured, as wines [53], is also used to describe things that have a pleasant, soft, rich colour, usually red, orange, yellow, or brown [54].

These are in accordance with the sensory descriptors used by the participants, such as Dried Fruit and Honey for the aroma description or Body, Length and Smoothness for the taste and mouthfeel sensations. For our participants these wines become less aggressive with time and this softness is reached after about 6 to 10 years.

5 Limitations of the Study

The limitations of this study are mostly concerned with the respondent sample and with the sensory related questions.

Despite a high number of worldwide responses (n = 680), the major limitation was related with the chosen platform for the survey (Google Forms), that is easily accessible but that has some drawbacks as described in section 3.1.1. Additionally, the origin of the respondents, dominated by Portuguese or European individuals, can be considered as a limitation. Probably, the low number of responses from Spanish people could be explained by their difficulty in understanding English language. Another limitation concerns the likely absence of true novices. Indeed, answering to these type of online questionnaires involves a certain degree of interest on the topic. These interested respondents may have the possibility of autonomous learning without a direct professional relation with wine thus explaining the similarity in responses from experts.

The approach used to obtain the sensory descriptors relied on a CATA questionnaire that directs possible answers to the given alternatives. It would have been interesting to have a free description of aged white wines based on memory that could bring other responses from people with different sensory worlds.

6 Conclusions and Future Work

The results from this study allowed us to formulate a tasting script for the characterization of an aged dry white wine and propose a metaphorical term to define these wines as “Mellowed wines” or “Wines mellowed by aging”. Our research supports the existence of a likely mental imagery for an aged dry white wine characterized by a well-defined sensory space. Furthermore, it appears that the expertise level barely exerted any influence on the overall concept of an aged dry white wine. Terms such as Petroleum/Kerosene, Wet Stone, Length or Saltiness were used by Experts with more frequency than Novices due to specificity or difficulty in defining these terms. The slight nuances between Experts’ and Novices’ characterizations were mainly based on use of more specific vocabulary and the diversity of terms used, validating the different studies which reveal that Experts have more cognitive and memory resources to perform non-tasting descriptions than Novices [1], [2].

Further studies should be aimed at checking if this sensory conceptual space corresponds to the taste perception elicited by of real wines. In addition, it would also be interesting to compare with the descriptions and appreciation of red and sweet wines with similar ages to ascertain relative aging potential for different types of wines. This type of questionnaire could also be further explored to fine tune the responses of Experts grouped by different professions.

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Appendix

Appendix I – Online Survey transcription

Concept of Aged Dry White Wine – Section 1

Initially, we'd like to take the opportunity to thank you for participating in the following questionnaire.

This questionnaire is composed of 24 questions, spread between 4 sections, and has been written in an attempt to take no more than 10 to 15 minutes to complete. This questionnaire has the goal of understanding the perception and preferences of consumers surrounding aging wines, specifically dry white wines. Throughout the questionnaire whenever "White Wine" appears it should be consider to be "Dry White Wine" and not a "Dessert Wine". Please note that this questionnaire is all about perception. We wish to understand the perceptions and feelings of the respondents. There are no correct or incorrect answers. Don't overthink it.

This research is being conducted by Mariana . Sequeira (mariana.rodriguesequeira@gmail.com) and it is a component of a Master's thesis, in Viticulture and Oenology Engineering, supervised by Professor Manuel Malfeito-Ferreira.

All responses are anonymous and will be used ONLY for academic purposes. Data will NOT be shared with any other entity. The results may be published in academic forums such as conferences, journals or books, and will most certainly be published as a component of the Master's thesis dissertation.

Once again thank you for your collaboration.

*Required

Demographic & Wine Habits – Section 2

1. Age*:
    a. 18 – 29
    b. 30 – 39
    c. 40 – 49
    d. 50 – 59
    e. > 60
2. Country*:
3. What term best describes your interest in wine?
    a. No interest
    b. Limited interest

c. Interested
d. Highly interested

4. What term best describes your knowledge of wine? *
    a. No knowledge
    b. Limited knowledge
    c. Knowledgeable
    d. Highly knowledgeable
5. What is your wine consumption frequency? *
    a. Daily
    b. 2 to 3 times a week
    c. 1 time per week
    d. 1 to 3 times per month
    e. Occasionally (less than 1 time per month)
6. Do you work in the wine sector? *
    a. Yes
    b. No
7. Is wine tasting part of your job? *
    a. Yes
    b. No
8. Years of wine industry experience*:
    a. Not Applicable
    b. Less than 1
    c. 1 - 5 years
    d. 5 - 10 years
    e. Over 10
    f. Over 30
9. What is your current job title? *
    a. Winemaker
    b. Sommelier
    c. Marketing & Sales
    d. Researcher
    e. Wine Educator
    f. Other:

Overall Wine Preferences – Section 3

1. Which type of older wine did you enjoy the most?*
    a. Red Wine
    b. White Wine
    c. Dessert Wine
2. From what age is a dry white wine considered old? *
    a. 2 - 5 years
    b. 6 - 10 years
    c. 11 - 20 years
    d. 21 - 40 years
    e. > 40 years
3. From what age is a red wine considered old? *
    a. 2 - 5 years
    b. 6 - 10 years
    c. 11 - 20 years
    d. 21 - 40 years
    e. > 40 years
4. From what age is a dessert wine considered old? *
    a. 2 - 5 years
    b. 6 - 10 years
    c. 11 - 20 years
    d. 21 - 40 years
    e. > 40 years
5. How do you believe that a dry white wine ages in comparison to a red wine? *
    a. Better
    b. Worse
    c. Same
6. Rank the following styles of wine by your preference. *(Mark only one per row and per column)

Examples:

- ❏ **Sparkling Wine** - Cava, Champagne
- ❏ **Dessert Wine** - Madeira, Port, Sauternes, Ice Wine
- ❏ **Unoaked aged dry White Wine** - Chardonnay, Riesling, Malvasia de Colares, Arinto
- ❏ **Full-Bodied Oak aged White Wine** - Chardonnay, Viognier, Chenin Blanc
- ❏ **Aromatic White Wine** - Gewürztraminer, Sauvignon Blanc, Verdejo, Alvarinho, Moscatel
- ❏ **Light-Bodied Red Wine - Burgundy style** - Pinot Noir, Nebbiolo, Lambrusco
- ❏ **Full-Bodied Red Wine - New world style** - Syrah, Cabernet Sauvignon, Tempranillo, Touriga Nacional

	1 - Most Preferable	2	3	4	5	6	7	8 – Least Preferable
Sparkling Wine								
Dessert Wine								
Rose Wine								
Unoaked aged dry White Wine								
Full-Bodied Oak aged White Wine								
Light-Bodied Red Wine								
Full-Bodied Red Wine								

7. Which attributes do you prefer in a wine? Check all that apply. *
    a. Acidity
    b. Aromatic Intensity
    c. Astringency
    d. Body
    e. Colour Intensity
    f. Complexity
    g. Easy Drinking
    h. Familiarity
    i. Harmony
    j. Limpidity
    k. Long Aftertaste
    l. Softness
    m. Sweetness
    n. Other:

8. Which terms do you associate with the complexity attributes? * (Mark only one per row)

	1 – Definitely Not	2	3	4	5 - Definitely
Deep Colour					
Strength of flavour					
Number of flavours able to be identified					
Ease of identifying flavours					
Persistence					
Balance or Harmony					

9. For which occasion would you choose an aged dry white wine? Check all that apply. *
    a. Business Event
    b. Casual Meal
    c. End-of-day Drink at Home
    d. Enjoy Wine by Myself
    e. Meeting with Friends
    f. Party
    g. Post-meal Drink
    h. Pre-meal Drink
    i. Restaurant Meal
    j. Romantic Meal
    k. Special Occasion

Aged Dry White Wines Attributes – Section 4

1. Which colours do you associate with an aged dry white wine? Check all that apply. *

- [ ] Pale Straw

- [ ] Medium Yellow

- [ ] Deep Yellow

- [ ] Deep Gold

- [ ] Pale Brown

- [ ] Medium Amber

- [ ] Deep Amber

2. Which terms would you use to describe the aroma of an aged dry white wine? Check all that apply. *
    a. Beeswax
    b. Bruised Apple
    c. Caramel
    d. Chamomile
    e. Citrus
    f. Curry
    g. Dried Fruit
    h. Earthy
    i. Floral
    j. Fresh Fruit
    k. Honey

l. Oak
m. Petroleum / Kerosene
n. Spicy
o. Straw
p. Tropical Fruit
q. Wet Stone / Flint Stone
r. Other:

3. Which terms would you use to describe the taste and mouthfeel sensations of an aged dry white wine? Check all that apply. *
    a. Acidity
    b. Astringent
    c. Bitterness
    d. Body
    e. Dryness
    f. Length
    g. Roughness
    h. Saltiness
    i. Smoothness
    j. Sourness
    k. Sweetness
    l. Viscosity
    m. Other:
4. How would you globally describe an aged dry white wine? Check all that apply. *
    a. Balanced
    b. Complex
    c. Concentrated in Flavours
    d. Concentrated in Mouth
    e. Creamy
    f. Durable Wine Fragance
    g. Evolution of the Wine in Glass
    h. Fresh
    i. Harsh
    j. Insipid
    k. Light
    l. Mineral
    m. Persistent
    n. Pungent

o. Rich
p. Round
q. Subtle
r. Varietal Typicality
s. Other:

5. Which feelings would you associate to an aged dry white wine? Check all that apply. *
    a. Aggressive
    b. Boring
    c. Chewable
    d. Desirable
    e. Disappointment
    f. Elegant
    g. Harmony
    h. Interesting
    i. Joyful
    j. Memorable
    k. Pleasant
    l. Sickening
    m. Surprising
    n. Unpleasant
    o. Other:
6. Which regions do you associate with aged dry white wines producers? Check all that apply. *
    a. Australia
    b. Bordeaux, France
    c. Burgundy, France
    d. California, USA
    e. Colares, Portugal
    f. Dão, Portugal
    g. New Zealand
    h. Rhine Valley, Germany
    i. Rioja, Spain
    j. Rueda, Spain
    k. I Don't Know

Appendix II – Characterization of an aged dry white wine: Total Result

The following tables (**Table A.1** to **Table A.4**) show the results for the question regarding the conceptual characterization of an aged dry white wine concerning colour, aroma, taste and mouthfeel sensation, and the global appreciation. Each table presents the frequency citation of each descriptor and the correspondent percentage. The records with fewer counts correspond to the ones added by the participants using the open answer option.

Table A.1. Frequency of answer in each Colour associated to an aged dry white wine

Colours	Total (%) (n=680)	Experts (%) (n=361)	(%) Novices (n=319)
Deep Amber	21.2	21.9	20.4
Deep Gold	63.4	76.5	48.6
Deep Yellow	40.3	48.8	30.7
Medium Amber	32.1	32.7	31.3
Medium Yellow	18.7	17.5	20.1
Pale Brown	45.6	52.9	37.3
Pale Straw	8.8	4.2	14.1

Table A.2. Frequency of answer in each aroma descriptor of an aged dry white wine

Aroma Descriptors	Total (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)
Beeswax	33.4	46.5	18.5
Bread	0.3	0.6	0.0
Bruised Apple	29.7	38.0	20.4
Butter	0.6	0.8	0.3
Caramel	46.2	53.2	38.2
Chamomile	13.7	16.1	11.0
Citrus	16.2	13.3	19.4
Cooked vegetable	0.1	0.3	0.0
Curry	13.7	21.1	5.3
Dried Fruit	62.1	70.4	52.7
Earthy	19.6	20.8	18.2
Floral	17.4	13.6	21.6
Fresh Fruit	4.6	1.7	7.8
Honey	56.3	77.0	32.9
Oak	45.4	46.0	44.8
Petroleum / Kerosene	32.1	50.1	11.6
Spicy	19.3	24.9	12.9
Straw	18.4	20.8	15.7
Tropical Fruit	14.4	13.6	15.4
Wet Stone / Flint Stone	19.3	25.5	12.2

Table A.3. Frequency of answer in each taste and mouthfeel sensation descriptor of an aged dry white wine

Taste Descriptors	Total (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)
Acidity	36.6	44.9	27.3
Astringency	14.0	9.1	19.4
Bitterness	15.9	15.0	16.9
Body	61.0	69.5	51.4
Dryness	36.9	39.6	33.9
Length	52.1	66.8	35.4
Roughness	14.6	11.9	17.6
Saltiness	16.5	23.3	8.8
Smoothness	38.8	45.7	31.0
Sourness	12.5	12.5	12.5
Sweetness	17.6	12.7	23.2
Viscosity	41.5	47.6	34.5

Table A.4. Frequency of answer in each global descriptor of an aged dry white wine

Global Descriptors	Total (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)
Balanced	31.0	37.7	23.5
Complex	70.4	85.9	53.0
Concentrated in Flavours	43.8	46.0	41.4
Concentrated in Mouth	41.3	44.9	37.3
Creamy	25.6	36.0	13.8
Drink potential	0.1	0.3	0.0
Durable Wine Fragrance	25.6	23.3	28.2
Evolution of the Wine in Glass	43.1	57.6	26.6
Fresh	8.7	6.1	11.6
Harsh	7.4	3.3	11.9
Insipid	2.2	1.1	3.4
Light	3.8	2.5	5.3
Mineral	18.5	24.7	11.6
Persistent	52.6	61.8	42.3
Pungent	12.6	11.6	13.8
Reduced	0.1	0.3	0.0
Rich	45.9	59.6	30.4
Round	22.4	31.9	11.6
Subtle	10.6	11.9	9.1
Varietal Typicality	12.8	14.4	11.0

Table A.5. Frequency of answer in each feeling associated to an aged dry white wine

Feelings	Total (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)
Aggressive	7.6	4.2	11.6
Boring	3.4	3.9	2.8
Chewable	10.3	10.2	10.3
Desirable	34.7	41.0	27.6
Disappointment	4.7	6.1	3.1
Elegant	59.0	60.4	57.4
Enigmatic	0.1	0.3	0.0
Harmony	42.4	47.1	37.0
Interesting	58.4	70.6	44.5
Joyful	14.6	16.9	11.9
Longevity	0.1	0.3	0.0
Memorable	53.1	67.3	37.0
Pleasant	42.5	47.4	37.0
Sickening	4.3	3.0	5.6
Surprising	41.6	55.1	26.3
Unpleasant	5.4	4.4	6.6

Table A.6. Frequency of answer in each occasion for aged dry white wine consumption

Occasion	Total (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)
Business Event	30.4	31.6	29.2
Causal Meal	23.5	22.4	24.8
End-of-day Drink at Home	30.6	29.9	31.3
Enjoy Wine by Myself	45.4	52.9	37.0
Meeting with Friends	51.5	54.8	47.6
Party	16.3	11.6	21.6
Post-meal Drink	14.9	16.1	13.5
Pre-meal Drink	22.1	19.4	25.1
Restaurant Meal	52.9	64.3	40.1
Romantic Meal	44.0	46.8	40.8
Special Occasion	64.4	74.0	53.6

Table A.7. Frequency of answer in each region associated with aged dry white wine producers

Regions	Total (%) (n=680)	Experts (%) (n=361)	Novices (%) (n=319)
Australia	11.9	11.9	11.9
Bordeaux, France	36.3	37.4	35.1
Burgundy, France	51.9	68.7	32.9
California, USA	17.8	18.6	16.9
Colares, Portugal	37.8	44.6	30.1
Dão, Portugal	41.9	44.3	39.2
I Don't Know	12.9	8.0	18.5
New Zealand	7.8	7.5	8.2
Rhine Valley, Germany	36.9	49.3	22.9
Rioja, Spain	23.7	26.9	20.1
Rueda, Spain	11.0	8.9	13.5