

## Article

# The Influence of the Bottle's Price and Label Reported Information on the Perception of the Minerality Attribute in White Wines

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**Abstract:** The use of the descriptor “minerality” in a wine has increased in the last few years. This term is frequently used to describe wines closely associated with their terroir. This concept represents the complete natural environment in which a particular wine is produced, including factors such as the soil, topography and climate. In addition, the term “minerality” is frequently used to increase the price of the bottle. However, little is known regarding how this complex concept is perceived by consumers and whether they use this extrinsic information related to the term “minerality” in the purchasing process. The aim of this study is to understand how the term “minerality” could influence consumers when they purchase wine when this descriptor is included as an extrinsic characteristic on the label and in the price of the bottle. For this purpose, the so-called CATA (check-all-that-apply) methodology was used with a panel of 25 judges in order to define the attributes that a “mineral” wine should contain in order to be chosen and if the information displayed on the label and the price could influence consumers in that process. This technique is a dynamic sensory evaluation in which participants select the terms they consider apply at each moment from a list of attributes and deselect them when they no longer apply. The judges blindly tasted two different white wines in eight different glasses displayed with different label information related or not with terms associated with the minerality concept. In a second round, judges tried six glasses presented with the only information of the bottle's price. In both tasting sessions, the used list of descriptors contained 44 terms, 16 of which were related to the attribute of minerality, 13 were considered antonyms of such a descriptor and 15 referred to extrinsic aspects. The results showed that consumers were not directly influenced by the label reported information or the bottle's price when they described a wine as mineral. Finally, the statistical evaluation conducted by the CATA analysis divided the list of 44 used terms by their range of importance when a wine is described as mineral. The terms were divided into those that help to classify a wine as mineral and those that are antagonistic to this concept.

**Keywords:** minerality; check-all-that-apply; wine label; wine bottle price; white wine

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## 1. Introduction

When defining a wine, it is generally accepted that its characteristics can be divided into intrinsic and extrinsic [1]. The intrinsic characteristics are those inherent in the product itself, while the extrinsic ones are those that can be modified without changing the nature of the product and that do not form part of the chemical nature of the product. The most common extrinsic attributes are the brand, the information on the label and the price, among others [2].

The descriptor “minerality” has frequently been associated with extrinsic factors such as a high price, the region of production or designation of origin, the climate and grape varieties [3,4]. Wine producers use different strategies such as the information displayed on

the label, the shape of the bottle and other extrinsic features in order to create expectations regarding the product [5]. According to Rocchi and Stefani (2005), extrinsic characteristics have an influence on consumers when making their purchase decisions. However, it is unclear whether consumers understand all this information because today, many retail stores offer a wide range of wine types, and consumers are confronted with vast arrays of products in a short period of time [6]. Later, when the product is tasted, the expectations for sensory experiences are compared with the products' real characteristics, leading to confirmation or disconfirmation [7] and consequently, they may repeat the purchase if the sensory experience confirms their expectations.

In order to know the strength of both sensory and extrinsic characteristics when defining a wine as mineral, a CATA (check-all-that-apply) exercise was conducted in two phases, which were aimed at:

1. Exploring the effect of the information contained on the label (grape variety, designation of origin, etc.).
2. Exploring the psychological effect of the price.

Both tasting sessions entailed using CATA methodology (check-all-that-apply), which includes the evaluation of a single ideal product. In this sensory evaluation technique, consumers are asked not only about real samples but also about imagined ideal products that fulfill all the characteristics that a hypothetical perfect product must have. The comparison of this ideal product with the real products helps to identify specific improvements for each individual product. Check-all-that-apply (CATA) questions are one way of understanding consumers' perceptions of products and their ideal product.

This statistical tool was previously used [8] to understand how extrinsic characteristics could influence consumers' expectations regarding the product because when the expectations created by the bottle are high, consumers may choose to buy the product.

Based on the information presented above, CATA trials have two clear advantages:

- They are intuitive and easy for consumers to use since they do not include answers with scales.
- They require less effort on the part of the judges, allowing for a combination of attributes of a diverse nature.

## 2. Materials and Methods

The experimental work was conducted in the sensory analysis room of the University of La Rioja (UR) and involved 25 judges (56% women and 44% men). Participants ranged in age from 20 to 36 years, participating voluntarily due to their interest in improving their knowledge of wine. All of them were students in the oenology department at the University of La Rioja, so consequently, they showed a remarkable knowledge of oenology and were trained in wine descriptors through the sensory analysis lectures received over two years of their course.

The CATA technique is a sensometric methodology of great potential that has been widely used in the food industry [9,10]. This methodology is conducted by consumers or semi-trained tasters for the identification of the characteristics that a particular product has by marking its quantitative and qualitative attributes on a tasting sheet. The items on the tasting sheet include hedonic and sensory characteristics as well as extrinsic properties. Here are some examples:

- Very sweet, salty, etc. Sensory attributes;
- Good, unpleasant, etc. Hedonic terms;
- It is of good quality, it is X brand, etc. Non-sensory terms;
- It is a product good for . . . , it is a product to be consumed in/at . . . . Terms related to occasions of use or context.

Through appropriate statistical analysis, a factor map representing products and all their features is obtained. Hence, this technique allows you to know the characteristics that

consumers associate with a given product, as well as the sensory features that they prefer when defining their ideal product.

The analysis of sensory check-all-that-apply (CATA) data includes the evaluation of a single ideal product. When evaluating samples in sensory tests, consumers are asked not only about real samples but also about imagined ideal products that fulfill all the characteristics that a hypothetical perfect product must have. The comparison of this ideal product with the real products helps to identify specific improvements for each individual product. Check-all-that-apply (CATA) questions are one way of understanding consumers' perceptions of products and their ideal product.

During the two tasting sessions conducted in La Rioja University, each participant completed the questionnaire card shown in Figure 1. The CATA tasting sheet was designed to contain 44 terms, 16 of which were related to the attribute of minerality, 13 were considered antonyms of such a descriptor and 15 referred to extrinsic aspects.

NAME: _____		
AGE: _____		
GENDER (M/F): _____		
DATE: _____		
SAMPLE CODE: _____		
1.- Test the sample which is presented and indicate in what scale you would classify it as mineral:		
0	_____	10
Non mineral		Highly mineral
2.- Taste the sample and mark its minerality grade in the following scale:		
<input type="checkbox"/> High acidity	<input type="checkbox"/> Ripe fruit	<input type="checkbox"/> Silex / schist
<input type="checkbox"/> Smoked	<input type="checkbox"/> Nuts	<input type="checkbox"/> Subtle
<input type="checkbox"/> Animal	<input type="checkbox"/> Rubber	<input type="checkbox"/> Terroir
<input type="checkbox"/> Sulfur	<input type="checkbox"/> Modern	<input type="checkbox"/> Earthy
<input type="checkbox"/> Balsamic	<input type="checkbox"/> Ordinary	<input type="checkbox"/> Typicality
<input type="checkbox"/> Mushroom	<input type="checkbox"/> Rusty	<input type="checkbox"/> Chalk / Plaster
<input type="checkbox"/> Cold climate	<input type="checkbox"/> Patisserie	<input type="checkbox"/> Rough
<input type="checkbox"/> Designation of origin	<input type="checkbox"/> Flint stone	<input type="checkbox"/> Toasted
<input type="checkbox"/> Elegant	<input type="checkbox"/> Slate	<input type="checkbox"/> Traditional
<input type="checkbox"/> Spiced	<input type="checkbox"/> Gunpowder	<input type="checkbox"/> Varietal
<input type="checkbox"/> Exclusive	<input type="checkbox"/> Pencil lead	<input type="checkbox"/> Vegetable
<input type="checkbox"/> Floral	<input type="checkbox"/> Purity	<input type="checkbox"/> Cheap wine
<input type="checkbox"/> Freshness	<input type="checkbox"/> Reduced	<input type="checkbox"/> Expensive wine
<input type="checkbox"/> White fruit	<input type="checkbox"/> Rock stone	<input type="checkbox"/> Table wine
<input type="checkbox"/> Citrus / tropical fruit	<input type="checkbox"/> Saline	

**Figure 1.** Tasting sheet given to judges in the CATA (check-all-that-apply) exercise.

The terms were presented in alphabetical order to avoid favoring any kind of provision that would promote associations of ideas. The list of the terms related to minerality and the extrinsic aspects was designed based on the descriptors proposed by Deneluin et al. (2016) [11] resulting from an open-ended survey on the perception of minerality without the tasting phase. Those descriptors were taken into account in order to generate their antonyms. The list was complete with a list of terms that took into account other chemical [12,13], sociocultural [14] and sensorial characteristics [15,16] related with the "minerality" concept based in a bibliographic research that considered the cognitive olfactory processing [17].

The first task to be completed by the judges was to grade the samples on an unstructured scale with respect to the term "mineral". Subsequently, they ticked each of the

attributes that they found on the list of the 44 available terms, associating them with the different products that were tasted during the session.

In order to choose two white wines in the study exemplifying mineral and non-mineral traits, a group of five trained tasters, all non-members of the panel, were recruited. These five testers were students in the oenology department at the University of La Rioja, so they showed a remarkable knowledge of oenology and were trained in wine descriptors through the sensory analysis lectures received over two years of their course. A tasting session of seven wines was organized among which the tasters eventually chose sample R15MA (Mosel, Germany Riesling 2015) as mineral and SB15RES (Sauvignon Blanc wine, Rueda, Spain 2015) as non-mineral.

Finally, a binary contingency table was made with data obtained from 25 judges using the XLSTAT Addinsoft 2017 software to perform the statistical analysis of the CATA trial.

For a given attribute, Cochran's Q tests the effect of an explanatory product on whether consumers recognize the attribute or not. A low  $p$ -value beyond a significance threshold indicates that products significantly differ from each other.

The contingency table is the sum of attribute tables across assessors. It is used to construct a correspondence analysis (CA). When the  $p$ -value is lower than the significance level it is very likely that real differences exist between the products in terms of their sensory profiles.

Data on liking are related to penalty analysis. A first analysis based on incongruence in which the attribute is missing in the real but not the ideal product allows for identifying the must-have attributes. The frequencies with which P (No) | (Yes) and P (Yes) | (Yes) occurs for each attribute are documented. The graphical representation of the penalty analysis shows these frequencies as well as the percentage of records for these occurrences.

### 2.1. Analysis of the Information on the Label

The participating judges were presented with 8 glasses of white wine numbered from 2 to 9. Sample number 1 corresponded to the ideal product (a fictitious wine that tasters take as their ideal reference of a mineral wine). In this first sample, the section corresponding to the scale of the degree of minerality was not filled in. In samples 2 to 9, only two different wines were actually served, but they were presented with the labels changed. These two wines were R15MA (defined as mineral) and SB15RES (defined as non-mineral). The order of presentation followed the sequence 2, 6, 4, 8, 3, 7, 5 and 9; in this way, the sensory judges never tasted the same wine consecutively. The samples were presented with non-corresponding labels in order to know if the information included on the label leads to use of the term "minerality". Table 1 shows the summary of the identification of every sample.

**Table 1.** The samples used in CATA (check-all-that-apply) on the influence of the label in the use of the descriptor "minerality" (M.—mineral; N.M.—non-mineral).

Sample Code	Summary	Description	Region and Country	Grape Variety
1	Ideal mineral	Mineral wine: ideal product	-	-
2	M. without label	R15MA without label	-	-
3	M. true label	R15MA with true label	Mosel, Germany	Riesling
4	M. false label M.	R15MA with false mineral label	Marlborough, New Zealand	Sauvignon blanc
5	M. false label N.M.	R15MA with false non-mineral label	La Mancha, Spain	Sauvignon blanc
6	N.M. without label	SB15RES without label	-	-
7	N.M. true label	SB15RES with true label	Rueda, Spain	Sauvignon blanc
8	N.M. false label M.	SB15RES with false mineral label	Franken (Alsace), Germany	Silvaner
9	N.M. false label N.M.	SB15RES with false non-mineral label	Rueda, Spain	Sauvignon blanc

## 2.2. Analysis of the Influence of Price

The second experiment was designed to evaluate the influence of the price on the perception of the attribute minerality. In order to assess the outcome, judges tasted six glasses of white wine identified from A to F with different prices. The answers from the ideal product obtained in the previous session were used to determine the terms that a wine should contain to be ideally categorized as mineral, for which the section corresponding to the degree of minerality had not been filled in. Only two samples were served, R15MA (defined as mineral) and SB15RES (defined as non-mineral). Table 2 shows the summary of the identification of each sample and the prices presented.

**Table 2.** Samples of CATA (Check-All-That-Apply) exercise on the influence of price in the use of the descriptor “minerality”. (M.—mineral; N.M.—non mineral).

Sample Code	Summary	Description	Price
A	Mineral low price	Wine R15MA presented with a low price	4.0 €
B	Mineral real price	Wine R15MA presented with its real price	10.0 €
C	Mineral high price	Wine R15MA presented with a high price	35.0 €
D	N.M. low price	Wine SB15RES presented with a low price	7.0 €
E	N.M. real price	Wine SB15RES presented with its real price	10.0 €
F	N.M. high price	Wine SB15RES presented with a high price	32.0 €

The six samples actually contained only two types of wine, and in order to make the tasters unaware of that, the samples were presented in the sequence A, E, C, D, B and F; thus, the tasters did not taste the same wine consecutively.

## 3. Results and Discussion

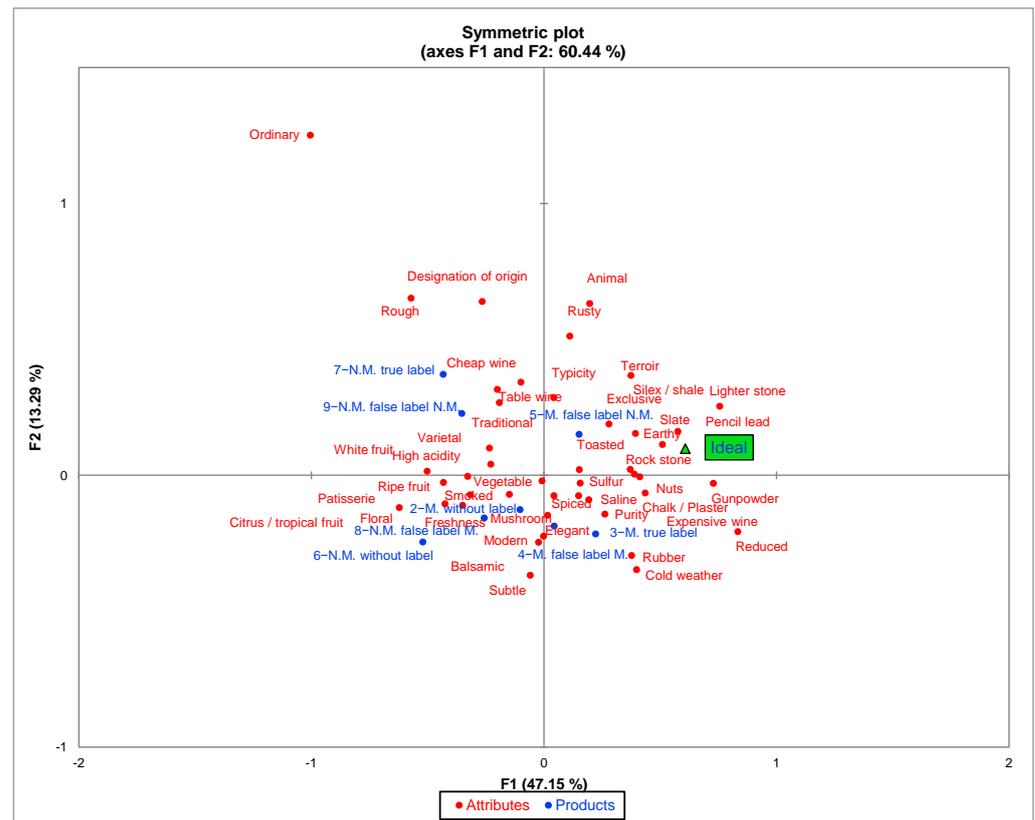
### 3.1. Influence of the Information on the Label on the Use of the Descriptor “Minerality”

For a given attribute, the Cochran Q test allows you to check whether consumers perceived the effect of an explanatory variable on certain attributes of the product. A low  $p$ -value beyond the significance threshold indicates that the products differ significantly from each other. Table 3 shows the independence test between variables and products. Since the  $p$ -value is lower than the level of significance ( $\alpha = 0.05$ ), it can be concluded that tasters perceived real differences between products.

**Table 3.** Samples of CATA (Check-All-That-Apply) exercise on the influence of price in the use of the descriptor “minerality”. (M.—mineral; N.M.—non mineral).

Description	Value
Chi-square (observed value)	499.883
Chi-square (critical value)	388.251
$p$ -value	<0.0001
Alpha ( $\alpha$ )	0.05

Figure 2 shows the results of the correspondence analysis. The first two dimensions explain 60.44% of the total inertia. According to the map, the ideal mineral wine should have the aroma of pencil lead, flint, earth, chalk, nuts and gunpowder. It should also show a certain saline taste and have an exclusive profile. It should also be linked to the profiles of rock, stone and slate. On the other hand, it should not contain white pulp fruit, citrus or tropical fruit aromas or vegetal notes.



**Figure 2.** Correspondence analysis for the study of the influence of the label information on the use of the descriptor “minerality”.

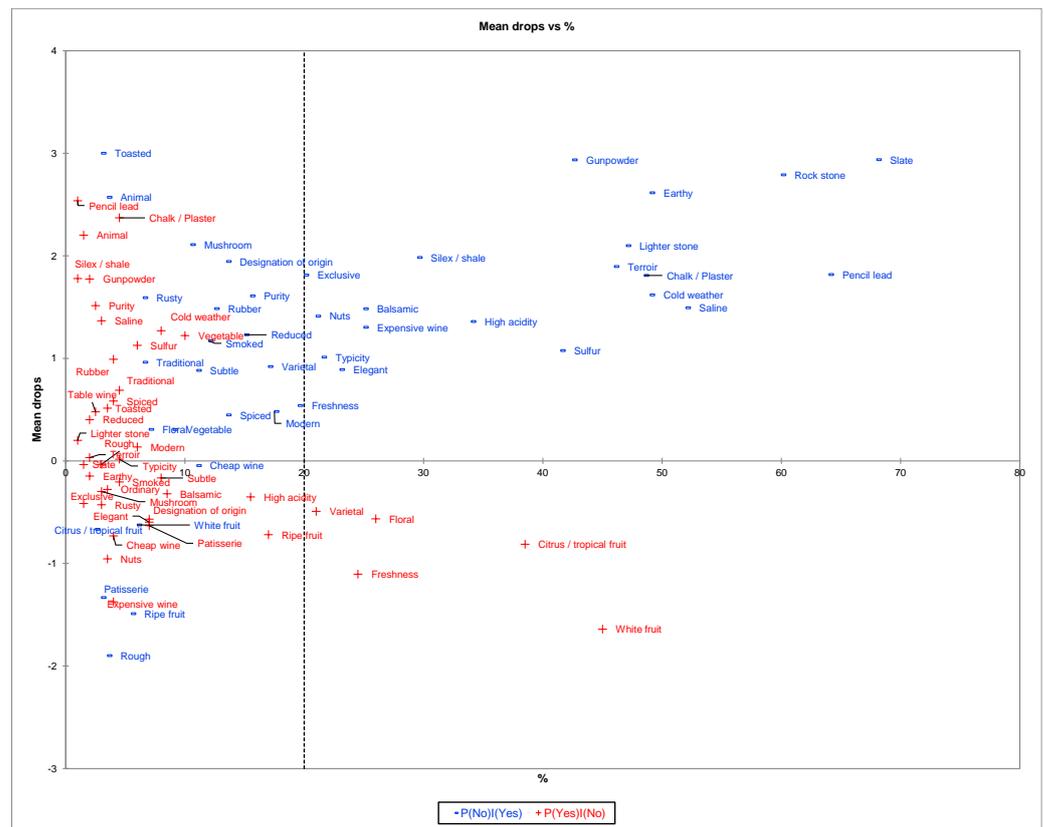
Product 5 (mineral wine R15MA presented with a theoretically non-mineral label) seems to be the closest to an ideally mineral wine; product 4 (mineral wine R15MA presented with a label theoretically mineral) and product 3 (mineral wine R15MA presented with its true label) are also relatively close to the ideal product. The results show the good performance of the panel of tasters who participated in the study.

On the opposite side, in the quadrants displayed on the left, products 7, 8 and 9 are located, with number 7, the non-mineral wine SB15RES presented with its true label; 8, the non-mineral wine SB15RES presented with a theoretically mineral label; and 9, the non-mineral SB15RES presented with its true theoretically non mineral label.

Regardless of the label displayed, the wine used as the mineral sample is always projected in the area closest to the ideal mineral wine. In contrast, the products presented with numbers 7, 8 and 9, which actually contained non-mineral wine, were in all cases projected in the quadrant farthest away from the ideal product according to the judges’ responses.

The so-called penalty analysis reported in Figure 3 was also conducted to decipher the contradiction of when an attribute is absent in a particular product but not in the ideal product. This study allows for identifying and classifying the attributes in different categories. The first type are the “must-have” attributes of a mineral wine. Two situations can occur that determine when an attribute is classified as essential. The first is when an attribute is not in the real product but it is found in the ideal [P (No) | (Yes)]. The second appears when an attribute exists in the real product and in the ideal [P (Yes) | (Yes)].

A second category is the “nice-to-have” attributes. This group includes attributes that are absent in the ideal product but not in the real one. The classification of an attribute as a “does-not-harm” occurs when it is not marked for the ideal product and the degree of minerality for products that are marked with this attribute is approximately the same when they are unchecked.



**Figure 3.** Penalty analysis for the study of the influence of the label information on the use of the descriptor “minerality”.

Finally, an attribute that is unchecked in the ideal product and is chosen as mineral for those products that do not have this attribute marked is classified as a “must-not-have”. Figure 3 represents the results of the penalty analysis performed, and Table 4 shows the summary of the classification of attributes in relation to the degree of minerality.

**Table 4.** Effect of the attributes included on the CATA tasting sheet in the penalty analysis of the influence of the label information on the use of the descriptor “minerality”.

Must Have	Does Not Harm	Must Not Have
High acidity	Smoked	Patisserie
Cold climate	Animal	Gunpowder
Flint stone	Sulfur	Purity
Slate	Balsamic	Reduced
Pencil lead	Mushroom	Silex/schist
Rock stone	Designation of origin	Subtle
Saline	Elegant	Typicity
Terroir	Spiced	Rough
Earthy	Exclusive	Toasted
Chalk/Plaster	Floral	Traditional
	Ripe fruit	Varietal

**Table 4.** *Cont.*

Must Have	Does Not Harm	Must Not Have
	Nuts	Vegetable
	Rubber	Cheap wine
	Modern	Expensive wine
	Ordinary	Table wine
	Rusty	

Out of the 44 attributes contained in the tasting sheet, the judges identified 10 as must have, 3 as must not have, and the remaining 31 as does not harm regarding their mineral profiles. The 10 attributes designated as must have correspond entirely to attributes that have been previously identified as closely related to minerality; six of them correspond to the descriptors related to aromatic minerality and/or aftertaste (flint stone, slate, pencil lead, rock, earthy and chalk), two descriptors refer to the gustatory minerality (saline and high acidity) and finally, two terms refer to abstract concepts (cold climate and terroir).

Likewise, amongst the attributes identified by the tasters as must not have when classifying a wine as mineral, two descriptors were found that refer to attributes of the olfactory and/or aftertaste phase (white pulp fruit, citrus and tropical fruit), and one descriptor corresponded to the gustatory phase (freshness in the mouth).

### 3.2. Influence of the Wine's Price on the Use of the Descriptor "Minerality"

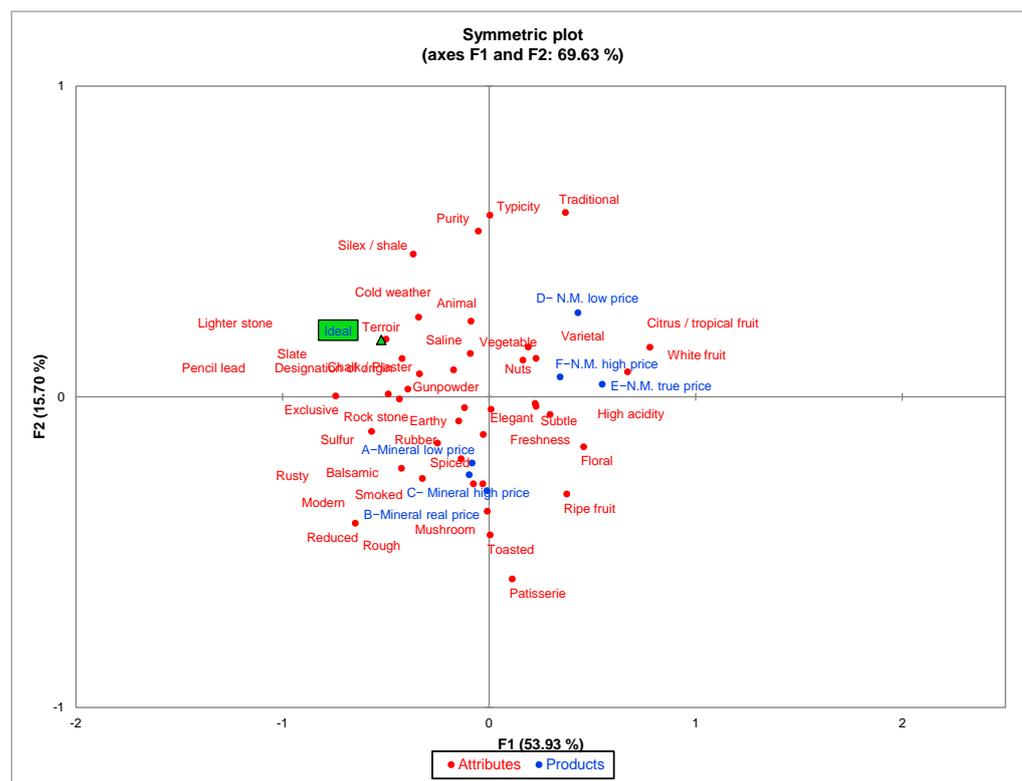
As in the previous section, the data obtained from the tasting session regarding the influence of the price in the use of the term "minerality" was used to apply a Cochran Q test. Table 5 shows the test of independence between attributes and products. Since  $p$  is lower than the level of significance ( $\alpha = 0.05$ ), it can be concluded that the semi-trained tasters noticed real differences in the products in terms of their sensory profiles.

**Table 5.** The test of independence in the study of the influence of price on the use of the descriptor "minerality".

Description	Value
Chi-square (observed value)	324.941
Chi-square (critical value)	283.586
$p$ -value	0.001
Alpha ( $\alpha$ )	0.05

A correspondence analysis was performed to verify the quality of the results. Figure 4 shows that the first two dimensions explain 69.63% of the total inertia. According to the correspondence map, price itself is not such a decisive factor in characterizing a wine as mineral. As shown in Figure 4, the samples containing the mineral wine R15MA were positioned very close in the quadrant with negative values for the F1 and F2 components. The samples with the non-mineral wine (SB15RES) were found in the opposite quadrant (the positive region of components F1 and F2).

The distribution of the wines in opposite quadrants shows how the organoleptic qualities prevailed when tasters evaluated the mineral character of the wine. Thus, the increase in the price of the same wine presented with different prices did not produce a strong effect when projecting the samples closest to the ideal wine in terms of minerality. As can be seen in the case of sample A (mineral wine R15MA with a low price), it was located closer to the ideal product than sample C (mineral wine R15MA with a high price).



**Figure 4.** Correspondence analysis in the study of the influence of the price of wine on the use of the descriptor “minerality”. Green part is the ideal mineral wine.

Subsequently, a penalty analysis was conducted. The results obtained and the summary of the classification of attributes in relation to the degree of minerality depending on the price are presented in Figure 5 and Table 6. Out of the 41 attributes contained in the CATA tasting sheet, the judges identified 8 as must have, 2 as must not have, 2 as nice to have and the remaining 29 as does not harm. The attributes classified as must and must not have indicate a great similarity in relation to the attributes obtained in the study of the influence of the information contained on the label.

As was concluded with the must have attributes related to the information contained on the label, the eight must-have attributes regarding the influence of the price in the minerality correspond to attributes that had previously been associated with minerality. Four of them correspond to extrinsic qualitative factors (cold climate, slate, rock stone and terroir) and the remaining four to sensory terms (high acidity, flint stone, earthiness and chalk/plaster). In addition, they all coincide with the essential attributes selected in the study of the influence of the information on the label. In the same way, the attributes identified by the tasters as must not have when it comes to classifying a wine as mineral (floral aroma and white pulp fruit) were already previously identified by Rodrigues et al. (2017) [13] as not being desirable in a mineral wine.

Taken together, these results seem to indicate not only that the extrinsic factors or the external characteristics influence the description of a wine as mineral but also that their sensory properties play a very important role.

In view of these results, it can be concluded that we can divide the term “minerality” into two subcategories. One is the sensorial minerality, which is closely related to the intrinsic characteristics of the wine. However, the term is also related to extrinsic factors such as the price and the information displayed on the label; this influence is smaller than the former, but we cannot deny what can be called the “psychological minerality”.



Table 6. *Cont.*

Must Have	Nice to Have	Does Not Have	Must Not Have
		Reduced	
		Subtle	
		Typicity	
		Rough	
		Toasted	
		Traditional	
		Varietal	

#### 4. Conclusions

The results found in the CATA study of two white wines (mineral and non-mineral) presented with different labels showed that their score was not directly influenced by the information displayed on their labels. Thus, the mineral wine was projected in its different versions in the closest areas to what the taster understood as an ideal mineral wine. Among the ten attributes identified as necessary, six corresponded to a mineral aroma and/or aftertaste (flint stone, slate, pencil lead, rock, earthiness and chalk), two descriptors referred to the gustatory minerality (saline and high acidity), and, lastly, two terms referred to abstract concepts (cold climate and terroir). In the same way, the attributes identified by the tasters as must not have were three descriptors that refer to attributes of the olfactory and/or aftertaste phase (white pulp fruit, citrus and tropical fruit) and one descriptor corresponded to the gustatory phase (freshness in the mouth).

The results obtained in the second CATA exercise, which evaluated the influence of the price on the perception of minerality as an attribute in the wine, revealed that price is not such a decisive factor in itself in characterizing a wine as mineral: the samples of mineral wine were positioned correctly regardless of the price presented to the tasters. The organoleptic qualities prevailed when assessing the intrinsic attributes rating rather than the price shown on each bottle. Similarly, increasing the price of the same wine did not significantly affect the position in relation to the ideal mineral wine in the factorial map of the correspondence analysis. Therefore, the price in itself does not seem to constitute a significant factor for the classification of wines as mineral.

Overall, since the information contained in the bottle and the price are the very first “signal” perceived looking at bottles, consumers use them to define more abstract concepts they use while assessing alternative products and choosing among them. From a methodological point of view, this study confirms the effectiveness of combining sensory and marketing concepts as a tool for developing the images and marketing strategies of new products and their future impacts on the market.

However, further research is needed to overcome some of the limitations of the present work. One of the main limitations of the present study is the small number of judges, although the judges involved in the study were semi-trained students in the oenology department; this fact supported decreasing the total number of judges. However, in order to verify the reported results, a larger sample of non-trained panelists is needed.

In the present study, only label reported information and bottle’s price were considered for understanding the term “minerality”. However, there are other characteristics such as the chemical difference in its composition that could be related with the “minerality” descriptor. In addition, as minerality is also reported in red wines, the same set of data should be obtained from a representative of mineral and non-mineral red wines.

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