



## Attitudes towards natural wines among Spanish winemakers: Relationship with environmental awareness

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### ABSTRACT

There is an important movement in the wine industry towards the production of alternative and more sustainable wines. Natural wine (NW) is a controversial category of alternative wines, which needs to be further explored. Given the role of technical experts as opinion leaders, the present work aims to explore the attitudes of Spanish winemakers towards NW and their relationship with their overall environmental awareness. Therefore, 307 Spanish winemakers completed a questionnaire to evaluate: (1) their attitudes towards NW by scoring their agreement with 31 statements, (2) their ecological awareness by evaluating 11 items, (3) their frequency of consumption and interest towards NW, and (4) their sociodemographic profile and general information about wine production. PCA with varimax rotation calculated on 28 of the 31 statements related to their attitudes showed six independent dimensions. Further hierarchical cluster analysis calculated with the six dimensions showed five clusters of wine experts with different attitudes towards NW. Results show that there is a major negative attitude towards the flavour of NW, their ageing capacity and their quality-price ratio, but a positive one in terms of economic impact for the wine industry. Aspects related to the role of NW in tradition, social identity, ecology, health, artisanal production and economic feasibility mark differential attitudes. Interestingly, the dimension related to winemakers' attitude towards tradition, social identity, and ecology of NW was positively correlated with their overall ecological awareness and thus their life style. This paper sheds light in the understanding of the behaviour of Spanish winemakers regarding ecological transition and provides tools for policymaking regarding NW certification.

### 1. Introduction

In the last decades, socioeconomic changes and globalisation have led companies to develop products adapted to the changing interests of consumers (Bresciani, 2017). This new generation has more options, greater knowledge and more effective means to acquire products they consider to have a higher value. However, the concept of "value" is changing in essence, and the consumption preferences and attitudes towards food products are changing profoundly (Migliore, Thrassou, Crescimanno, Schifani, & Galati, 2020). There is growing consumer concern about health and environmental issues, which has led to increased interest for organic foods (Picchi, Canuti, Bertuccioli, & Zanoni, 2020). Since the 2000s, the organic food sector, including the wine industry, is experiencing massive growth. Nonetheless, most wines

are produced by the so-called "conventional" methods, which can make use of legal plant protection products and fertilisers in the vineyards and allow oenological practices in the cellar that can vary considerably among countries, regions, and Protected Denominations of Origin (PDOs) (Picchi et al., 2020). A smaller proportion of wines made through so-called "alternative" practices is in constant growth and demand, including organic, biodynamic and, more recently, natural wines (NWs). While organic and biodynamic wines are well defined through both public and private certifications, the concept of NW is blurry and raises important discrepancies and conflicts among the different actors of the wine industry (Alonso González, Parga Dans, & Fuentes Fernández, 2022). In Spain, the consumption of NW has grown gradually among consumers in the last decade, and thus there is a tendency among winemakers to produce these wines, motivated either by a new market

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niche, or by a genuine philosophy applied to the professional field.

### 1.1. Definition of NW

France is the hotspot of NW, it is where the term is most used and more efforts have been invested to define it in recent decades. In fact, it is the only country where there is a specific regulation. In September 2019, *le Syndicat de Défense des Vins Nature* was created, which at the beginning of 2020 managed to reach an agreement with the French Ministry of Agriculture, the French National Institute of Origins and Quality (INAO) and the French Fraud Control Office to establish a very precise specification that would define what a NW is. They decided to adopt the name *Vin Méthode Nature*, which after a trial period of three years will become a certification supported by the French government. Among other requirements, the certification requires that the grapes come from organic or biodynamic vineyards, grapes must be handpicked and no additives or physical processes like pasteurisation, reverse osmosis, membrane use, filtration or clarification can be applied in their elaboration. The regulations allow two options regarding sulphites: 1) *without added sulphites*: the addition of exogenous sulphites is not allowed, 2) *< 30 mg/L total sulphites*: the addition of quantities lower than 30 mg/L just before bottling (and not at the arrival of grapes to the cellar) is allowed.

Beyond France, there is no legal definition or bodies to certify NWs, and consequently, there is no unanimity concerning its definition among consumers, critics or even producers themselves. The main controversy concerns what is considered an acceptable level of intervention and added sulphites. Despite this controversy, there is a significant level of cohesion within the professional groups advocating the less interventionist line when it comes to cultivating the vine and making wine. These groups are generally organised in associations and are present in various events (Alonso González & Parga-Dans, 2020). For example, in UK, Germany and USA, the association *Raw Wine* defines a NW as: “*Farmed organically or biodynamically, using permaculture or the like and make (or rather transformed) without adding or removing anything in the cellar. No additives or processing aids are used, and intervention in the naturally occurring fermentation process is kept at minimum. As such, neither fining nor tight filtration are used. The result is a living wine-wholesome and full of naturally occurring microbiology*”. In France, the association of NWs (*L'Association des Vins Naturels, AVN*) provides the following definition: “*a wine whose grapes come from organic or biodynamic agriculture. A wine that is vinified and bottled without any input or additives*”. In turn, the French association SAINS (*Sans Aucun Inérant Ni Sulfite*), born as a radical branch of the previous French AVN (*Association des Vins Naturels*), defines it as “*NW without inputs and sulphites added*”. In Italy, the VAN, *Triple AAA*, *Vini Veri* and *VinNatur* associations have no official certification but provide some guidelines. For instance, *Vini Veri* requires organic grapes, and total sulphur content lower than 80 mg/L in dry wines and 100 mg/L in sweet wines. In turn, *VinNatur* requires: no synthetic pesticides, and total sulphur content lower than 50 mg/L. In Spain, the association *Asociación de Productores de Vino Natural (PVN)* defines NW as: “*wine made with natural grapes, without adding or removing anything from the grape*” and upholds the following rules: 1) no chemical fertilisers, herbicides, pesticides, systemic fungicides or genetically engineered organisms used, and 2) no sulphites added.

### 1.2. Attitudes towards NWs

Few studies have evaluated attitudes towards NWs. Urdapilleta, Demarchi, and Parr (2021) explored the representations of French and New Zealand consumers and professionals about three types of wines: conventional, organic and natural. French participants showed overall positive representations of organic and NWs, mentioning concepts such as “free of sulphites, pesticides and fungicides,” “sustainability”, and “being healthier”. New Zealand participants showed a less positive representation of NWs than their French counterparts, with terms such

as “cloudy” for consumers, “flat” for professionals and “unpredictable” for both groups. The more negative attitude of Neo-Zealanders is partially explained by the fact that they are less exposed to this type of wines. Cultural differences in the perception of the “naturalness” of wines were previously reported by Staub, Michel, Bucher, and Siegrist (2020) between Swiss (a population culturally similar to France) and Australian (a population culturally similar to New Zealand) wine consumers. One conclusion was that the techniques used in conventional winemaking such as the addition of products to avoid oxidations and microbiological alterations were more accepted by the Australian than by the Swiss respondents as far as the adjective “natural” is concerned. The Swiss respondents, in line with the results of Urdapilleta et al. (2021), were stricter in terms of representations of the adjective “natural” for wines than the Australian ones, who were much less demanding in terms of the oenological techniques used.

Further, Capitello and Sirieix (2019) analysed different attributes associated with a discrete number of dimensions that French and Italian wine consumers related to different types of wines: conventional, sulphite-free, biodynamic, organic and natural among others. The dimensions that most differentiated the attitudes towards the different types of wines were the benefits for health, taste and ethical values. The only positive associations expressed by respondents regarding NW were related to better ethical values and its connection to the promotion of local trade. Along the same line, Galati et al. (2019) studied the attitudes of Italian consumers towards NW. They found that consumption frequency, the information provided on the label in terms of ingredients, method of elaboration and sensory characteristics, and the general interest in more natural products, were the most relevant drivers for NW purchase.

More recently, a paper dealing with the cross-cultural effect observed among consumers of NWs was published by Vecchio et al. (2021). The authors compared Spanish and Italian consumers in terms of perception and information about NWs. While Spanish consumers strongly link NWs to products without sulphites, they are considered as environmentally friendly and without additives by Italian consumers. The authors also highlighted that the motivations to consume NWs differed between both groups of consumers. While Italian participants were mainly guided by sustainable motivations, Spanish participants seemed to be driven by both sustainable and hedonic motivations. Interestingly, the higher involvement of consumers with wine was related to lower consumption of NW for both Italian and Spanish participants. This highlights the negative valence attributed to this category of wines among wine-concerned consumers. Recently, Parga-Dans et al. (2023) analysed attitudes towards a certification for NW between Spanish and Italian consumers. Findings revealed that NW consumers in both countries deem necessary to establish a certification for this wine type. Also, significant differences regarding consumers’ attitudes to NWs were found in both countries. In Spain, certification should be linked to eco-healthy and proximity-craft attributes of wine, and was considered more important by non-professional consumers and those with lower educational level, in line with Vecchio et al. (2021). In Italy, on-label information and the purchase experience were the most important factors to aid in recognising NW. Finally, the study highlighted a gender bias since women showed a significant higher interest than males in the NW certification.

To sum up, the wine sector is experiencing a transition towards sustainability and ecologically-minded production in different ways and alternatives to conventional production are in constant growth and demand. There are several studies that have focused on the consumer perspective, but to date no study has focused on producers’ attitudes towards NW. Given the philosophical character of the concept and production of NWs, the present work seeks to investigate the attitudes of Spanish winemakers towards NWs and evaluate the relationship of their attitudes with their lifestyle, more specifically with their overall environmental awareness. In doing so, this paper aims to answer the following research questions: 1. Could different attitudes towards NW be

identified among Spanish winemakers? 2. Does the lifestyle related to their overall environmental awareness impact attitudes towards NW? The significance of understanding their attitudes lays both on their role as opinion leaders in the wine industry and to shed light on their behaviour in terms of ecological transition and policymaking regarding NW certification.

## 2. Material and methods

### 2.1. Participants

This article is informed by a survey of Spanish winemakers based on a convenience sample. The recruitment was carried out by contacting Spanish winemakers through an extensive number of regional associations, and associations of NW producers such as *Asociación de Productores de Vinos Naturales*, *Vignerons de Huesca* and *Vinos Auténticos*. Specific information of natural wineries detailed in the book *Vinos Naturales en España* (Gómez Pallarés, 2018) was also considered and producers were contacted by email and phone. The recruitment information was also sent to wine journals including: *Enólogos*, *Infowine*, *La Semana Vitivinícola*, *La Prensa del Rioja*, *Vinetur*, *Verema* and *Vitivin*, which posted the questionnaire in their social networks.

Eventually, a total of 359 Spanish winemakers were surveyed between March 8th and May 4th 2021. Of them, 307 (85%) corresponded to the selection criterion, which was that they were wine producers in a Spanish region, and thus their results were considered for further analysis.

Most producers meeting the selection criteria were male (61%) and in the range between 30 and 59 years old with a University degree, mostly a 5-year University diploma (see Table S1 and Figure S1 of Appendix A). All the main Spanish wine production regions were represented (see Figure S2 of Appendix A). The north-centre regions were the most represented (i.e., La Rioja, Basque Country and Navarra: 30%) followed by Castilla y León (22%) and Castilla La Mancha (13%). Regarding the experience in winemaking, ca. 70% of participants declared more than 10 years of experience in the sector, while only 15% declare less than 5 years. Approximately 90% of the winemakers reported to produce Protected Designation of Origin (PDO) wines (Fig. S3a of Appendix A). Thirty % of participants reported to produce NWs. This category includes both winemakers who declare to produce exclusively NW and those who produce only a certain amount of NW, the non-producers of NW are conventional and/or organic wine producers (Fig. S3b of Appendix A).

### 2.2. Ethical approval

Ethical approval for the involvement of human subjects in this study was granted by CSIC Research Ethics Committee on 23/03/2021 with Reference #211/2020.

### 2.3. Procedure

An on-line questionnaire was elaborated with the Google Forms® platform in Spanish and was distributed following a snowball technique. Prior to implementation, different pre-tests were conducted to identify mistakes in the questionnaire, technical difficulties, and adjust the time to a maximum of 10 min. Items that were identified as unclear by six experimenters involved in the project were then revised. The final pre-test was completed and validated by 10 other members of the ICVV, whose responses were not further considered.

The full survey is provided in Appendix B. The study was explained at the beginning of the online questionnaire, avoiding to disclose the specific aim of the project until they had completed the whole questionnaire. Participants were informed that all data were anonymised and only reported in the aggregate. All participants acknowledged an informed consent statement in order to participate in the study. They

were not financially compensated for their participation.

After the presentation of the project, the first part of the questionnaire was devoted to confirm the inclusion criteria (winemakers producing in Spain), and identifying the region/s where they work and the years of experience in winemaking (see Appendix B).

The second part consisted of 31 statements representing attitudes towards NWs (Table 1) together with other 10 wine-related statements used as distractors to avoid participants identifying the objective of the study. Statements about NWs were related to the following eight a priori dimensions: Sensory properties (2), Health (4), Eco-friendly practices (5), Economy (7), Social Identity (3), Technology (5), Tradition (3), and Mode (2) which were extracted from a literature review (Alonso González & Parga-Dans, 2020; Alonso González et al., 2022; Fuentes-Fernández & Gilinsky Jr, 2022). Participants had to rate their level of agreement with the 41 statements using a four-point Likert scale (1-completely disagree; 2-disagree; 3-agree; 4-completely agree). Four-point scale avoided centring biases (tendency to use the middle category) resulting in more easily interpretable results. Only the 31 statements linked to NW were considered for data analysis. Items were formulated as both positive and negative statements towards NW in order to avoid response biases (i.e., in negative: “NWs have sensory defects more frequently than conventional wines”; in positive: “NWs, produced with minimal intervention, favour the expression of terroir in wines”).

The third part of the questionnaire included 11 statements aiming to evaluate the overall environmental awareness of participants in their everyday life. The statements were extracted from the bibliography (Table 2). They include general items related to overall pro-environmental behaviours (items 5–8) and more specific sustainable behaviours concerning: food (items: 9, 10, 11), energy and recycling (item 1), green purchasing (items: 2, 3, 9), and mobility (item 4) as suggested by Castellini et al. (2023). Participants evaluated every statement on a 6-point scale (0: I am not identified at all; 5: I am much identified).

The questions for the second and third parts were presented in a random order different for each participant.

The fourth section of the questionnaire evaluated participants': 1) frequency of consumption of NWs (*never, less than once a month, at least once a month, at least once a week, 2/3 times per week, everyday*), 2) interest in visiting wineries producing NW (0: I am not interested at all; 5: I am very interested), 3) interest in reading information about NW (0: I am not interested at all; 5: I am very interested), and 4) the type of wine regarding the production of “alternative wine” (NW, organic, biodynamic, without sulphites, vegan) and in terms of origin (table wine, Geographical Indication-GI, Protected Designation of Origin-PDO) and volume of wines they produce (nothing, a small part, the major part, in exclusivity) of each type of wine category. Finally, sociodemographic information about age, gender and level of education was collected.

### 2.4. Data analysis

#### 2.4.1. Evaluation of the internal consistency of the questionnaire

The internal consistency of the questionnaire was evaluated by means of the standardised Cronbach's  $\alpha$ . This is a reliability coefficient that ranges from 0 to 1. Higher values of Cronbach's  $\alpha$  indicate higher internal consistency. The Cronbach's  $\alpha$  was calculated with the 31 items related to attitude towards NWs considering the eight a priori dimensions (Table 1). For a given dimension, Cronbach's  $\alpha$  values higher than 0.50 were considered acceptable, otherwise the non-related items were identified and removed from the dimension and Cronbach's  $\alpha$  recalculated.

Three out of the original 31 statements were removed (not marked with \* in Table 1) for the final analysis.

#### 2.4.2. Identification of different attitudes towards NW

A correlation-based Principal Component Analysis (PCA) with

**Table 1**

Attitudes towards NWs including statements, code and a priori dimensions. Participants answered using a 4-point scale of agree/disagree. The code of statements consists of the dimension (Se, He, Eco-F, Econ, Sold, Tr, Tech, Mo), then the type of wine described, either NW or Conventional Wine (CW), the positive or negative character of the statement (+or -) and then a brief word summarising the sentence. Within each dimension, items marked with \* show an acceptable internal consistency according to standardised Cronbach's  $\alpha$ .

Dimension	Code	Statement
<b>Sensory (Se)</b> * $\alpha$ -Cronbach = 0.632	<i>Se-NW-default*</i>	NW presents sensory defects with higher frequency than CWs.
	<i>Se-NW-visual*</i>	The visual appearance of NWs is less appealing than CWs.
<b>Health (He)</b> * $\alpha$ -Cronbach = 0.777	<i>He-NW + lowAdditives*</i>	NWs are healthier than CWs because they present fewer additives.
	<i>He-CW-SO<sub>2</sub>* </i>	The presence of more than 10 mg/L of total sulphur dioxide in wines is harmful to health.
	<i>He-NW + noHeadache* </i>	Wines made without sulphur generate fewer headaches.
<b>Eco-friendly (Eco-F)</b> * $\alpha$ -Cronbach = 0.788	<i>He-CW-highAdditives*</i>	Nowadays wines contain large amounts of additives that can be harmful to health.
	<i>EcoF-NW + auxmaterials*</i>	In the production of NWs, auxiliary materials (packaging, bottles...) are usually less polluting than in conventional winemaking.
	<i>EcoF -NW + sustainable*</i>	NWs promote sustainable agriculture.
	<i>EcoF -NW + envfriendly*</i>	The production of NWs promotes the production of environmentally friendly products.
<b>Economy (Econ)</b> * $\alpha$ -Cronbach = 0.731	<i>EcoF -NW + climatechange*</i>	The production of wines with minimal intervention both in the vineyard and in the winery is a way to minimise the effects of climate change.
	<i>EcoF-CW-chemicals</i>	Conventional agriculture uses chemicals unfavourable to ecosystems.
	<i>Econ-NW + Q/price*</i>	NWs have an excellent quality/price ratio.
	<i>Econ -NW + niche*</i>	NWs could become an important market niche in Spain.
	<i>Econ -NW + sector*</i>	The production of NWs is positive for the development of the wine sector.
	<i>Econ -NW + demand*</i>	There is a growing demand for NWs.
<b>Social identity (Sold)</b> * $\alpha$ -Cronbach = 0.745	<i>Econ -NW-nonprofitable*</i>	The production of purely NWs, without intervention, is not feasible from an economic point of view.
	<i>Econ -NW + price*</i>	You would be willing to pay a higher price for a NW than for a CW.
	<i>Econ-NW-differentiation*</i>	The new trend to stand out among the multitude of wines on the market is the production of wines with minimal intervention (without sulphur, spontaneous fermentations...).
	<i>Sold-VN + especial*</i>	Consuming NW makes me feel special because it is an exclusive product.
	<i>Sold -NW + commonInterests*</i>	The production of NWs allows you to belong to a very interesting, collaborative circle of producers with common interests.
<b>Tradition (Tr)</b> * $\alpha$ -Cronbach = 0.691	<i>Sold -NW + belong*</i>	I belong or would like to belong to the circle of winemakers who produce NWs.
	<i>Tr-NW + terroir*</i>	NWs, made with minimal intervention, favour the expression of terroir in wines.
	<i>Tr-NW + tradition*</i>	Natural winemaking is a way to preserve traditional winemaking practices.
<b>Technology (Tech)</b> * $\alpha$ -Cronbach = 0.568	<i>Tr-CW-technological*</i>	Conventional winemaking today is too technological.
	<i>Tec-NW-traces*</i>	The production of NWs generates more traces of harmful products than CWs.
	<i>Tec-CW + preserve*</i>	CWs are better preserved than those made without the addition of oenological products.

**Table 1 (continued)**

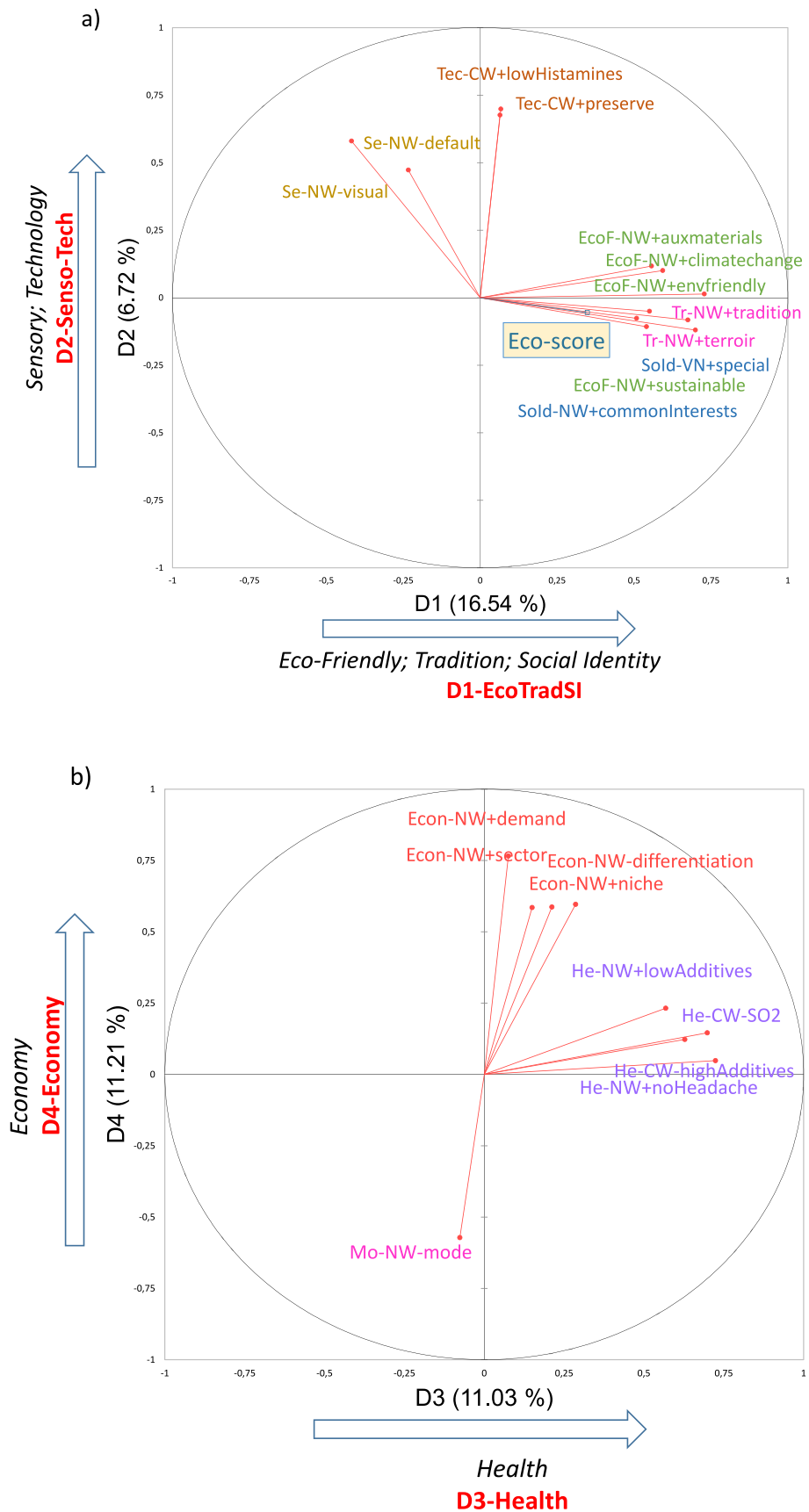
Dimension	Code	Statement
<b>Mode (Mo)</b> * $\alpha$ -Cronbach = 0.530	<i>Tec-CW + lowHistamines*</i>	Wines made with commercial yeasts and/or bacteria result in lower levels of histamines and contaminants of microbiological origin.
	<i>Tec-CW-standard</i>	The addition of commercial yeasts in alcoholic fermentation is leading to standardised wines.
	<i>Tec-CW + filtration</i>	The filtration of wines does not affect their sensory quality.
	<i>Mo-CW + artisanal*</i>	Wine in general in itself is already a natural and artisan product.
	<i>Mo-NW-mode*</i>	NWs are simply a passing fad.

**Table 2**

Statements (and source) formulated to evaluate the ecological awareness in participants' everyday life.

Statement	Bibliography
1. In my day to day, I am concerned about taking care of the environment, saving water and electricity and recycling.	(Milfont & Duckitt, 2010)
2. When I go shopping, I look at the packaging of the products and choose those whose packaging is more sustainable.	(Liobikiene & Juknys, 2016)
3. I try to buy products in bulk to avoid the use of plastics.	Self-generated
4. I use my own car whenever I need it, without thinking about air pollution or the possibility of taking urban transport.	(Rhead, Elliot, & Upham, 2015)
5. When I see that a factory emits a large amount of gases, I think that the legislation in this regard should be more restrictive.	(Milfont & Duckitt, 2010)
6. I support or would like to support an organization in defence of the environment.	(Kil, Holland, & Stein, 2014)
7. I am the kind of person who makes big efforts to preserve natural resources.	(Pienaar, Lew, & Wallmo, 2013)
8. In my opinion, protecting the environment is more important than protecting economic growth.	(Kil et al., 2014)
9. When I go shopping, I carefully inspect the list of ingredients and try to choose the most natural ones.	(Renner, Sproesser, Strohbach, & Schupp, 2012); (Roininen et al., 2001)
10. I consume more and more organic products.	(Brunner, van der Horst, & Siegrist, 2010)
11. I take special care to consume healthy products, without additives and with low caloric content.	(Hemmerling, Hamm, & Spiller, 2015)

varimax rotation was firstly calculated with the 28 out of 31 (Table 1) statements measuring the attitudes towards NW (selected based on the Cronbach's  $\alpha$ ) as active variables. The rotation was carried out with the first six dimensions of the PCA, which displayed eigenvalues greater than 1. This multivariate analysis allows identifying independent and easy-to-interpret dimensions. Thirdly, a Hierarchical Cluster Analysis (HCA) was performed on the first six varimax-rotated dimensions of the PCA using Euclidean distance and Ward's agglomeration criteria. This allowed the identification of groups of participants with different attitudes towards NW. One-way ANOVAs with cluster as between-subject factor were calculated for continuous variables, and a Z-test of proportions for the type of wine produced (NW or Conventional Wine: CW). Continuous variables included: the 28 statements related to the attitudes towards NWs, the three questions related to the frequency of consumption of NWs, the interest in visiting wineries producing NW and the interest in reading information about NWs.



**Fig. 1.** The six varimax-rotated dimensions of the PCA calculated on the 28 attitude statements. Only items contributing the most to each dimension are represented on the figure.

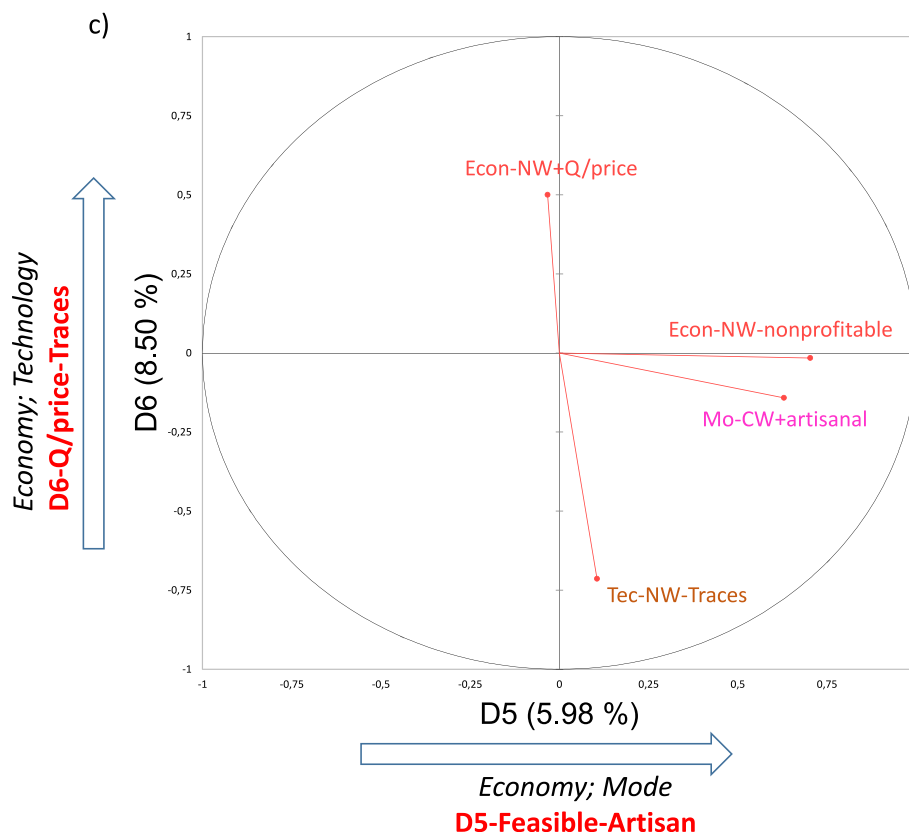


Fig. 1. (continued).

#### 2.4.3. Relationship between the Eco-score and the attitudes towards NWs

Calculation of the Eco-score: a PCA was performed on the 11 environmental awareness statements (third section of the questionnaire). All the statements showed a positive correlation with the first PC ( $r > 0.60$ ), except for “I use my own car whenever I need it, without thinking about air pollution or the possibility of taking urban transport”. An overall environmental score (i.e., Eco-score) was then calculated for each participant by averaging the 10 correlated items.

Relationship between the Eco-score and attitudes: The Eco-Score was projected as supplementary variable on the PCA with varimax rotation calculated with the 28 items of Table 1 as described in Section 2.4.2. Further, a one-way ANOVA with cluster (clusters identified as described in Section 2.4.2) as between-subject factor was calculated with the Eco-score in order to identify clusters of participants with different Eco-score. Significance threshold was set at  $\alpha = 0.05$ . Fisher (LSD) post-hoc tests were carried out on significant effects.

All statistical analyses were carried out with XLSTAT (version 19.03. Addinsoft, Paris, France).

### 3. Results

#### 3.1. Could different attitudes towards NW be identified among Spanish winemakers?

##### 3.1.1. Identification of independent dimensions explaining attitudes of winemakers towards NW

The PCA performed on the initial statements yielded six dimensions with an eigenvalue greater than one suggesting that the eight *a priori* dimensions can be reduced to six independent dimensions. Fig. 1 shows the projections of the items contributing the most to the six dimensions after varimax rotation. For a given dimension, an item was considered important when: 1) the contribution (%) was higher than the average and 2) the  $\cos^2$  of the variables after rotation was higher than 0.250 (i.e.,

correlation coefficient between the item and the dimension higher than 0.5).

Fig. 1a shows the first two rotated dimensions. The first dimension, (D1, explaining 16.5% of the original variance), is mainly driven by statements related to Ecofriendly (all the four items included in the PCA belonging to this *a priori* dimension), Tradition (two out of three items), and Social Identity (two out of three). More specifically, this dimension is driven by ecological-related aspects (Eco) of NW including: “In the production of NWs, auxiliary materials (packaging, bottles,...) are usually less polluting than in conventional winemaking”, “NWs promote sustainable agriculture”, “The production of NWs promotes the production of environmentally friendly products”, and “The production of wines with minimal intervention both in the vineyard and in the winery is a way to minimise the effects of climate change”. These items are correlated with attitudes related to social identity (SI) and tradition (Trad). More specifically, it is contributed by the following statements belonging to social identity: “Consuming NW makes me feel special because it is an exclusive product”, “The production of NWs allows you to belong to a very interesting, collaborative circle of producers with common interests”, and tradition: “NWs, made with minimal intervention, favour the expression of terroir in wines”, and “Natural winemaking is a way to preserve traditional winemaking practices”. We will refer to this dimension as D1-EcoTradSI from now on (Table 3). The second dimension (6.72% of variance) represents the two sensory-related items (Table 3) and two technological questions (“Conventionally produced wines are better preserved than those made without the addition of oenological products” and “Wines made with commercial yeasts and/or bacteria result in lower levels of histamines and contaminants of microbiological origin”). This will be referred to as D2-Senso-Tech. The third item belonging to the *a priori* Technology dimension (i.e., Tec-NW-traces) is not included in D2-Senso-Tech together with the other two Tech-related items, which is supported by the Cronbach alpha below 0.7 (i.e., threshold usually employed to confirm the coherence among the items of one dimension) of this dimension (Table 1).

**Table 3**

Codes and questions significantly contributing to the six independent dimensions derived from the PCA with varimax rotation.

Code	Related questions
D1-EcoTradSI	<p><b>Eco:</b> In the production of NWs, auxiliary materials (packaging, bottles...) are usually less polluting than in conventional winemaking.</p> <p><b>Eco:</b> NWs promote sustainable agriculture.</p> <p><b>Eco:</b> The production of NWs promotes the production of environmentally friendly products.</p> <p><b>Eco:</b> The production of wines with minimal intervention both in the vineyard and in the winery is a way to minimise the effects of climate change.</p> <p><b>Sold:</b> Consuming NW makes me feel special because it is an exclusive product.</p> <p><b>Sold:</b> The production of NWs allows you to belong to a very interesting, collaborative circle of producers with common interests.</p> <p><b>Tr:</b> NWs, made with minimal intervention, favour the expression of terroir in wines.</p> <p><b>Tr:</b> Natural winemaking is a way to preserve traditional winemaking practices.</p>
D2-Senso-Tech	<p><b>Se:</b> NW presents sensory defects with higher frequency than CWs.</p> <p><b>Se:</b> The visual appearance of NWs is less appealing than CWs.</p> <p><b>Tech:</b> CWs are better preserved than those made without the addition of oenological products.</p> <p><b>Tech:</b> Wines made with commercial yeasts and/or bacteria result in lower levels of histamines and contaminants of microbiological origin.</p>
D3-Health	<p><b>He:</b> NWs are healthier than CWs because they present fewer additives.</p> <p><b>He:</b> The presence of more than 10 mg/L of total sulphur dioxide in wines is harmful to health.</p> <p><b>He:</b> Wines made without sulphur generate fewer headaches.</p> <p><b>He:</b> Nowadays wines contain large amounts of additives that can be harmful to health.</p>
D4-Economy	<p><b>Econ:</b> NWs could become an important market niche in Spain.</p> <p><b>Econ:</b> The production of NWs is positive for the development of the wine sector.</p> <p><b>Econ:</b> There is a growing demand for NWs.</p> <p><b>Econ:</b> You would be willing to pay a higher price for a NW than for a CW.</p> <p><b>Econ:</b> The new trend to stand out among the multitude of wines on the market is the production of wines with minimal intervention (without sulphur, spontaneous fermentations...).</p>
D5-Feasible-Artisan	<p><b>Econ:</b> The production of purely NWs, without intervention, is not feasible from an economic point of view.</p> <p><b>Mo:</b> Wine in general in itself is already a natural and artisan product.</p>
D6-Q/price-Traces	<p><b>Econ:</b> NWs have an excellent quality/price ratio.</p> <p><b>Tech:</b> The production of NWs generates more traces of harmful products than CWs.</p>

Fig. 1b represents the third (11.03% of variance) and fourth (11.21%) rotated dimensions. These two dimensions are mainly contributed to by Health-related (four out of four initial items related to this *a priori* dimension) and Economy items (four out of seven items), respectively. They will be referred to as D3-Health and D4-Economy. To note is that the item Mo-NW-mode (“NWs are simply a passing fad”), included initially in the mode dimension (Table 1), would be rather be included in the Economy dimension given its linkage to D4-Economy (Fig. 1b).

Fig. 1c represents the last two rotated dimensions. Dimension 5 (5.98% of variance) is linked to one Economy-related item (“The production of purely NWs, without intervention, is not feasible from an economic point of view”) and one belonging to the *a priori* dimension Mode (“Wine in general in itself is already a natural and artisan product”). From now on, it will be referred to as D5-Feasible-Artisan. Finally, dimension 6 (8.50% of variance) is mainly contributed to by one Economy question (“NWs have an excellent quality/price ratio”), and one Technological question (“The production of NWs generates more traces of harmful products than CWs”). This dimension will be named D6-Q/price-Traces.

### 3.1.2. Identification and characterisation of clusters of winemakers with different attitudes towards NW

The HCA performed on the projection of the winemakers on the six

varimax-rotated PCA dimensions yielded five clusters of winemakers (Fig. 2). The statistical analyses carried out to characterise these clusters (ANOVA and Z test, alpha risk = 5%) showed differences among clusters both in terms of production and consumption behaviour and in term of attitude towards NWs.

Concerning NWs production, significant differences are observed among the five clusters of producers. Fig. 3 shows that winemakers of Cluster 4 reported that their production of NW is significantly lower than for the rest of participants. Cluster 4 comprises 37 participants (12% of all surveyed participants) and includes 3% of NW producers (1 participant declaring to produce a small part), while Cluster 5, with a total of 64 winemakers, includes the highest percentage of NW producers: 44% (28 winemakers), 22% of them declaring (14 participants) to produce a small part of NW, 14% (9 winemakers) a major part, and 8% (5 winemakers) in exclusivity. The other clusters included at least 25% of participants who declared to produce at least a small part of NW. Cluster 2 (67 participants) comprises 36% and Cluster 1 (67 participants) 31% of NW producers, followed by Cluster 3 (63 participants) with 25% NW producers. It is worth noting that, in contrast, no significant difference between clusters was observed concerning the production of other alternative wines. Overall, most participants whatever the cluster are producers of wines within a PDO (90% of them) (see Fig. S3a of Appendix A), and an important part of them declared to produce at least a small fraction of alternative wines (see Fig. S3b of Appendix A). Among these alternative wines, organic wines are the most frequent (60% of participants among which 29% declared producing organic wines majorly or in exclusivity) followed by vegan (49% / 35%), without sulphites (32% / 7%), natural (30% / 12%), and finally biodynamic wines (17% / 6%).

Regarding NWs consumption, while participants generally declared to consume NW scarcely (around once a month in average), winemakers of Cluster 4 show the lowest consumption frequency ranging from never to less than once a month (Fig. 4). They are also significantly less interested in getting information about NW production and visiting NW wineries, than winemakers from Cluster 5 followed by Cluster 1 and then by Cluster 2 and 3.

To sum up, this first analysis highlights a behavioural difference between winemakers of Cluster 4 and the other winemakers, especially those of Cluster 5. Cluster 4 winemakers are mainly non-producers of NWs, not interested in getting information about NW production and do not drink NW. On the opposite side, producers of Cluster 5 include an important part of NW producers (44%), and are especially interested in the production of alternative wines and visiting NW wineries. Winemakers of Cluster 1, followed by Cluster 2 and 3, are just behind Cluster 5 in the number of NW producers composing the cluster and in their interest in the production method and visiting NW wineries.

Regarding winemakers' attitudes towards NW, Table 4 shows a summary of the positive or negative attitudes of each cluster towards NWs for each PCA dimension (D1-D6). There is an overall negative attitude among all participants towards NWs, regardless of the cluster, in terms of the sensory and technological dimension D2-Senso-Tech (Fig. 5) and D6-Q/price-Traces (Fig. 6) and a positive one for CW. More specifically, winemakers mainly agree in that NWs present sensory defects with higher frequency than CWs (Se-NW-default: average scores of at least 3 for all clusters in a 4 point scale), and that CWs are better preserved (Tec-CW + preserve) and their production method generates lower levels of histamines than NWs (Tec-CW + lowhistamines). The exception are respondents of Cluster 2, who declare to be in disagreement with these last technological-related items (Tec-CW + preserve and Tec-CW + lowhistamines). Contrary to this general negative attitude in terms of defects of NWs, a positive representation of all clusters is observed regarding their visual aspect, except for Cluster 4. Thus, Clusters 1–3 and 5 do not agree in that the visual appearance of NW is less appealing than CWs (Se-NW-visual). Similarly, there is a shared negative attitude in relation to D6 (Fig. 6), because producers do not agree in that NW shows a good Quality/price ratio. Besides, Spanish

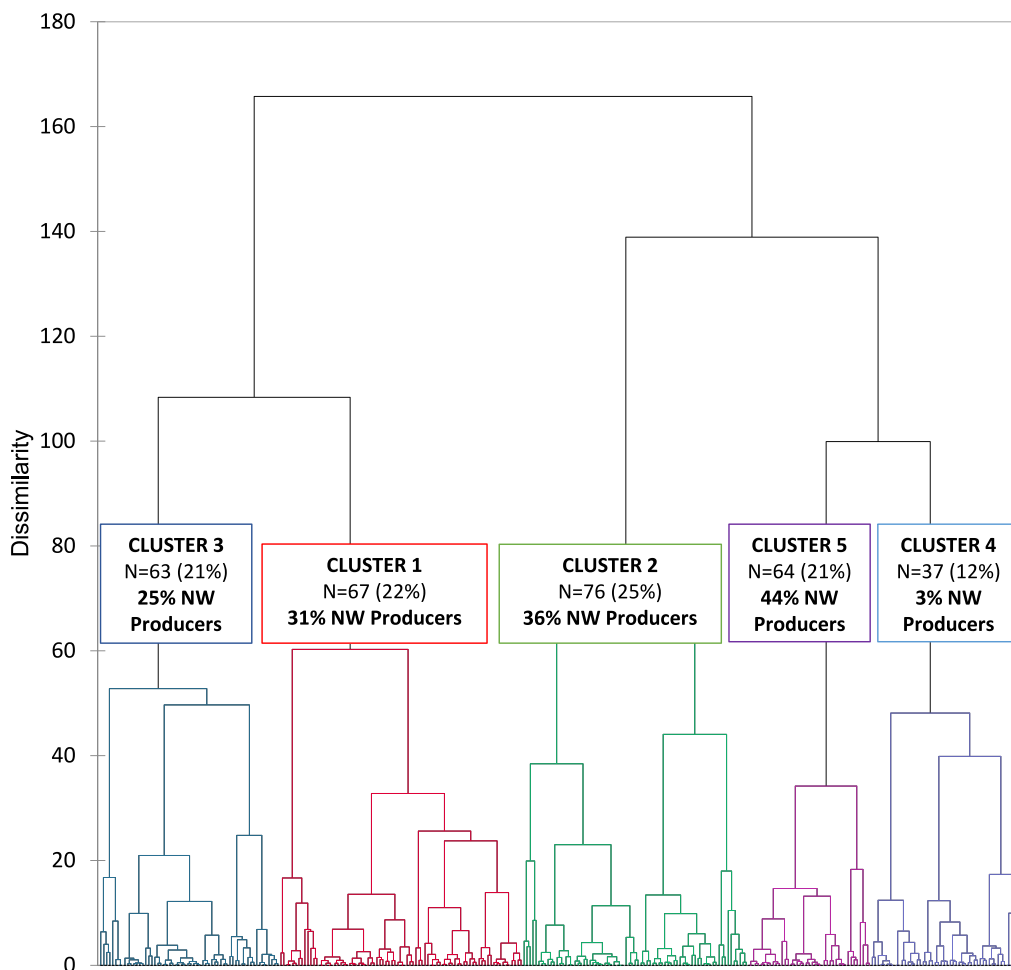


Fig. 2. Dendrogram obtained from the HCA calculated with the six varimax-rotated dimensions derived from the PCA performed on the 28 items related to winemakers' NW attitudes.

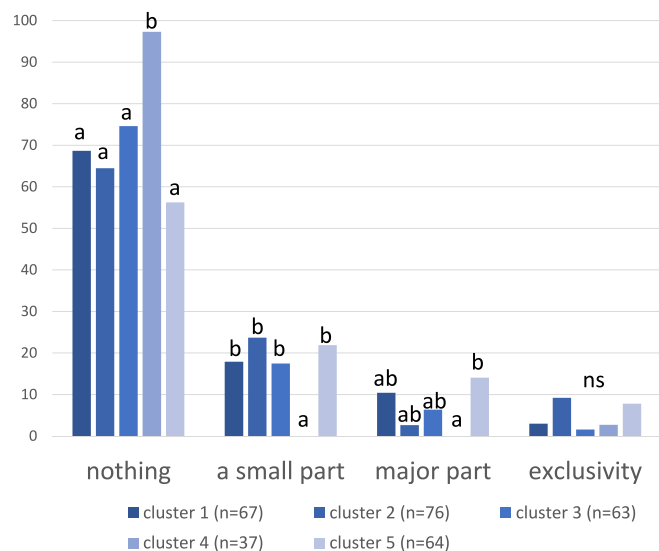


Fig. 3. Percentage of NW producers for each cluster and the share of NW they produce (nothing, a small part, major part or in exclusivity). Different letters indicate significant differences ( $P < 0.05$ ) for a category (nothing, a small part, major part or exclusivity) among clusters according to chi-square and Marascuilo posthoc test.

winemakers in overall are in disagreement with the fact that NW production generates more traces of harmful products than CWs, except for participants of Cluster 4, that would be in relative agreement (average score close to 3, Fig. 6).

Most clusters are favourable for NWs regarding dimension D4-Economy (Table 4 and Fig. 7). All groups of winemakers, except for those belonging to Cluster 4, agree in that the production of NW is positive for the sector. They agree that NW opens a new market niche with high demand, and that it is not simply a passing fad.

To sum up, leaving aside D2-Senso-Tech, D4-Economy, and D6-Q/price-Traces that show major agreement among winemakers, the attitudes of participants regarding D1-EcoTradSI (Fig. 8), D3-Health (Fig. 9), and D5-Feasible-Artisan (Fig. 10) are segregated. Winemakers of Cluster 4 present the most negative attitude towards NW, showing negative attitudes for the six dimensions (Table 4). This is in agreement with their lowest interest in the consumption and production of NW reported above. Winemakers of Cluster 3, except for the dimension D4-Economy, report similar negative attitudes. The opposite is observed for winemakers of Clusters 2 and 5, who report an overall positive attitude towards NWs, especially those belonging to Cluster 2 and in relation to D5-Feasible-Artisan dimension. To this regard, they do not agree in that 1) NW is not feasible from an economic point of view and 2) CW is a natural and artisanal product. Cluster 1 followed by Cluster 5 show similar attitudes in relation to this dimension. Regarding D1-EcoTradSI (Fig. 8), related to aspects of ecology, tradition and social identity of NW, winemakers of Clusters 1 and 5 show the most positive attitude, followed by Cluster 2. Winemakers belonging to these clusters agree in



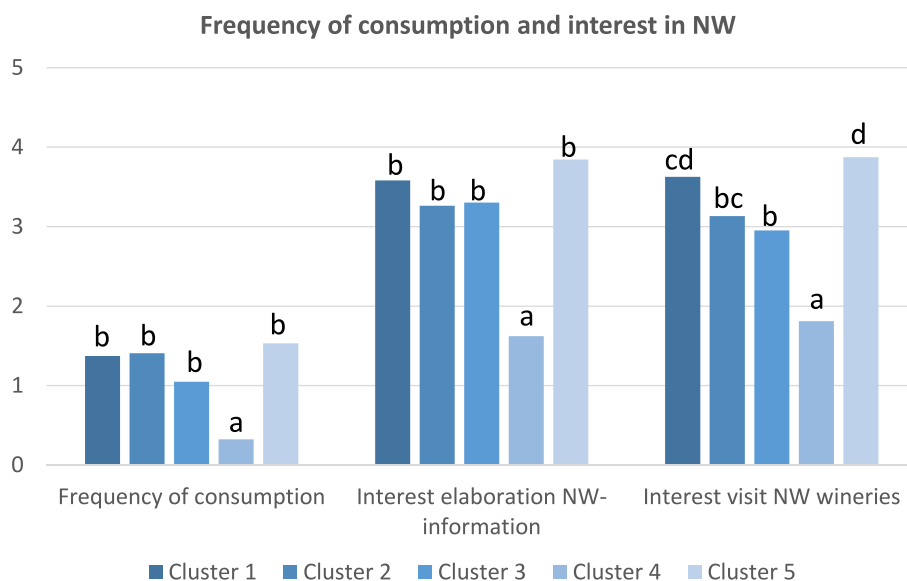


Fig. 4. Average scores of participant's clusters for consumption habits and interest towards NWs. Different letters indicate significant differences ( $P < 0.05$ ) among clusters.

Table 4

Summary of the positive (+) or negative (-) attitudes of the clusters of producers related to the six independent dimensions derived from the PCA with varimax.

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
D1-EcoTradSI	++	+	-	-	+
D2-Senso-Tech	--	-	--	---	--
D3-Health	--	+	-	-	+
D4-Economy	+	+	+	-	+
D5-Feasible-Artisan	++	++	---	-	+
D6-Q/price-Traces	-	-	-	-	-

that NWs are mainly eco-friendly, a way of preserving the terroir and representing a traditional winemaking style. For them, NWs are linked to social identity, because their consumption makes them feel special, and their production allows them to belong to a collaborative circle of producers with common interests (Fig. 8).

In relation to D3-Health, winemakers of Cluster 5 and Cluster 2 report the most positive attitude towards NW (Fig. 9). They agree in that 1) NWs are healthier than CWs because they present fewer additives, and 2) more than 10 mg/L of total sulphur dioxide in wines is harmful to health and generate headaches. Besides, they agree in that nowadays wines contain large amounts of additives that can be harmful to health.

Overall (Table 4), winemakers of Cluster 4 show the most negative attitude towards NWs, followed by those of Cluster 3, that only show a positive attitude in terms of Economy-related aspects. Differently, winemakers belonging to Cluster 5 and Cluster 2 show the most positive attitude. Participants of Cluster 1 show an intermediate reported behaviour. This result is well related to the number of NW producers constituting each cluster and to their interest in visiting, drinking and getting information about NWs.

### 3.2. Does environmental awareness affect attitudes towards NW of Spanish winemakers?

The second research question concerned the relationship between winemakers' overall environmental awareness calculated through an

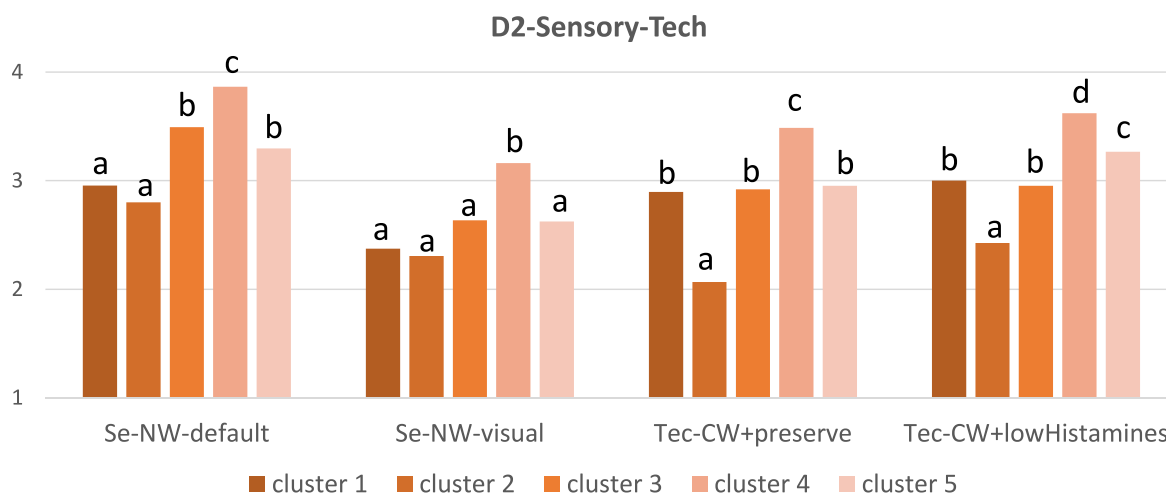


Fig. 5. Average scores for each of the five clusters of the four items contributing to D2-Senso-Tech. Different letters indicate significant differences ( $P < 0.05$ ) among clusters.

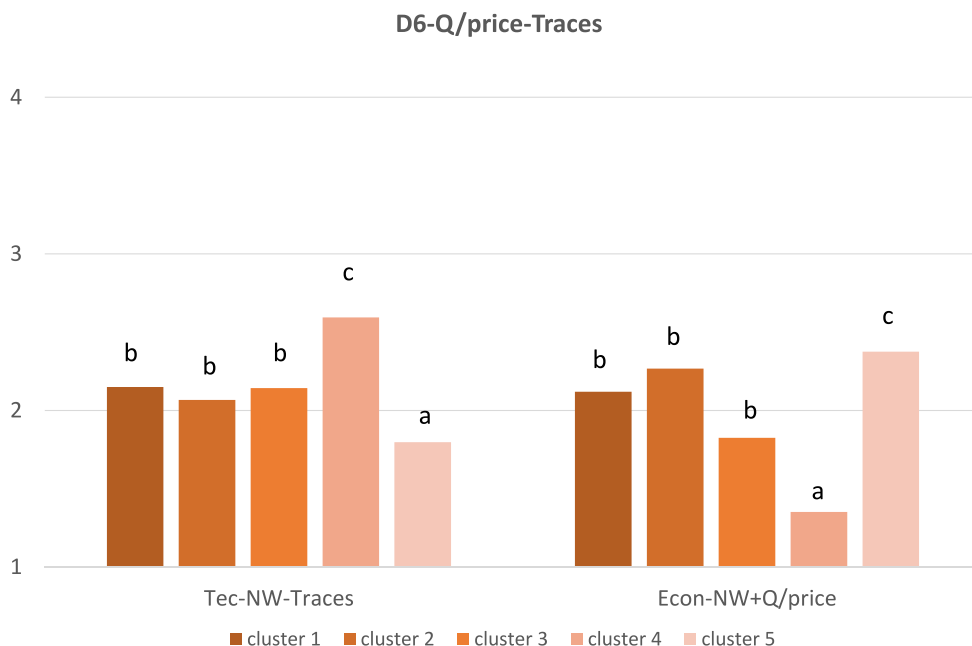


Fig. 6. Average scores for each of the five clusters of the two items contributing to D6-Senso-Tech. Different letters indicate significant differences ( $P < 0.05$ ) among clusters.

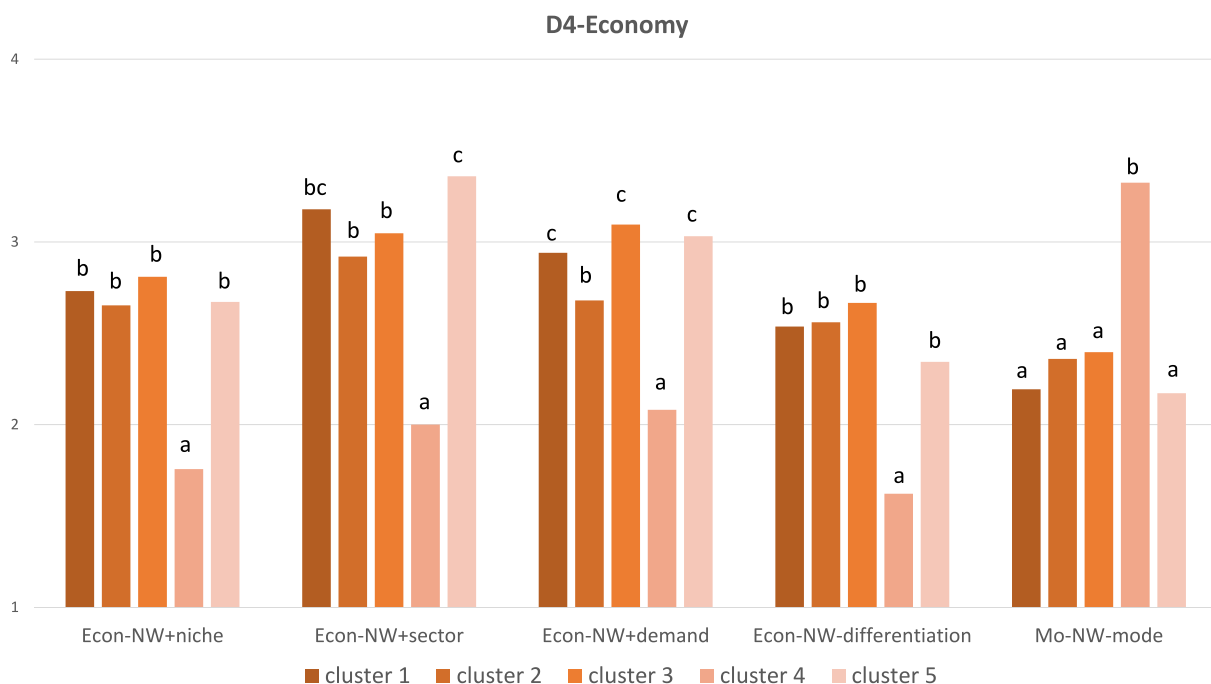


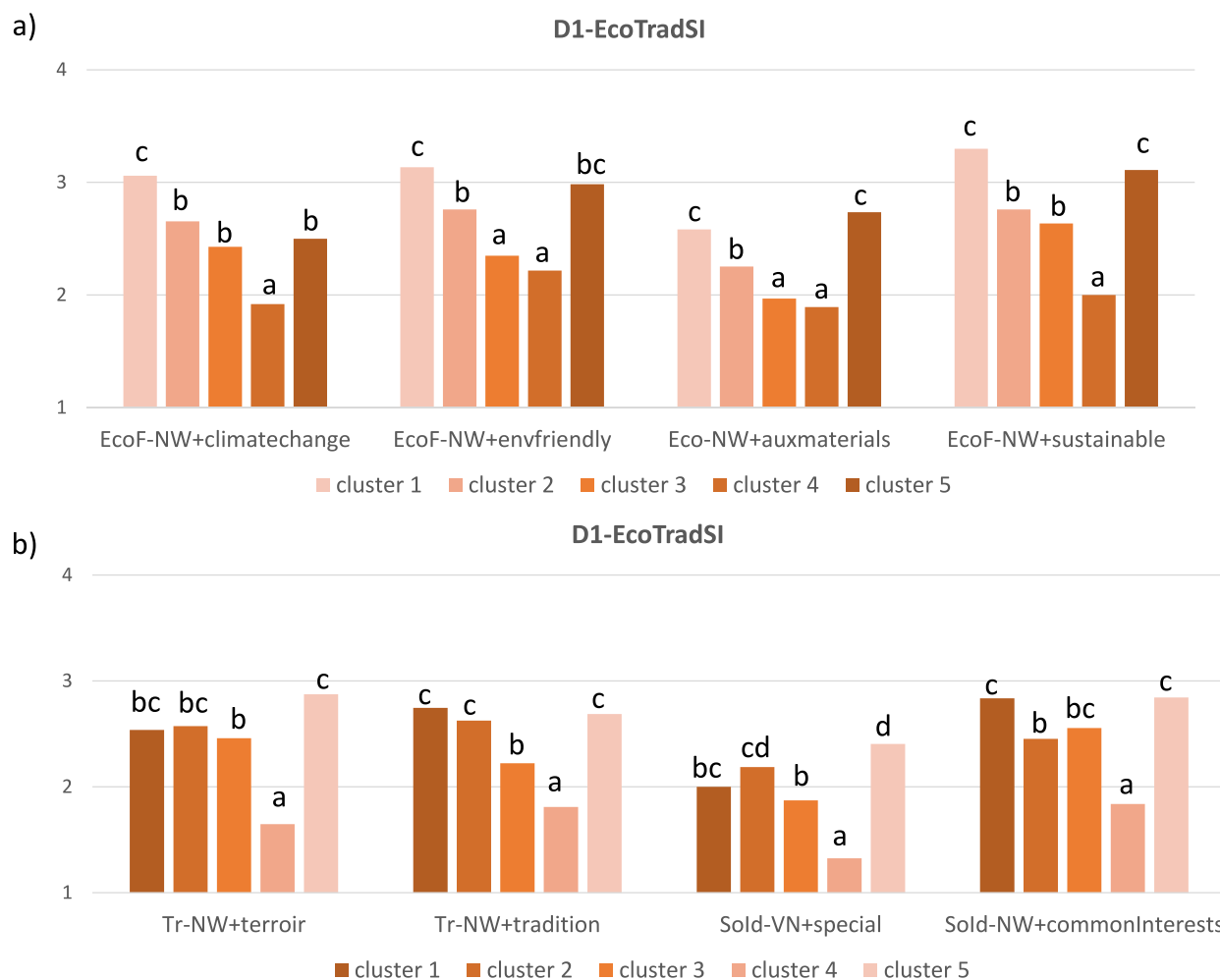
Fig. 7. Average scores for each of the five clusters of the items contributing to D4-Economy. Different letters indicate significant differences ( $P < 0.05$ ) among clusters.

Eco-score and their attitude towards NW. The Eco-score, projected as illustrative variable on the varimax rotated PCA (Fig. 1a), is significantly correlated with D1-EcoTradSI ( $F = 42.02$ ;  $p < 0.0001$ ;  $R^2 = 0.60$ ). The remaining five PCA-rotated dimensions do not present significant correlation with the Eco-score. This result shows that positive attitudes for D1-EcoTradSI (namely Cluster 1 followed by Cluster 2 and 5, Table 4) show higher Eco-score. This is confirmed by the ANOVA that shows that the Eco-score significantly differed among clusters ( $F = 3.17$ ;  $P < 0.05$ ). Cluster 1 ( $3.7 \pm 0.7$ ) and Cluster 4 ( $3.2 \pm 0.7$ ) presented the highest, and the lowest scores, and the most positive and negative attitude for D1-

EcoTradSI (Table 4), respectively. The other three clusters showed intermediate Eco-score values (Fig. 2).

#### 4. Discussion

The literature in the field has mainly examined the attitudes of consumers towards NW, while experts motivations are least explored. Regarding consumers' representation of NW, different dimensions of the product are weighted up, mainly those related to their influence on health, eco-friendly character, proximity-craft relationship, and flavour



**Fig. 8.** Average scores for each of the five clusters of the items contributing to D1-EcoTradSI, specifically items related to a) ecofriendly (Eco), and b) tradition (Tr) and social identity (SI). Different letters indicate significant differences ( $P < 0.05$ ) among clusters.

(Parga-Dans et al., 2023; Urdapilleta et al., 2021). Based on the literature, this study started by exploring a more extended number of dimensions able to impact winemakers' motivations towards NW, namely related to sensory (i.e., flavour, taste and visual aspect), health (i.e., being healthier products), eco-friendly, economy, social identity, traditional production, technology-related, and mode (i.e., social and economic tendency) aspects. The first result showed that these eight dimensions could be reduced to six independent dimensions able to explain the motivations of Spanish winemakers: D1-EcoTradSI (eco-friendly-tradition-social identity), D2-Senso-Tech (sensory-technological), D3-Health, D4-Economy, D5-Feasible-Artisan, and D6-Q/price-Traces. Results showed major agreement among winemakers for D2-Senso-Tech, D4-Economy, and D6-Q/price-Traces, while differences in attitudes for D1-EcoTradSI, D3-Health, and D5-Feasible-Artisan mark their differential attitudes.

Overall, the results show that there is a major agreement among Spanish winemakers in that NWs present higher sensory defaults than CWs. Technical experts follow a top-down process during wine tasting, which is developed with expertise. They are able to produce elaborated sensory descriptions of wines alongside a diagnosis based on their technical expertise (Honoré-Chedozeau, Desmas, Ballester, Parr, & Chollet, 2019; Parr, White, & Heatherbell, 2003). Importantly, the presence of technical defaults as defined by winemakers does not necessarily need to be perceived as negative by non-technical consumers (Sáenz-Navajas et al., 2015) or critics (Le Grand, 2023). Leaving aside the effect of expertise on wine intrinsic quality, the negative attitude of

Spanish winemakers towards NW is well in agreement with recent research exploring the sensory profile of Spanish white NWs (Sáenz-Navajas et al., 2023). In this paper, 70% of the NW characterised showed technical defects mainly related to the lack of or reduced use of sulphites (i.e., acetic acid/ethyl acetate, animal or oxidised aromas). Interestingly, despite the higher turbidity (due to their lack of clarification and filtration) reported for NW, winemakers do not declare that NW have lower appealing visual characteristics than CW overall. This result suggests that winemakers, different from consumers (Urdapilleta et al., 2021) and wine critics (Jackson, 2009), do not show a clear negative perception of wine turbidity on intrinsic quality. Winemakers also report to share their vision regarding the low potential of NW for ageing. This fact can be easily explained in terms of technical knowledge. The absence or low sulphite levels hinders the protection of wines against the chemical oxidation occurring during wine ageing favouring the production of Strecker aldehydes and thus the appearance of oxidation-related aromas linked to lower intrinsic quality (Bueno, Carrascón, & Ferreira, 2016). Alternatively, there are other new approaches like bioprotection (e.g., chitosan,  $\alpha$ -pinene, chestnut polyphenols or non-Saccharomyces strains to prevent microbial deviation and oxidation or addition of oenological tannins) that are now being explored as substitute to sulphite addition (Lebleux et al., 2023; Lisanti, Blaiotta, Nioi, & Moio, 2019). However, the replacement of sulphites to protect wine against chemical oxidation or microbiological deviations remains a challenge and has to be explored to provide alternatives for the production of wines in the least interventionist line such as NW. In any case,

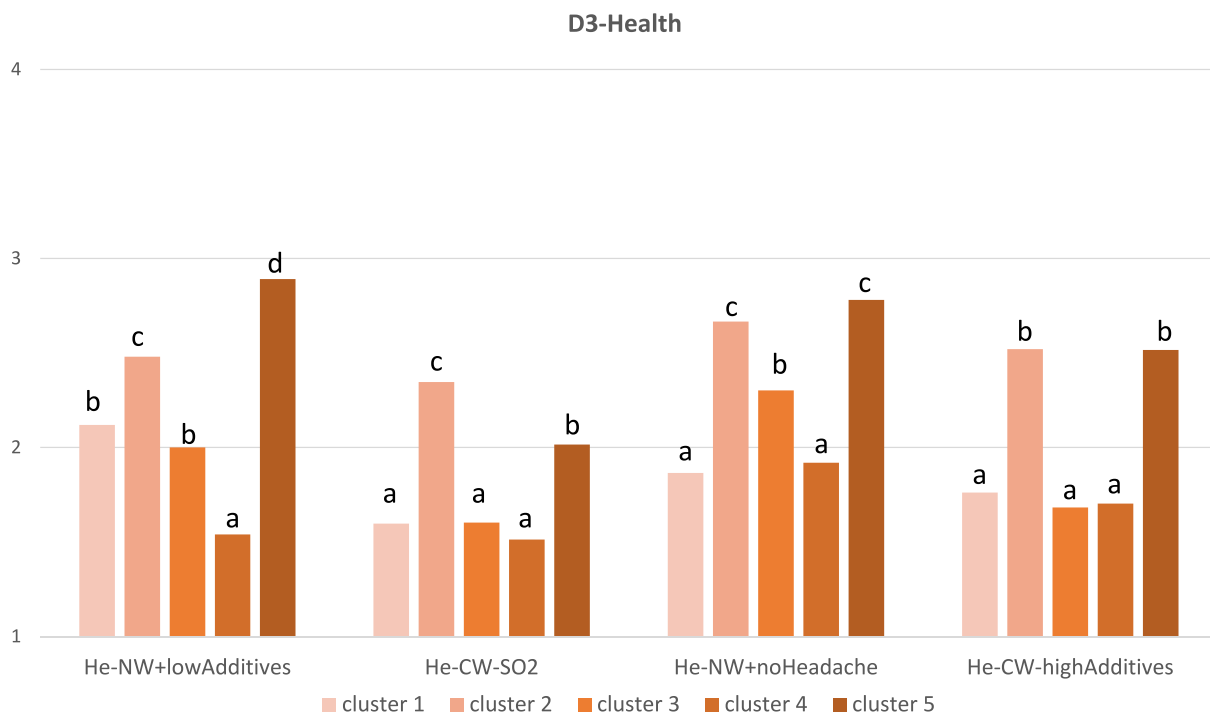


Fig. 9. Average scores for each of the five clusters of the items contributing to D3-Health. Different letters indicate significant differences ( $P < 0.05$ ) among clusters.

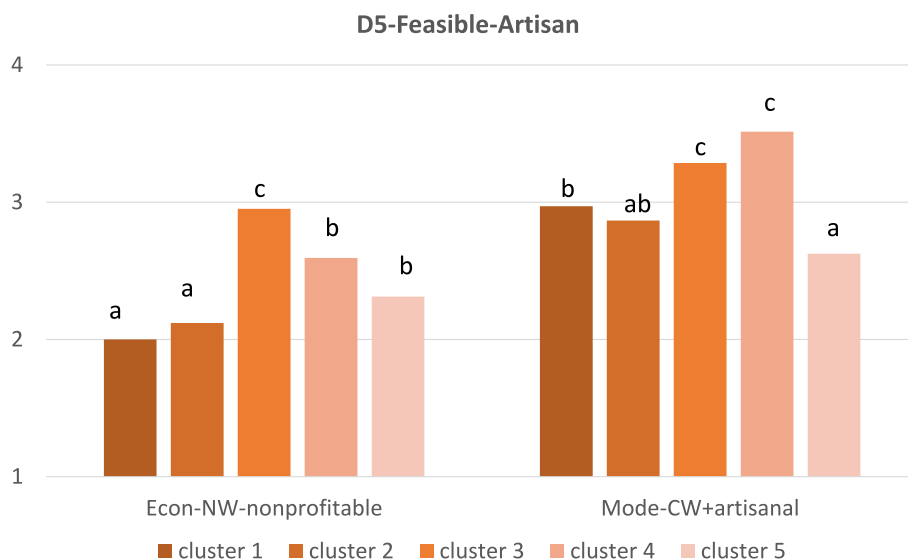


Fig. 10. Average scores for each of the five clusters of the items contributing to D5-Feasible-Artisan. Different letters indicate significant differences ( $P < 0.05$ ) among clusters.

natural winemakers generally oppose the addition of any product whatsoever (Alonso González & Parga-Dans, 2023).

The Spanish winemakers share the view that NW production can provide benefits to the wine industry, as they declare that they have potential for becoming an important market niche in Spain. This fact is in accordance with the growing demand reported for NWs among Italian consumers. They are willing to pay (WTP) higher prices for this segment of wines, and associated with the drinking frequency and occasion, organic production, sulphite content, income, and attitudes towards healthy eating and the environment (Vecchio, Annunziata, Parga Dans, & Alonso González, 2023). Spanish winemakers perceive NWs to be a new trend to stand out among the many wines on the market. However, they agree that NW present low perceived intrinsic quality and attribute

it to their higher incidence for flavour defaults. This can explain why they also share the view that NWs do not present an excellent quality/price ratio. Similarly, they agree that NWs do not present significantly higher quantities of traces of harmful substances than CWs, but they declare that CW production can limit the production of histamines as recently reported (Sáenz-Navajas et al., 2023). These authors showed that the levels of putrescine were significantly higher in NW production than CW, while remaining within the legal limits.

Despite these overall commonalities in the representation of NW among Spanish winemakers, there are clear differences regarding other three dimensions: D1-EcoTradSI (eco-friendly-tradition-social identity), D3-Health, and D5-Feasible-Artisan, which lead to five clusters of producers with differential attitudes towards NW. First, two out of the five

clusters, namely Cluster 5 followed by Cluster 2, share the vision of NW being healthier than CW. Contrarily, winemakers of Cluster 4 followed by Cluster 1 and 3 show a clear negative attitude towards NW in this dimension. Differently, among Spanish wine consumers, Parga-Dans et al. (2023) argue that NW are considered to be overwhelmingly healthier than other wines, which is the main motivation for its consumption among those demanding certification for natural wine.

Second, Cluster 3 followed by Cluster 4 and 5 agree in that the production of purely NWs, without any intervention, is not feasible from an economic point of view. Except for Cluster 5, most participants report that wine is already a natural and artisan product. This reflects the vision of most winemakers interviewed regarding the “naturalness” of wine as a product, this cue not being therefore necessarily attributable to NW in exclusivity. This aspect confronts with the conceptualisation of NW among Swiss (Staub et al., 2020) or French (Urdapilleta et al., 2021) consumers, and is more in line with consumers from New Zealand and Australia, where conventional production is more accepted as the adjective “natural” is related. Thirdly, Spanish winemakers differ in their representation regarding eco-friendly, tradition and social identity aspects of NW production. Interesting to note is that more positive attitudes towards this dimension (D1-EcoTradSI), is linked to their overall environmental awareness (measured through an Eco-score) in their everyday life. Results from this research converge with anthropological and ethnographic accounts of the NW movement highlighting the fact that ethical, philosophical and lifestyle motivations underlie the adoption of natural winemaking practices (Alonso González & Parga-Dans, 2023; Black, 2013; Smith Maguire, 2019; Viecelli, 2021). Indeed, “natural wine can be better understood as a food phenomenon exhibiting a sustainable alternative mode of production and consumption that unites a loose coalition of diverse actors” (Alonso González & Parga-Dans, 2023). Moreover, as highlighted by this research, there are different trends within the movement, which increases complexity. Some natural winemakers emphasise ecological and biodiversity conservation, but this is only one motivation among others including healthiness, anti-industrial and entrepreneurial ethics, and promotion of craftsmanship and self-sufficiency.

## 5. Conclusion

This paper is the first to advance knowledge about the motivations behind producers’ interest in natural winemaking, and perceptions of Spanish winemakers about natural wines. It shows that there is a correlation between ecological awareness and interest in natural winemaking, both in practice (winemaking) and in theory (knowing more about natural winemaking). Although more ecological aware winemakers have more positive attitude towards NW and are more inclined to produce NW, most of our participants expressed concerns about the sensory properties of NW. Future research should focus on consumer perceptions of NWs in Spain, trying to understand whether consumers’ ideas converge with producers’ ideas, given the current information asymmetry in the wine market.

This study presents limitations inherent to its exploratory character. Given that a convenience sampling method was used to recruit the participants, some winemaker categories were underrepresented in our sample. Further studies should use more balanced designs to test more precisely some hypotheses emerging from our work.

## CRedit authorship contribution statement

**María-Pilar Sáenz-Navajas:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Estela Terroba:** Investigation, Formal analysis. **Eva Parga-Dans:** Writing – review & editing, Funding acquisition, Conceptualization. **Pablo Alonso-González:** Writing – review & editing, Funding acquisition, Conceptualization. **Purificación Fernández-Zurbano:** Writing – review &

editing, Project administration, Funding acquisition. **Dominique Valentin:** Writing – review & editing, Supervision, Methodology, Conceptualization.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodres.2024.114022>.

## References

- Alonso González, P., & Parga-Dans, E. (2020). Natural wine: Do consumers know what it is, and how natural it really is? *Journal of Cleaner Production*, 251, Article 119635. <https://doi.org/10.1016/j.jclepro.2019.119635>
- Alonso González, P., Parga Dans, E., & Fuentes Fernández, R. (2022). Certification of Natural Wine: Policy Controversies and Future Prospects. *Frontiers in Sustainable Food Systems*, 6. <https://doi.org/10.3389/fsufs.2022.875427>
- Alonso González, P., & Parga-Dans, E. (2023). The natural wine phenomenon and the promise of sustainability: Institutionalization or radicalization? *Culture, Agriculture, Food and Environment*. <https://doi.org/10.1111/cuag.12310>
- Black, R. E. (2013). *Vino Naturale: Tensions between Nature and Technology in the Glass Wine and Culture: Vineyard to Glass* (pp. 279–294). London: Bloomsbury.
- Bresciani, S. (2017). Open, networked and dynamic innovation in the food and beverage industry. *British Food Journal*, 119(11), 2290–2293. <https://doi.org/10.1108/bfj-08-2017-0458>
- Brunner, T. A., van der Horst, K., & Siegrist, M. (2010). Convenience food products. *Drivers for consumption*. *Appetite*, 55(3), 498–506. <https://doi.org/10.1016/j.appet.2010.08.017>
- Bueno, M., Carrascón, V., & Ferreira, V. (2016). Release and Formation of Oxidation-Related Aldehydes during Wine Oxidation. *Journal of Agricultural and Food Chemistry*, 64(3), 608–617. <https://doi.org/10.1021/acs.jafc.5b04634>
- Capitello, R., & Sirieix, L. (2019). Consumers’ perceptions of sustainable wine: An exploratory study in France and Italy. *Economies*, 7(2). <https://doi.org/10.3390/economies7020033>
- Castellini, G., Acampora, M., Provenzi, L., et al. (2023). Health consciousness and pro-environmental behaviors in an Italian representative sample: A cross-sectional study. *Scientific Reports*, 13, 8846. <https://doi.org/10.1038/s41598-023-35969-w>
- Fuentes-Fernández, R., & Gilinsky, A., Jr (2022). Cooptation as improvisation: An exploratory comparative case study investigation into Spain’s natural wine industry. *International Journal of Wine Business Research*, 34(2), 308–328. <https://doi.org/10.1108/ijwbr-12-2020-0062>
- Galati, A., Schifani, G., Crescimanno, M., & Migliore, G. (2019). “Natural wine” consumers and interest in label information: An analysis of willingness to pay in a new Italian wine market segment. *Journal of Cleaner Production*, 227, 405–413. <https://doi.org/10.1016/j.jclepro.2019.04.219>
- Gómez Pallarés, J. (2018). *Vinos naturales en España. Placer auténtico y agricultura sostenible en la copa*. Barcelona: RBA.
- Hemmerling, S., Hamm, U., & Spiller, A. (2015). Consumption behaviour regarding organic food from a marketing perspective—a literature review. *Organic Agriculture*, 5(4), 277–313. <https://doi.org/10.1007/s13165-015-0109-3>
- Jackson, R. S. (2009). *Análisis sensorial de vinos: Manual para profesionales*. Editorial Acribia.
- Honoré-Chedozeau, C., Desmas, M., Ballester, J., Parr, W. V., & Chollet, S. (2019). Representation of wine and beer: Influence of expertise. *Current Opinion in Food Science*, 27, 104–114. <https://doi.org/10.1016/j.cofs.2019.07.002>

- Kil, N., Holland, S. M., & Stein, T. V. (2014). Structural relationships between environmental attitudes, recreation motivations, and environmentally responsible behaviors. *Journal of Outdoor Recreation and Tourism*, 7–8, 16–25. <https://doi.org/10.1016/j.jort.2014.09.010>
- Lebleux, M., Alexandre, H., Romanet, R., Ballester, J., David-Vaizant, V., Adrian, M., et al. (2023). Must protection, sulfites versus bioprotection: A metabolomic study. *Food Research International*, 173. <https://doi.org/10.1016/j.foodres.2023.113383>
- le Grand, E. (2023). Legitimizing taste in cultural fields: Generational classifications and symbolic struggles in representations of ‘natural’ wine. *Journal of Consumer Culture*. <https://doi.org/10.1177/14695405231199293>
- Liobikiene, G., & Juknys, R. (2016). The role of values, environmental risk perception, awareness of consequences, and willingness to assume responsibility for environmentally-friendly behaviour: The Lithuanian case. *Journal of Cleaner Production*, 112, 3413–3422. <https://doi.org/10.1016/j.jclepro.2015.10.049>
- Lisanti, M. T., Blaiotta, G., Nioi, C., & Moio, L. (2019). Alternative Methods to SO 2 for Microbiological Stabilization of Wine. *Comprehensive Reviews in Food Science and Food Safety*, 18(2), 455–479. <https://doi.org/10.1111/1541-4337.12422>
- Migliore, G., Thrassou, A., Crescimanno, M., Schifani, G., & Galati, A. (2020). Factors affecting consumer preferences for “natural wine”: An exploratory study in the Italian market. *British Food Journal*, 122(8), 2463–2479. <https://doi.org/10.1108/bfj-07-2019-0474>
- Milfont, T. L., & Duckitt, J. (2010). The environmental attitudes inventory: A valid and reliable measure to assess the structure of environmental attitudes. *Journal of Environmental Psychology*, 30(1), 80–94. <https://doi.org/10.1016/j.jenvp.2009.09.001>
- Parga-Dans, E., Vecchio, R., Annunziata, A., González, P. A., & Enríquez, R. O. (2023). A Certification for Natural Wine? A Comparative Analysis of Consumer Drivers in Italy and Spain. *Wine Economics and Policy*, 12(1), 23–35. <https://doi.org/10.36253/wep-12890>
- Parr, W., White, G., & Heatherbell, D. (2003). The Nose Knows: Influence of Colour on Perception of Wine Aroma. *Journal of Wine Research*, 14(2–3), 79–101.
- Picchi, M., Canuti, V., Bertuccioli, M., & Zanoni, B. (2020). The Influence of Conventional and Biodynamic Winemaking Processes on the Quality of Sangiovese Wine. *International Journal of Wine Research*, 12, 1–16. <https://doi.org/10.2147/IJWR.S245183>
- Pienaar, E. F., Lew, D. K., & Wallmo, K. (2013). Are environmental attitudes influenced by survey context? An investigation of the context dependency of the New Ecological Paradigm (NEP) Scale. *Social Science Research*, 42(6), 1542–1554. <https://doi.org/10.1016/j.ssresearch.2013.07.001>
- Renner, B., Sproesser, G., Strohbach, S., & Schupp, H. T. (2012). Why we eat what we eat. The Eating Motivation Survey (TEMS). *Appetite*, 59(1), 117–128. <https://doi.org/10.1016/j.appet.2012.04.004>
- Rhead, R., Elliot, M., & Upham, P. (2015). Assessing the structure of UK environmental concern and its association with pro-environmental behaviour. *Journal of Environmental Psychology*, 43, 175–183. <https://doi.org/10.1016/j.jenvp.2015.06.002>
- Roininen, K., Tuorila, H., Zandstra, E. H., De Graaf, C., Vehkalahti, K., Stubenitsky, K., et al. (2001). Differences in health and taste attitudes and reported behaviour among Finnish, Dutch and British consumers: A cross-national validation of the health and taste attitude scales (HTAS). *Appetite*, 37(1), 33–45. <https://doi.org/10.1006/appe.2001.0414>
- Sáenz-Navajas, M. P., Avizcuri, J. M., Ballester, J., Fernández-Zurbano, P., Ferreira, V., Peyron, D., et al. (2015). Sensory-active compounds influencing wine experts’ and consumers’ perception of red wine intrinsic quality. *LWT - Food Science and Technology*, 60, 400–411. <https://doi.org/10.1016/j.lwt.2014.09.026>
- Sáenz-Navajas, M. P., Sánchez, C., González-Hernández, M., Bueno, M., Peña, C., Fernández-Zurbano, P., et al. (2023). Natural versus conventional production of Spanish white wines: An exploratory study. *Journal of the Science of Food and Agriculture*, 103(7), 3540–3549. <https://doi.org/10.1002/jsfa.12479>
- Smith Maguire, J. (2019). *Natural Wine and the Globalization of a Taste for Provenance The Globalization of Wine* (pp. 171–190). London: Bloomsbury Academic.
- Staub, C., Michel, F., Bucher, T., & Siegrist, M. (2020). How do you perceive this wine? Comparing naturalness perceptions of Swiss and Australian consumers. *Food Quality and Preference*, 79, Article 103752. <https://doi.org/10.1016/j.foodqual.2019.103752>
- Urdapilleta, I., Demarchi, S., & Parr, W. V. (2021). Influence of culture on social representation of wines produced by various methods: Natural, organic and conventional. *Food Quality and Preference*, 87, Article 104034. <https://doi.org/10.1016/j.foodqual.2020.104034>
- Vecchio, R., Annunziata, A., Parga Dans, E., & Alonso González, P. (2023). Drivers of consumer willingness to pay for sustainable wines: Natural, biodynamic, and organic. *Organic Agriculture*, 13(2), 247–260. <https://doi.org/10.1007/s13165-023-00425-6>
- Vecchio, R., Parga-Dans, E., Alonso González, P., & Annunziata, A. (2021). Why consumers drink natural wine? Consumer perception and information about natural wine. *Agricultural and Food Economics*, 9(1), 22. <https://doi.org/10.1186/s40100-021-00197-1>
- Viecelli, C. (2021). Local bubbles: Natural wines between globalisation and locavorism. *Ethnologie française*, 51(3), 589–599. <https://doi.org/10.3917/ethn.213.0589>