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Pairing Prosecco wine and Asiago cheese: Insights from a panel assessment and consumer test

Giovanna Lomolino[1], Alberto De Iseppi[1,2]*, Alice Stiletto[3], Mateo Marangon[1,2], Andrea Curioni[1,2], Gabriella Pasini[1], Simone Vincenzi[1,2], Deborah Franceschi[1,2], Antonella Crapisi[1], Samuele Trestini[2,3]

[1]Department of Agronomy, Food, Natural Resources, Animals and Environment (DAFNAE), University of Padua, Viale dell'Università 16, Legnaro (PD), Italy; [2]Interdepartmental Centre for Research in Viticulture and Enology (CIRVE), University of University of Padua, Conegliano (TV), Italy; [3]Department of Land, Environment, Agriculture and Forestry (TESAF), University of Padua, Viale dell'Università 16, Legnaro (PD), Italy

***Corresponding Author:** Alberto De Iseppi, Department of Agronomy, Food, Natural Resources, Animals and Environment (DAFNAE), University of Padua, Viale dell'Università 16, Legnaro (PD), Italy; Interdepartmental Centre for Research in Viticulture and Enology (CIRVE), University of University of Padua, Conegliano (TV), Italy. Email: alberto.deiseppi@unipd.it

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ORIGINAL ARTICLE

Abstract

This study investigates the traditional pairing between Prosecco wine and Asiago cheese to identify the key sensory attributes influencing consumer preference. Three styles of Prosecco and three Asiago maturations were first evaluated separately using Descriptive Analysis. The resulting nine pairings were then tested by a trained panel and by consumers. Multivariate analyses (PCA and HCPC) were used to relate sensory profiles to consumers' liking. Results show that consumers prefer pairings based on sensory synergy or contrast, particularly those involving sparkling Prosecco with fresh or ripened Asiago, demonstrating the key role of specific sensory attributes in determining pairing success.

Keywords: cheese ripening; gastronomy; PDO products; sensory analysis; sparkling wine; wine-cheese pairing

Introduction

In the last decades, sensory analysis has become an important tool in describing wines. Both analytical and hedonic approaches are applied to wines tested alone to obtain reproducible and representative data (Galmarini, 2020). However, a significant share of consumers drink wine primarily with food, which has been recognized as one of the main factors influencing wine choices (Thach, 2012). In such contexts, wine is expected to complement the food, enhancing the overall tasting experience (Galmarini, 2020). Although common, wine and food pairing has received limited attention in scientific literature, as only recently has there been a noticeable increase in the number of studies addressing this topic, which almost doubled in the last 5 years (Scopus, 2025). In this context, the concept of "pairing principles" has been introduced to describe the factors guiding consumers' choices in food and wine combinations (Rune *et al.*, 2021). These principles are diverse, and a single consumer may adhere to different ones depending on the context (Eschevins, 2018; Eschevins *et al.* 2019). Typical pairing strategies include similarity (e.g., sweet wine with desserts), balance or harmony (e.g., red wine with red meat), tradition (e.g., Champagne with oysters), and personal preference (Galmarini, 2020; Harrington, 2007; Jackson, 2020; Vandenberghe-Descamps *et al.*, 2022).

Pairings based on tradition and geographical origin are increasingly relevant to local producers, tourism

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operators, and regional organizations, as they promote and valorize gastronomic heritage (Carvalho *et al*., 2021; Duarte Alonso *et al*., 2022; Serra *et al*., 2021). In this context, matching local wines and food can strengthen consumer connection with the local culture and history. This approach can be aligned with a model of sustainable development that is committed to preserving the local environment, economy, and culture, as reported for Greek (Karagiannis and Metaxas, 2020), South African (Ferreira & Müller, 2013), and Portuguese (Carvalho *et al*., 2021; Serra *et al*., 2021) case studies.

In Italy, the *Triveneto* area, including the North Eastern regions of Veneto, Trentino-Alto Adige, and Friuli-Venezia Giulia, is the country's most visited, attracting over 30 million tourists yearly (Istituto nazionale di statistica, 2023; Regione Veneto -Sistema Statistico Regionale, 2023). In addition to its artistic and natural attractions, the region offers a wide variety of traditional foods and wines, many of which hold EU Protected Designation of Origin (PDO) status. Among these, Prosecco stands out as the most produced wine, with 660 million bottles in 2024 (Consorzio Prosecco DOC, 2025). Being an affordable and easy-to-drink wine, Prosecco gained global success for its consumption during social gatherings or aperitifs, where it is often consumed along with appetizers (Procidano *et al*., 2021). Besides the well-known sparkling version, Prosecco is also produced as semi-sparkling and still wines, mainly for the domestic market.

As for food, Asiago cheese is one of the first *Triveneto*'s geographical indications with an annual production of about 21,000 t (Lora *et al*., 2020). This semihard cheese can undergo a natural aging process for 20–40 days (Fresh), 4–9 months (Medium seasoned), and 10–15 months (Mature). Each type features in regional cuisine and is also consumed on its own, often paired with both red and white wines (Fletcher, 2011). Prosecco and Asiago being the pillars of the regional gastronomy, they have been objects of sensory investigations with different approaches (Alessandrini *et al*., 2017; Benedetti and Mannino, 2007; Marangon *et al*., 2006; Slaghenaufi *et al*., 2023). However, no scientific sensory data have been reported about the Asiago/Prosecco tradition-driven pairing.

This study aims to fill this gap by investigating how these two products interact during tasting, intending to define the best matches between different Prosecco styles and Asiago cheese maturations. On the hypothesis that consumer preferences for specific combinations are guided by recognizable sensory patterns, the study examined nine distinct pairings involving three levels of Asiago maturation (fresh, medium-aged, and mature) and three Prosecco styles (still, semi-sparkling, and sparkling). A dual approach was employed, combining analytical and hedonic sensory analysis, to identify which sensory attributes drive consumer preference. A graphic representation of the study's experimental design is reported in Figure 1. Additionally, the study explores whether

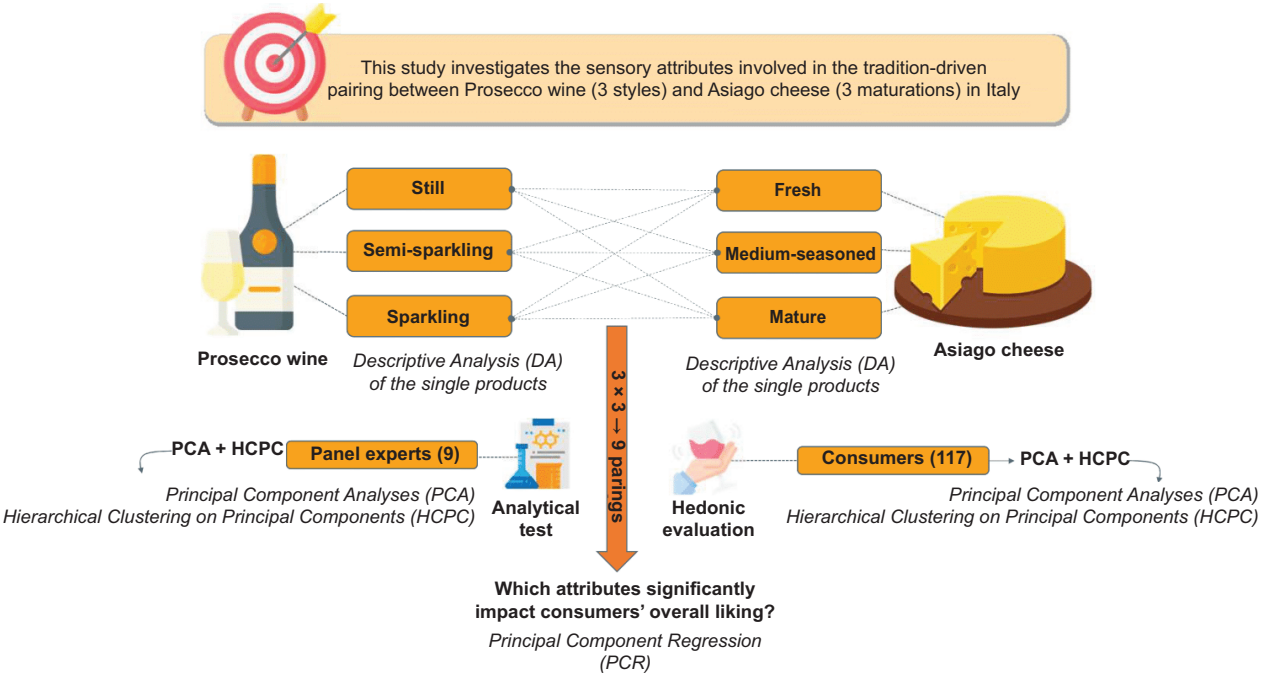

Figure 1. Experimental design.

descriptive analysis (DA) can serve as a predictive tool for consumer preferences, potentially reducing the need for more resource-intensive consumer tests.

Materials and Methods

Sample description and preparation

Three types of Asiago cheese (Table 1) and three types of Prosecco wine (Table 2) were studied. The three Asiago PDO cheeses were purchased from "Pennar cheese factory," a local producer on the Asiago plateau (Asiago, Veneto region, Italy). The choice was based on the ripening period to maximize differences in flavors. The preparation of cheese, for sensory analysis, was conducted according to Donadini *et al*. (2013), with some modifications. Cheese samples were kept at room temperature (21°C) for 30 min before sensory analysis. Ten minutes before service, the rind of cheeses was removed (15 mm width). Then, cheese samples were prepared by cutting them into 25 g strips (2.5 × 2.5 × 5.0 cm in size). These samples were presented in white paper dishes, labelled with three-digit codes, and covered with plastic film to preserve volatile compounds.

The three Prosecco wines were purchased by the "Bortolomiol" winery (Valdobbiadene, Italy) and were prepared as follows. Before analysis, the wines were stored at 12°C in the dark. During the sensory analysis session, the wine samples were served at 8°C. 30 mL of the wine was poured into ISO glasses (ISO 3591, 1977) identified with a three-digit number and covered with a plastic plate upon testing.

Descriptive analysis

The descriptive analysis (DA) tests (Donadini *et al*., 2015; Souza Gonzaga *et al*., 2020) of Prosecco and Asiago were conducted by a panel consisting of nine trained experts (4 females and 5 males) aged 25–35, all with extensive experience in wine and cheese sensory analysis. The tests were conducted under controlled conditions, at a temperature of 21.0°C and under artificial white lighting, following ISO 8589 (2007) standards, in a sensory analysis laboratory at the Agripolis Campus, University of Padua, Italy. Before each assessment, panelists were trained during 10 sessions of 2 h (5 for wine, 5 for cheese) with the aim of familiarizing themselves with the sensory characteristics of the chosen cheeses and wines. Wines and cheeses were tasted in distinct sessions. For each product, in the first session, panelists were asked to name attributes that better describe the sensory profile of wine and cheese samples. Descriptors mentioned by at least 25% of the panel (listed in ST1 and ST2) were selected for the DA assessments. In the following training sessions, the panel was trained on each descriptor using the reference standard for discrimination and intensity (listed in ST1 and ST2). Aromas were tested only through the retronasal route for consistency with following pairing assessments. Panelists were trained on rating each attribute using a discontinuous scale from 0 ("not perceived at all") to 10 ("extremely Intense") (Donadini *et al*., 2013, 2015). Both training and testing data were acquired by Fizz software (Biosystemes, Couternon, France). Tests were carried out on different days, always in the morning hours.

Descriptive analysis of Asiago cheeses

The DA was performed in duplicate (2 morning sessions). The assessors first evaluated the appearance and texture,

Table 1. Technical information of Asiago cheese samples provided by the producer (Pennar cheese factory, Asiago, Italy).

Cheese	Ageing time	Milk	Characteristics	Sample name
Asiago pressato fresco (PDO)	1 month	Pasteurized, full-fat	Soft, creamy, milky, butter-like flavor	Asiago Fresh
Asiago d'Allevo mezzano (PDO)	6 months	Raw, semi-skimmed	Semihard, flavor of dry fruits	Asiago medium-seasoned
Asiago d'Allevo stravecchio (PDO)	24 months	Raw, semi-skimmed	Hard, flavor of dry fruits, slightly spicy	Asiago mature

Table 2. Technical information and analytical features of Prosecco wine samples, as reported by the producer (Bortolomiol Winery, Valdobbiadene, Italy).

Wine	Grape and vintage	Style	Alcohol	Sugar	Total acidity	Characteristics	Sample name
Prosecco tranquillo (DOCG Valdobbiadene)	Glera (2018)	Still	11.5%	8.0 g/L	6.0 g/L	Fruity and well-balanced	Prosecco still
Prosecco frizzante (DOC Treviso)	Glera (2018)	Semi-sparkling	11.0%	9.0 g/L	5.5 g/L	Fresh, delicate, and fruity	Prosecco semi-sparkling
Prosecco Superiore, extra dry (DOCG Valdobbiadene)	Glera (2018)	Sparkling	11.5%	15.0 g/L	6.0 g/L	Fruity and aromatic	Prosecco sparkling

and after ingestion, taste and aromas (retronasal route). Between samples, panelists waited 5 min during which they were asked to eat unsalted crackers and rinse their mouths with water. Each sample was marked with a three-digit random number established before the test.

Descriptive analysis of Prosecco wine

The DA was performed in duplicate (2 morning sessions). Wines were served at 12°C. The assessors first evaluated the color, followed by effervescence, taste, and aromas and after ingestion (retronasal route). The panelists had to wait 5 min between each sample. During this time, they were asked to eat unsalted crackers and rinse their mouth with water. Each sample was marked with a three-digit random number established before the test.

Panel analytical assessment of Prosecco–Asiago pairings

The Prosecco–Asiago pairing test was conducted by the same trained panel that performed the DA tests (Section "Descriptive analysis") in the same environmental conditions. The protocol followed was based on the method established by Donadini *et al.* (2013), with modifications. A preliminary training session (2 h) was conducted to establish the most appropriate descriptors to define the sensory characteristics of the wine–cheese pairing. The five most frequently mentioned descriptors (listed in ST3) were selected for both analytical and hedonic assessments of the pairings. A second training session (2 h) focused on calibrating the intensity of these descriptors using a discontinuous scale ranging from 0 ("not perceived at all") to 10 ("extremely intense").

The pairing evaluation was conducted over 3 days, with two analysis sessions per day—one in the morning and one in the afternoon—resulting in a total of six sessions. The three Prosecco wines and Asiago cheeses generated nine unique pairings, each of which was tested by every panelist. The combined wine and cheese samples were presented in a randomized order and identified by three-digit codes.

Each wine was first tasted on its own, followed by a 5-minute break, after which it was tasted in combination with the Asiago cheese. The tasting procedure was as follows: 1) take a bite of cheese, 2) chew for 5 s, 3) take a sip of wine, 4) chew the cheese and wine together for 5 s, and 5) swallow. The panelists then rated the intensity of each descriptor on a scale from 0 (not perceived) to 10 (maximum intensity). Between samples, mineral water was provided for mouth rinsing, and a 15-min interval was observed between pairings (Donadini *et al.*, 2013).

Consumer hedonic assessment of Prosecco–Asiago pairings

The hedonic evaluation was performed by 117 individual students for each of the three sessions belonging to the millennials' generation, 57.7% males and 42.3% females, aged between 20 and 28 years, who were approached randomly among the students of the Agripolis Campus (University of Padua, Italy). Before tasting, students (from now on "consumers") were profiled by filling out a questionnaire on demographic data and on the frequency of consumption of cheese and wines ("regular: every week"; "moderate: every 1 or 2 months"; "non-consumer: rarely or never"). Volunteers who declared themselves as nonconsumers of wine or cheese were excluded from the analysis. The tasting took place inside the university premises in three different sessions organized over 16 days. In a preliminary phase, consumers were instructed on the methods of separate tasting (wine and cheese) and paired (wine–cheese, paired).

To limit fatigue, the assessment of the pairings was conducted in three separate sessions. A total of 117 consumers participated in each of the sessions following an incomplete block design. Students were allowed to participate in more than one session. Each session comprised two parts: initially, consumers were asked to taste each product (3 wines and 3 cheeses) separately and provide their hedonic evaluation using a hedonic scale ranging from 0 (extremely dislike) to 10 (extremely like). Subsequently, consumers were asked to assess the pairings between one Prosecco style and three Asiago maturations following the scheme: Session (S)1, still Prosecco; S2, semi-sparkling Prosecco; and S3, sparkling Prosecco. During the pairing assessment, the consumers were asked to: 1) take a bite of cheese, 2) chew for 5 s, 3) drink a sip of wine, 4) chew cheese and wine together for 5 s, and 5) swallow. Consumers were asked to evaluate their liking for specific attributes of the pairing (flavor, sourness, mouthfeel, taste intensity, overall liking) (ST3) of the products, using a hedonic scale ranging from 0 (extremely dislike) to 10 (extremely like). Between testing the samples, mineral water was used to rinse the mouth, and 1.5 min elapsed (Donadini *et al.*, 2013).

Statistical analysis

To assess consumers' preferences for the proposed pairings and to define the sensory profiles of the selected products, highlighting differences and similarities among products, Principal Component Analyses (PCAs) were performed, being the most suitable technique to be applied to DA data (Ghosh & Chattopadhyay, 2012). Then, a Hierarchical Clustering on Principal Components (HCPC) was applied to identify groups of

similar observations in the dataset, using the coordinates of the PCA as a starting point to aggregate these matches according to their hedonic (or analytical) evaluation. Differences in consumers' hedonic and panel evaluation of wines and cheese of the pairing were previously assessed through the analysis of variance (ANOVA). Specifically, a one-way ANOVA was performed for each sensory attribute (both hedonic and analytical), using the nine wine–cheese pairings as a single fixed factor. The factor combined three wine types and three cheese maturities, resulting in nine levels. Post hoc comparisons were carried out using Tukey's HSD test to identify significant differences among pairings. Then, to investigate the relationships between the overall liking of the pairing products and the specific hedonic attributes and panel evaluation, Principal Component Regressions (PCRs) were performed, along with the PCAs. Data were analyzed using R 4.2.1 (FactoMineR package).

Results

Products' sensory profile and overall liking

Table 3 reports the DA results and consumer overall liking scores for the three Prosecco wines and the three Asiago cheeses. This sensory profiling provided a basis to interpret the interactions observed in the pairings. In addition, consumers' liking data for each product was collected to evaluate whether initial appreciation could change because of the pairing.

Among the three Prosecco wines, the still one is perceived as the most diverse, being characterized by a more intense color and apple note compared to the sparkling and semi-sparkling wines, reporting higher fruity, floral, lemon notes as well as more pronounced acidity, sapidity, astringency, and, of course, effervescence. In all these indicators, the highest scores were reported by the sparkling Prosecco which received higher scores across several sensory descriptors, suggesting a richer sensory profile compared to the other two wines.

Considering the three Asiago cheese ripening, the fresh one was perceived as the most different from the other two. The fresh cheese was mainly characterized by the milk, sweet, and fatty notes, which, as expected, progressively decreased with the increased ripening time. Ripened cheeses reported higher scores ($P < 0.05$) in the different sensory descriptors, indicating the development of multiple flavors (fruit, green, spicy, salty, umami, bitter, acid), a more intense color, and higher astringency and hot sensations. In accordance, the highest scores for these indicators were reported by the 12-month mature Asiago (Table 3).

Regarding the overall liking expressed by the consumers, all three Asiago cheeses reported similar scores, while among the three Prosecco wines, a significantly higher liking score has been reported for the sparkling one compared to the other styles, reporting comparable scores (Table 3). It is worth noting that 81 and 89% of consumers stated that they were accustomed to consuming wine and cheese weekly, respectively. The remaining 19 and 11% consumed the products every 1 or 2 months.

Multivariate analysis of wine–cheese pairing

After providing individual DA, the products were tasted in the nine possible wine–cheese combinations and evaluated according to four representative attributes: flavor, sourness, mouthfeel, and taste intensity. The same attributes were evaluated by both the expert panel and the consumers. To explore the relationship between sensory attributes and consumer responses, PCAs were performed separately on analytical and hedonic data, as well as on their combination. PCRs were then used to identify which sensory attributes, both hedonic and analytical, provide a better prediction of consumer preferences in sensory studies.

The first PCA, described in Section "Pairings' panel assessment", examines the ratings provided by the expert panel (analytical evaluation). The second PCA, presented in Section "Pairings' hedonic assessment", identifies consumer preferences for the proposed pairings. The third PCA, outlined in Section "Comparison between hedonic and analytical pairing assessments", integrates both consumer and panel evaluations, offering a comprehensive analysis of consumer behavior with the sensory attributes defined by the panel using DA and consumer testing. All hedonic and analytical pairing attributes included in the PCAs significantly affect both consumers' and panel's evaluation for each variable, as suggested by the ANOVA and Tukey test (Table 4).

Pairings' panel assessment

To identify the most relevant sensory descriptors in the expert panel's evaluation of the pairings, a PCA was performed on a 9 × 4 matrix (nine pairings × four analytical attributes). Although only four variables were included, PCA enabled a multivariate visualization of how these attributes covaried across the different pairings. As shown in Figure 2, PC1 and PC2 describe 91.6% of the experimental variance, with 64.7% of the variance in PC1 and 26.9% in PC2. PC1 is defined by mouthfeel (35.44%), flavor (28.81%), and taste intensity (35.44%), all with positive loadings. Instead, PC2 was primarily driven by sourness, with a strong negative loading (90.15%). The pairings were mainly distributed along PC1, and clusters were observed according to both wine and cheese types.

Table 3. Descriptive analysis of the 3 Asiago cheeses and 3 Prosecco wines.

	Asiago cheese				Prosecco wine		
	FRESH	MEDIUM	RIPENED		STILL	SEMI-SPARKLING	SPARKLING
Color	3.74^{c}	6.44^{b}	7.67^{a}	Color	7.78^{a}	5.28^{b}	2.44^{c}
Hardness	4.84^{c}	7.28^{b}	9.22^{a}	Effervescence (mouth)	1.00^{c}	5.83^{b}	8.06^{a}
Holes	6.74^{b}	8.50^{a}	8.39^{a}	Aroma intensity	6.83^{b}	7.00^{b}	8.28^{a}
Spicy	2.21^{c}	4.72^{b}	7.33^{a}	Apple	7.61^{a}	6.39^{b}	5.94^{c}
Green	3.00^{c}	3.72^{b}	6.44^{a}	Fruity	5.39^{c}	7.11^{b}	7.94^{a}
Fruity	6.32^{b}	7.61^{a}	4.83^{c}	Floral	3.72^{b}	4.44^{a}	4.56^{a}
Milk	8.79^{a}	6.11^{b}	4.94^{c}	Lemon	3.94^{c}	6.44^{b}	7.94^{a}
Sweet	7.74^{a}	5.33^{b}	2.61^{c}	Sapidity	2.50^{c}	6.33^{b}	8.28^{a}
Salty	6.05^{c}	6.94^{b}	7.72^{a}	Acid	5.00^{c}	6.56^{b}	8.11^{a}
Acid	5.16^{a}	3.78^{b}	2.83^{c}	Sweet	1.94^{a}	1.78^{a}	1.67^{a}
Bitter	1.58^{c}	3.72^{b}	5.22^{a}	Bitter	3.44^{a}	2.67^{b}	2.22^{b}
Umami	5.95^{c}	7.39^{b}	8.83^{a}	Flavor persistence	6.83^{b}	6.33^{b}	7.56^{a}
Fatty	7.05^{a}	4.72^{b}	2.61^{c}	Astringency	4.44^{c}	6.28^{b}	7.22^{a}
Astringent	2.95^{c}	4.72^{b}	6.50^{a}	Overall linking (Hedonic)	6.72^{c}	6.48^{b}	7.95^{a}
Hot	1.58^{c}	4.89^{b}	7.33^{a}				
Flavor persistence	6.53^{b}	6.78^{b}	8.61^{a}				
Overall linking (Hedonic)	7.82^{a}	7.67^{a}	7.73^{a}				

Means not sharing a letter within a line are significantly different ($P < 0.05$). ANOVA and Tukey–Kramer tests are used to test statistically significant differences in means. All indicators come from the analytical panel test except "Overall linking," which was evaluated by the consumers (hedonic assessment, n = 117).

Table 4. ANOVA by pairing.

	A1	A2	A3	B1	B2	B3	C1	C2	C3	P
Hedonic evaluation										
Flavor	7.21^{a}	6.50^{bc}	7.07^{ab}	6.98^{abc}	6.40^{c}	6.74^{abc}	7.21^{a}	6.45^{bc}	6.93^{abc}	0.000
Sour	4.66^{a}	5.17^{ab}	4.86^{ab}	5.00^{ab}	5.50^{ab}	5.45^{b}	5.45^{b}	5.40^{ab}	5.49^{b}	0.000
Mouthfeel	5.92^{ab}	4.8c	5.07^{c}	6.03^{a}	5.07^{c}	4.89^{c}	6.11^{a}	5.23^{bc}	5.20^{bc}	0.000
Taste intensity	5.41^{ab}	5.89^{abc}	6.94^{de}	4.96^{b}	6.15^{c}	6.93^{de}	5.07^{b}	6.30^{ce}	7.02^{d}	0.000
Overall liking	6.96^{abcd}	6.26^{d}	7.11^{a}	7.05^{ab}	6.27^{cd}	6.95^{abcd}	6.98^{abc}	6.40^{bcd}	7.12^{a}	0.000
Panel evaluation										
Flavor	6.278^{f}	7.00^{def}	7.94^{bc}	6.67^{ef}	6.78^{ef}	8.56^{ab}	7.33^{cde}	7.56^{cd}	9.22^{a}	0.000
Sour	5.17^{c}	3.83^{e}	4.00^{de}	6.33^{b}	5.17^{c}	5.00^{c}	7.67^{a}	4.61^{cd}	5.28^{c}	0.000
Mouthfeel	2.50^{d}	5.33^{b}	3.78^{c}	3.89^{c}	5.33^{b}	5.72^{b}	5.50^{b}	5.61^{b}	7.44^{a}	0.000
Taste intensity	4.89^{e}	6.28^{d}	5.39^{e}	6.28^{d}	7.00^{c}	8.22^{b}	7.56^{bc}	8.11^{b}	8.94^{a}	0.000

Means not sharing a letter within a row are significantly different (F-statistics < 0.05). ANOVA and Tukey–Kramer tests are used to test statistically significant differences in means. Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium-seasoned cheese; "3" to mature cheese.

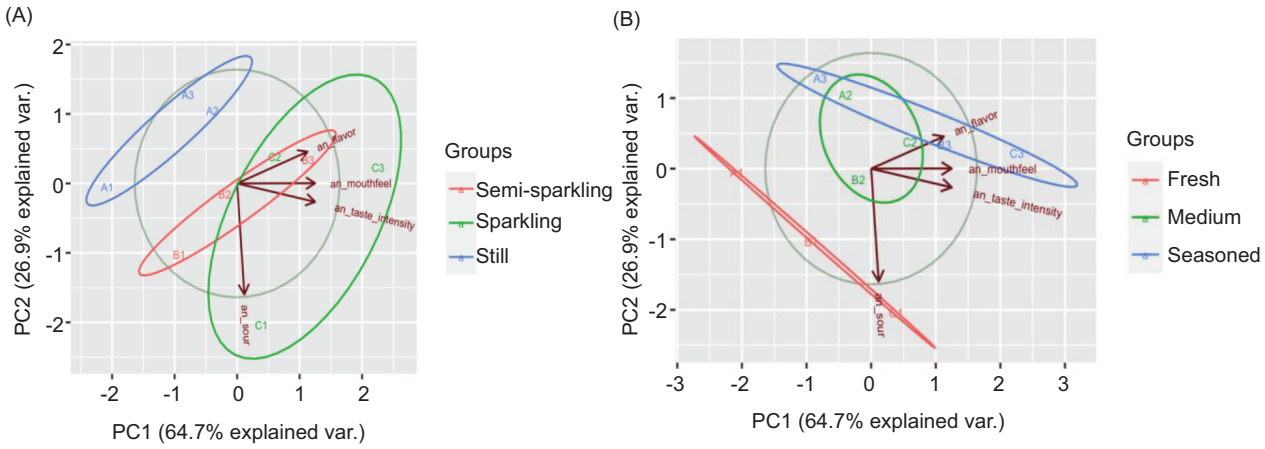

Figure 2. Principal Component Analysis on analytical evaluation of pairing (by panel), clustered by wines (A) and cheeses (B). "An" prefix before the attribute's names refers to "Analytical" evaluation (namely, panel evaluation). Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium-seasoned cheese; "3" to mature cheese.

However, these were not strictly separated, as confirmed by the HCPC, which identified four clusters (Table 5). These clusters reveal specific sensory profiles not solely attributable to wine or cheese type.

To illustrate, Cluster 1 was primarily defined by pairings with fresh cheese (except pairing C1). Pairings in this group exhibited significantly lower mouthfeel scores compared to the others (Table 5). Cluster 2 included pairings with medium-seasoned cheese (A2, B2, C2), as well as still wine paired with mature cheese (A3). These pairings did not stand out for any specific attribute, as they were positioned near the center of the factorial plane, indicating that their mean values were not statistically different from the overall mean of the attributes. In contrast, Cluster 3, represented by pairing C1 (sparkling wine with fresh cheese), showed a significantly higher level of sourness compared to the other pairings. This is also evident in Figure 2, where C1 is positioned close to the sour attribute on PC2. Finally, Cluster 4, which included all pairings with mature cheese except for A3 (still wine with mature cheese), was characterized by having more pronounced flavor scores.

Pairings' hedonic assessment

A second PCA (Figure 3) was performed on a 9 × 5 matrix, representing the nine pairing combinations and five hedonic attributes. PC1 and PC2 explained 86.2% of the variance. Flavor (27.92%) and mouthfeel (32.44%), with negative loadings, were the main contributors to PC1, while sourness (30.78%) and overall liking (32.29%) influenced PC2. Notably, *hed_overall liking* was positively correlated with *hed_mouthfeel* and *hed_flavor* in PC1, and *hed_sour* in PC2. This indicates that consumers rated pairings more favorably (in terms of overall liking) when they scored high for flavor and mouthfeel (PC1) or sourness (PC2).

The loadings plot (Figure 3) highlights the relationships between the different attributes, with the distances between their locations on the map illustrating the degree of similarity or difference. The map clearly shows that the most preferred pairing was C1 (sparkling wine with fresh cheese), while A2 (still wine with medium-aged cheese) and B2 (semi-sparkling wine with medium-aged cheese) were the least appreciated by consumers. Grouping pairings by cheese type revealed clearer clusters than grouping by wine type, suggesting that cheese played a more decisive role in shaping consumer preferences, with medium-aged cheeses (6 months of aging) being the least favored.

This was confirmed by the HCPC (Figure SF1, Table 6), which grouped the pairings into three distinct consumer preference clusters based on PCA coordinates. Indeed, statistically significant differences in hedonic ratings were found only when grouped by cheese type, consistent with ANOVA results (ST4). Table 6 describes the main attributes characterizing each cluster (v.test). Cluster 1, including pairings with medium-seasoned cheese, was the least preferred, showing low scores for the flavor attribute. Cluster 2, which included pairings with mature cheese, had the highest scores for the hedonic attribute related to taste intensity. Lastly, Cluster 3, consisting of pairings with fresh cheese, was the most appreciated, scoring high in mouthfeel and flavor, despite lower scores for taste intensity.

Comparison between hedonic and analytical pairing assessments

To compare expert and consumer responses, a PCA was performed on a combined dataset (9 pairings × 9 variables: 4 analytical + 5 hedonic). As shown in Figure 4, the hedonic and analytical taste intensities clustered, indicating a strong alignment. In contrast, analytical attributes such as mouthfeel and sourness were negatively associated with consumer liking.

However, from the cluster analysis (SF2), it emerged that the most preferred pairing was C1 (sparkling wine–fresh cheese), which was characterized by a high level of sourness (*an_sour*) and was particularly appreciated for its flavor (*hed_flavour*) and mouthfeel (*hed_mouthfeel*). The relatively high level of sourness, as detected by the expert panel, was well received by consumers, as reported in Table 4.

HCPC (SF2) revealed that consumer appreciation was again more influenced by cheese type. This trend was reflected in the PCA map (SF2, right), where each cheese category occupied a distinct region of the plot (fresh: ●; mature: ■; medium-aged: ▲). Specifically, Cluster 1

Table 5. Most relevant attributes for pairings in each cluster.

Attributes	v.test	Mean in category	Overall mean	P
	Cluster 1: Pairings with fresh cheese (excluded C1)			
An_ mouthfeel	−2.04	3.19	5.01	0.041
	Cluster 2: Pairings with medium-seasoned cheese (plus A3)			
Null	–	–	–	–
	Cluster 3: C1 pairing (fresh cheese and sparkling wine)			
An_sour	2.20	7.67	5.23	0.028
	Cluster 4: Pairing with mature cheese (excluding A3)			
An_flavor	2.36	8.89	7.48	0.018

"Mean in category" refers to the cluster mean, while "Overall mean" represents the average value on all the pairings for that specific attribute. "An" prefix before the attribute's names refers to "Analytical" evaluation (namely, panel evaluation).

Table 6. Most relevant attributes for pairings in each cluster.

Attributes	v.test	Mean in category	Overall mean	P
	Cluster 1: Pairings with medium-seasoned cheese			
Hed_flavor	−2.50	6.45	6.83	0.017
Hed_Overall_liking	−2.78	6.31	6.79	0.005
	Cluster 2: Pairings with mature cheese			
Hed_taste_intensitty	2.35	6.96	6.07	0.018
	Cluster 3: Pairings with fresh cheese			
Hed_mouthfeel	2.72	6.02	5.37	0.006
Hed_flavor	1.98	7.13	6.83	0.047
Hed_taste_intensity	−2.45	5.15	6.07	0.014

"Mean in category" refers to the cluster mean, while "Overall mean" represents the average value on all the pairings for that specific attribute. "Hed" prefix before the attribute's names refers to "Hedonic" evaluation (namely consumers' evaluation).

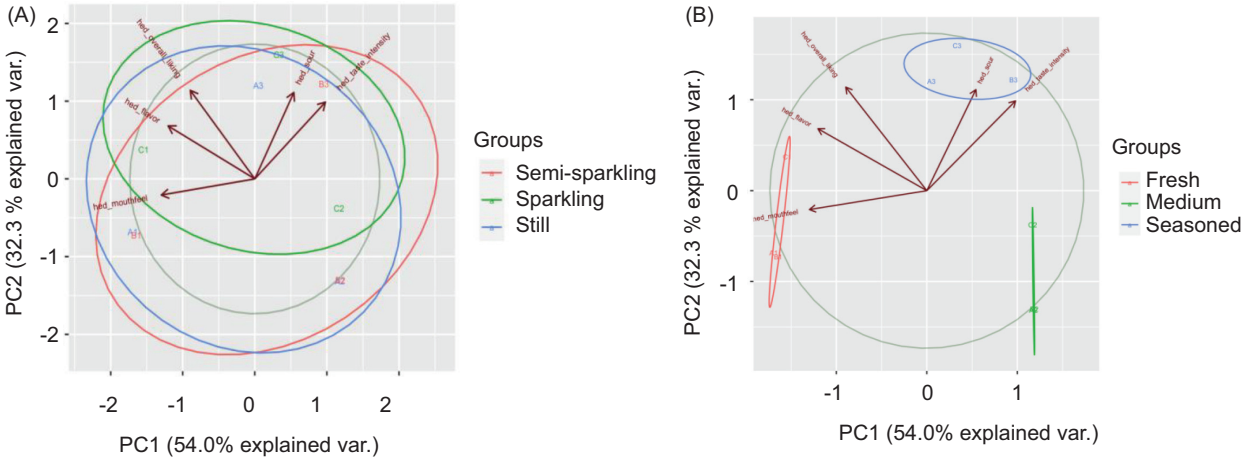

Figure 3. Principal Component Analysis on hedonic attributes of pairing, clustered by wines (A) and cheeses (B). "*Hed*" prefix before the attribute's names refers to "Hedonic" evaluation (namely consumers' evaluation). Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium-seasoned cheese; "3" to mature cheese.

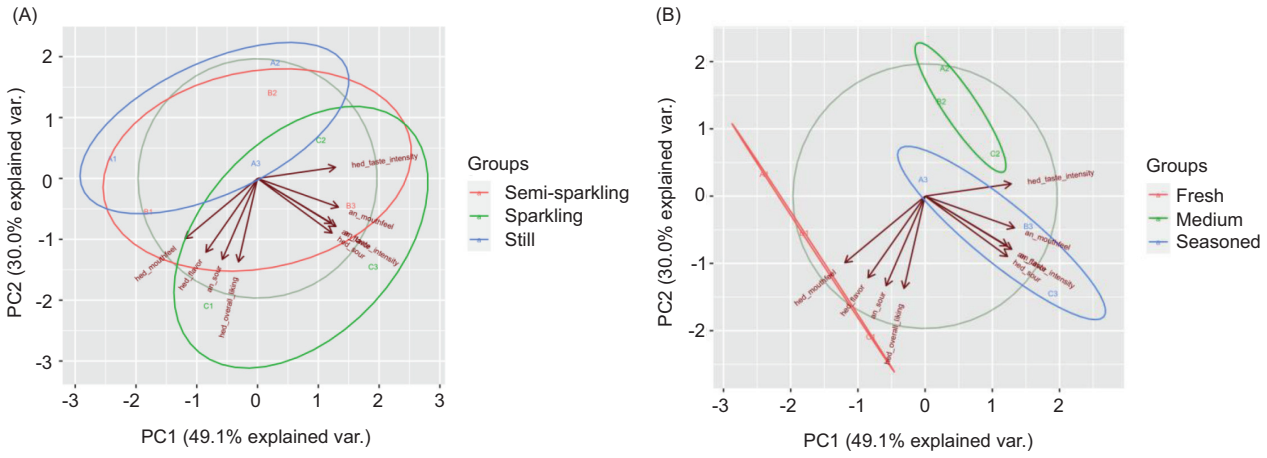

Figure 4. Principal Component Analysis on analytical evaluation of pairing (by panel), clustered by wines (A) and cheeses (B). "*An*" prefix before the attribute's names refers to "Analytical" evaluation (namely, panel evaluation). "*Hed*" prefix before the attribute's names refers to "Hedonic" evaluation (namely, consumers' evaluation). Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium-seasoned cheese; "3" to mature cheese.

(with fresh cheeses) included pairings that were most appreciated by consumers, particularly for their high scores in hedonic mouthfeel and flavor. These pairings also had high levels of analytical sourness (*an_sour*), suggesting that sourness was positively perceived in this context. Cluster 2 (medium-aged cheese) contained the least appreciated pairings, mainly due to lower hedonic flavor scores. On the contrary, pairings in Cluster 3 (with mature cheese) were particularly appreciated by consumers for their taste intensity, having also a high level of flavor (*an_flavor*).

Principal Component Regression

Principal Component Regression was used to identify which attributes (hedonic or analytical) most influenced overall liking. Unlike what is commonly done in simple regression analysis, PCR uses the principal components as the predictor variables for regression instead of the original variables. Thus, a PCA should first be applied to generate principal components (k) from the predictor variables (p). Keeping only the first k principal components, which explain most of the variance (where $k < p$), a linear regression model on these k principal components has been performed. Specifically, two different PCRs have been conducted on analytical and hedonic variables to understand which variables affect the overall liking of consumers and assess which approach (namely, hedonic evaluation or panel analysis) should be used for better forecasting the consumers' preferences in sensory studies.

Focusing on the hedonic evaluation of the pairings, the PCR results identified two principal components based on their eigenvalues, following the Kaiser criterion (Kaiser, 1960). These components explained 61.1 and 25.2% of the total variance. As reported in Figure 5, *hed_mouthfeel* and *hed_taste_intensity* were the most significant in explaining PC1, while *hed_sour* and *hed_flavor* defined PC2. Indeed, as previously discussed in Section "Pairings' hedonic assessment," the contribution of each variable in accounting for the variability in any principal component was depicted by the distance of the variable (arrow) to the origin (Figure 5, left) and can be easily visualized in the correlation graph (Figure 5, right). Variables within the same quadrant were positively correlated.

Supplementary Figure 3 (SF3) shows the contributions of each pairing to the definition of PC1 and PC2. Pairings with fresh cheese, specifically A1 and B1, contributed most to PC1 (SF3, left), and were particularly appreciated for their hedonic mouthfeel and taste intensity (Table 8). In contrast, pairings A2 (still wine with medium-aged cheese) and C1 (sparkling wine with fresh cheese) were the main contributors to PC2 (SF3, right), characterized by high hedonic scores for flavor and sourness. As shown in Table 8, only PC2 emerged as a significant predictor of consumers' overall liking. This suggests that, among the evaluated attributes, higher scores for flavor and sourness are most closely associated with increased consumer preference.

When it comes to analytical data (i.e., panel data), two PCs have been found in the PCR, which explained 64.7 and 26.9% of the variance. Results of the PCA (already reported and discussed in Section "Multivariate analysis of wine–cheese pairing") suggested that PC1 was mostly defined by *an_mouthfeel* and *an_taste intensity*, while

PC2 was defined by *an_sourness*. For clarity purposes, a brief overview of the analysis is reported in Figure 6.

In Supplementary Figure 4 (SF 4), the contributions of the pairings in defining PC1 and PC2 are reported. Unsurprisingly, A1 (still wine – fresh cheese) and C3 (sparkling wine–mature cheese) pairings are those that defined the most PC1, having the lowest and highest value of astringency (*an_mouthfeel*), respectively, or being very low or highly tasty (*an_taste intensity*), as reported in Table 8. On the other hand, pairings A3 (still wine – mature cheese) and C1 (sparkling wine–fresh cheese), which contributed principally to PC2, had the lowest and the highest levels of *an_sourness,* respectively.

Given this overview, Table 9 reports that it was not possible to forecast consumers' preferences focusing only on analytical data (namely, on the evaluation of the expert panel), as no PC is significant in explaining the overall liking of consumers.

Table 7. Most relevant attributes for pairings in each cluster.

Attributes	v.test	Mean in category	Overall mean	P
	Cluster 1: Pairings with fresh cheese			
Hed_ mouthfeel	2.72	6.02	5.36	0.007
An_sour	2.09	6.39	5.23	0.036
Hed_flavor	1.98	7.13	6.83	0.047
Hed_taste_intensity	−2.45	5.15	6.07	0.014
	Cluster 2: Pairings with medium-seasoned cheese			
Hed_flavor	−2.52	6.45	6.83	0.012
Hed_overall_liking	−2.78	6.31	6.79	0.005
	Cluster 3: Pairing with mature cheese			
An_flavor	2.43	8.57	7.48	0.015
Hed_taste_intensity	2.35	6.96	6.07	0.018

"*Mean in category*" refers to the cluster mean, while "*Overall mean*" represents the average value on all the pairings for that specific attribute.

Discussion

Even if the literature on wine sensory analysis has focused on testing the product alone, wine is often consumed during meals and other occasions where it needs to pair well with the food served. In this research, the

Table 8. Principal Component Regression (PCR) on Hedonic data.

Attributes	Coeff.	Std. Error	P
Intercept	6.789	0.076	0.000
PC1	−0.085	0.051	0.147
PC2	−0.273	0.089	0.014
R^2	*0.706*		

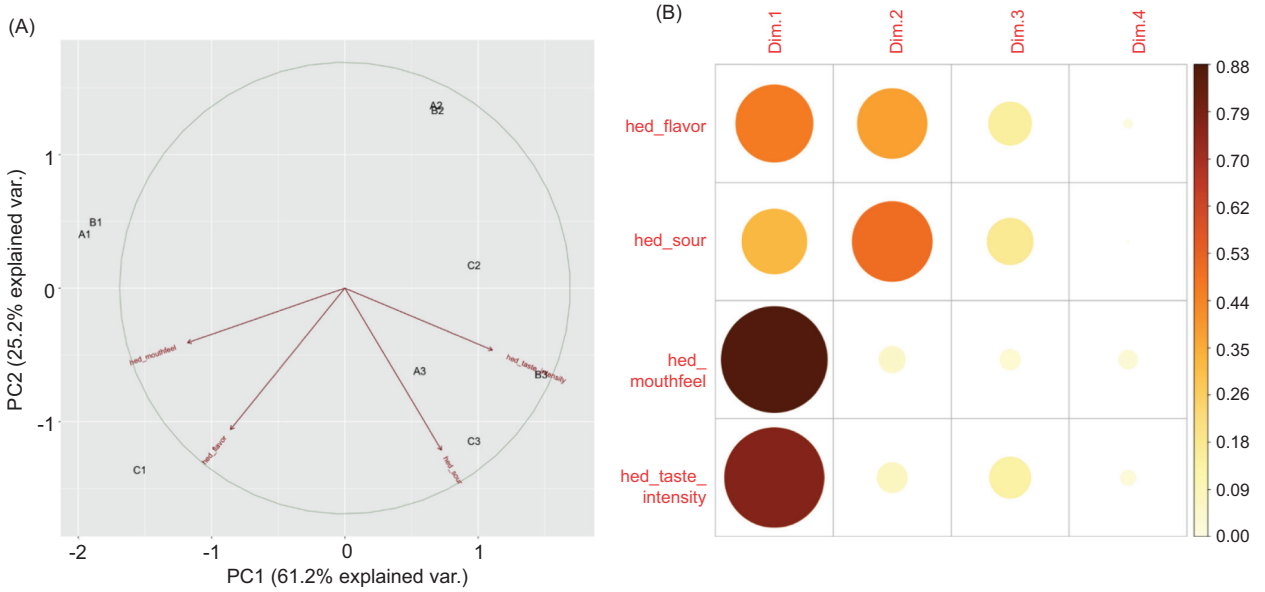

Figure 5. Principal Component Analysis on hedonic data (A) and relative correlation plot (B). "*Hed*" prefix before the attribute's names refers to "Hedonic" evaluation (namely, consumers' evaluation). Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium-seasoned cheese; "3" to mature cheese.

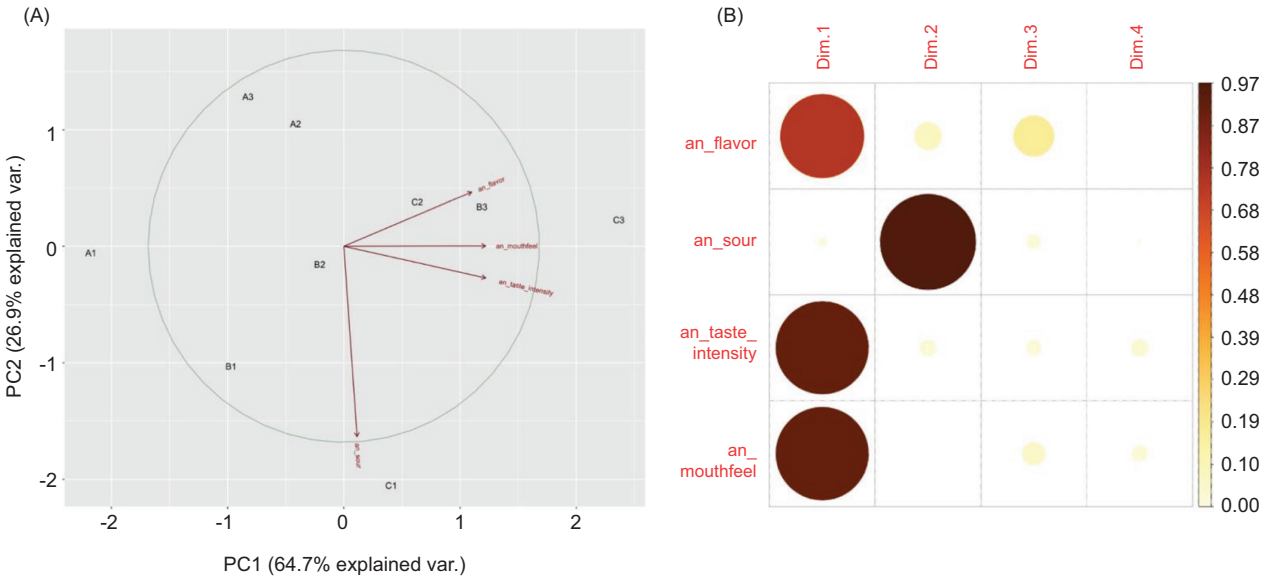

Figure 6. Analysis on panel data (A) and relative correlation plot (B). "*An*" prefix before the attribute's names refers to "analytical" evaluation (namely, experts panel evaluation). Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium-seasoned cheese; "3" to mature cheese.

Table 9. Principal Component Regression (PCR) on Panel data.

Attributes	Coeff.	Std. Error	P
Intercept	6.789	0.135	0.000
PC1	0.013	0.089	0.885
PC2	−0.087	0.138	0.553
R^2	0.065	–	–

pairing of different styles of Prosecco wine with different maturations of Asiago cheese was studied with both analytical and hedonic sensory analysis. Being Prosecco and Asiago the most produced wine and cheese PDOs in Italy's *Triveneto* area, the applied approach offers the opportunity to identify the key sensory attributes influencing consumers' liking in this tradition-driven pairing.

When tested alone by the panel of experts, the three styles or maturations of Prosecco wine and Asiago cheese exhibited different DA profiles (Table 3), which align with previous reports on Prosecco and Asiago (Alessandrini et al., 2017; Santillo & Albenzio, 2023). However, the overall liking expressed by the consumers was, within each product, the same for the three styles or maturations, except for sparkling Prosecco, which gained the highest score among the wines (Table 3). It is worth highlighting that the latter style is by far the more popular and probably meets the expectations that consumers have about this product (Onofri *et al.*, 2015).

When Prosecco and Asiago are tasted together, the consumer responses were much more diversified compared to when the products were tasted alone. When tested by the panel of experts, the nine different pairings were mostly clustered according to the cheese maturation, with sample C1 (sparkling Prosecco with fresh Asiago) highlighted for its high sourness (Figure 2, Table 5), resulting from the high acidity reported by its two components when tested individually (Table 3).

When the nine pairings were tested by the consumers (millennial students), feedbacks were only driven by the type of cheese rather than the wine style, indicating an even more cheese-driven experience compared to what was reported by the panel of experts (Figure 2, Table 5). PCA and cluster analysis (Figure 3, Table 6) show that all Prosecco pairings with medium-seasoned cheese (A2, B2, C2) (Table 6, Cluster 1) were substantially rejected by the consumers, who did not appreciate the pairings' flavor. Conversely, pairings with fresh and mature cheese were more appreciated by the consumers, with the sample C1 (sparkling Prosecco with fresh Asiago) being the preferred one (Figure 3, Table 6). This preference was due to different aspects. In the case of Prosecco wines with fresh Asiago cheese (A1, B1, C1) (Table 6, Cluster 3), the consumers in the sample appreciate the flavor and mouthfeel, as well as the mild taste intensity. On the other hand, the Prosecco wines paired with mature Asiago cheese (A3, B3, C3) (Table 6, Cluster 2) are liked by consumers for their sourness and high taste intensity.

Combining the outcomes of both consumer and analytical panel assessments in the PCA space (Figure 4) enabled a more comprehensive description of the pairings and allowed for assessing the relation between analytical and hedonic indicators. Even if a certain degree of separation can be noted for the wine style, the samples remained mostly grouped according to the cheese ripening, which remains the variable that distinguishes the clusters (Table 7). In addition to the above-mentioned hedonic indicators, the cluster made by all the pairings with fresh cheese (Table 7, Cluster 1) is, according to the analytical panel, also connotated by a high sourness, which reaches its maximum in the most preferred C1 sample (Table 5). This outcome aligns with the analytical DA profile, where fresh Asiago and sparkling Prosecco were perceived as the sourest cheese and wine, scoring 5.16/10 and 8.11/10, respectively (Table 3). This high level of acidity was appreciated by the consumers, which attributed to this sample's sourness a higher hedonic score compared to other combinations (Table 4). In this case, sparkling Prosecco's sourness is suggested as the key factor making the fresh Asiago/sparkling Prosecco the preferred pairing by the consumers. Indeed, in this pairing, Prosecco's acidity can reach a good balance with two fresh Asiago's key characteristics: sweetness and fattiness. In the first case, sparkling Prosecco's acidity (8.11/10) and fresh Asiago's sweetness (7.74/10) (Table 3) created a contrast that, as in other food and wine pairings (Durrieu *et al*., 2023), was probably appreciated by the consumers. This sweetness/sourness balance is also one of the main quality factors for sweet wines (Harrington, 2007). A second factor that is expected to explain the preference for fresh Asiago/sparkling Prosecco pairing is the balance of tactile sensations. Indeed, the acidity (8.11/10) and with the effervescence (8.06/10) of sparkling Prosecco are expected to cut through the high fattiness in fresh Asiago (7.05/10) (Table 3), the only one made with full fat milk (Table 1) (Bastian *et al*., 2009; Harrington, 2007; Koone *et al*., 2014).

Other pairings reporting a comparable "overall liking" (Table 4) were still Prosecco/fresh Asiago (A1), and all the pairings with mature Asiago (A3, B3, C3), all included in Cluster 3 (Table 7). In the latter case, the pairings were reported as having high taste intensity and, according to the panel, also an enhanced aroma resulting in a higher flavor (Table 7). These characteristics found in the pairing are expected to be mainly due to the mature Asiago which, over the 12 months of aging, have developed a higher taste and a richer aroma as perceived by panel of experts in the DA test (Table 3). However, the fact that this occurs particularly when mature Asiago was paired with semi-sparkling and, even more, with sparkling Prosecco can be directly related to the degree of sparklines. This direct relation of flavor/sparklines appears clear by looking at the C3 sample (mature Asiago/sparkling Prosecco) which got by far the highest flavor score by the panel of experts (Table 4). This relation could be explained by the mechanical effect of CO_2 bubbles in boosting the volatility of aromas (Pozo-Bayón *et al*., 2009). This phenomenon, mostly studied in Champagne wines, is due to the movement and the collapse of CO_2 bubbles which pulls volatile molecules to the liquid surface and headspace (Ghabache et al., 2016; Liger-Belair & Cilindre, 2021). In the present case, this can occur when wine and cheese are in the mouth, thus boosting the number of volatile compounds (released from both products) that were perceived with the retronasal olfaction. A partial confirmation of this can be found by looking at the spatial distribution of Cluster 2 samples (A2, B2, C2; all pairings with medium-seasoned Asiago) (Table 7), which also show a direct relation between flavor and sparklines, (Figure 4) but with low absolute scores (Table 4), probably due to the lower contribution in aromas by the medium-seasoned asiago (Table 3).

The finding that flavor and sourness hedonic ratings were the primary drivers of consumers' overall liking for these pairings was further supported by PCR based on hedonic data. As shown in Table 8, consumers' overall liking was significantly described by PC2, a principal component defined mainly by flavor and sourness hedonic indicators.

In particular, the most appreciated pairings (C1 and C3) (Figure 5) involved contrast (sweetness/sourness) or synergy (aroma) highlighting the importance of sensory interactions in shaping consumer preferences. Conversely, when conducted on panel data alone, the PCR analysis showed no significant correlation with consumer liking (Table 9), confirming that combining analytical and consumer tests is the most effective approach to understand and predict preferences.

Conclusions

Foods and wines are often consumed together because it is precisely through their combination that the sensorial characteristics are enhanced. Pairing wine and cheese is a hedonic experience, often an expression of a territory representing tradition and history, that also contributes to the definition of hedonic liking. Paring between Asiago cheese and Prosecco wine, products linked to the history and tradition of the Italy's *Triveneto* area, represent example of cultural pairing which has been poorly investigated with sensory analysis tools. In this study, pairings between three Asiago maturations and three Prosecco styles were tested by both panel and young consumers (millennials students) of the *Triveneto* area providing insights about which sensory perceptions make consumers prefer some Asiago/Prosecco combinations compared to others.

The principal component (PCA) and regression (PCR) analyses indicate that hedonic attributions of flavor and sourness were the key factors driving consumers' overall liking of the pairings. The DA profiles of the wines and cheeses tasted individually allowed to state that consumers appreciate the pairings following two different principles: synergy and contrast. In the latter case, the contrast between sweet and sour notes, both particularly present in fresh Asiago cheese and sparkling Prosecco, as well as the balance of fresh Asiago's fattiness ensured by the acidic and sparkling Prosecco, was appreciated. Samples containing mature Asiago cheese, on the other hand, seem to have been rewarded for their taste and olfactory intensity (=flavor), which appears to be particularly enhanced by the effervescence of the wine, which could (physical effect of bubbles) influence the flavor. This was indirectly confirmed by the lower liking reported by the three pairings with medium-seasoned Asiago. In this case, the intermediate ripening makes the cheese not flavorful enough to create a positive synergy with the wines and not sweet enough to balance their sourness. No significant relationship was found between any of the descriptors used by the panel in evaluating the pairings and the overall liking expressed by consumers, indicating that it was not possible to predict consumer preferences solely based on the pairings' evaluation of the expert panel. Although the styles and maturations selected are the most common, a limitation of the study is that the Prosecco wines and Asiago cheeses were sourced from a single producer. Additionally, evaluating all nine pairings was challenging from an organizational perspective and constrained the number of sensory descriptors analyzed, providing insights that could be expanded in future studies with more targeted and instrumentally supported sensory analyses. Despite that, this study represents the first assessment studying the sensory characteristics of pairings between the main styles and maturations of Prosecco and Asiago, two most renowned PDO products of Italy's *Triveneto* area. The research has highlighted the most preferred combination and the key sensory attributes that influence consumers' overall liking, offering insights that could benefit the consumer experience in this and similar gastronomic contexts. Nevertheless, it must be considered that the study has a limited external validity due to the fact that involved consumers were millennial students of the *Triveneto* area.

Authors' Contributions

Giovanna Lomolino: Conceptualization, Supervision, Data curation, Formal analysis, Funding acquisition, Methodology, Project administration, Writing – original draft. Alberto De Iseppi: Data curation, Visualization, Writing – original draft, Writing – review & editing. Alice Stiletto: Data curation, Methodology, Software, Visualization, Writing – original draft. Matteo Marangon: Supervision, Writing – review & editing. Andrea Curioni: Supervision. Gabriella Pasini: Writing – review & editing. Simone Vincenzi: Writing – review & editing. Deborah Franceschi: Methodology, Writing – review & editing. Antonella Crapisi: Writing – review & editing. Samuele Trestini: Data curation, Methodology, Software, Supervision, Writing – original draft, Writing – review & editing.

Conflicts of 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.

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Supplementary

Table S1. Asiago cheese's DA descriptors and references.

Descriptors	Definition	References
Color	The color of cheese, from white to yellow	NCI Cheese Color Standard Chart from white (Min) to orange (Max)
Hardness	The extent of resistance offered by cheese, assessed during the first 5 chews using the front teeth, ranged from soft to firm	Different cheeses from Melted Emmental (Min) to Parmigiano (Max)
Holes	The appearance of the cheese paste, whether it has irregularities, porosity or not.	Different cheeses from Parmigiano (Min) to Emmental (Max)
Spicy	The flavor associated with spices tested from the retronasal route	Mixture of Cloves, nutmeg, cinnamon extracts from 0% (Min) to 0.1% (Max) in 5% ethanol.
Green	The aromatic blend associated with grass, herbs, and vegetables tested from the retronasal route	Different leaves from salad (Min) to spinach (Max).
Fruity	The aromatic blend associated with different fresh fruits tested from the retronasal route	Sliced 1 cm of banana, pear, and apple
Milk	The aroma associated with fresh milk tested from the retronasal route	Cow milk in water: from 0% (Min) to 100% (Max)
Salty	The fundamental taste associated with NaCl	NaCl from 0% (Min) to 0.5% (Max) in water
Bitter	The fundamental taste associated with caffeine	Caffeine from 0% (Min) to 0.1% (Max) in water
Acid	The fundamental taste associated with acids	Lactic acid from 0% (Min) to 0.1% (Max) in water
Sweet	The fundamental taste associated with sugar	Sucrose from 0% (Min) to 5.0% (Max) in water
Umami	The fundamental taste associated with monosodium glutamate	Monosodium glutamate from 0% (Min) to 0.5% (Max) in water
Fatness	The extent to which the cheese coats the palate and the teeth during mastication	Different products from water (Min) to unsalted butter and cream (Max)
Astringency	Tactile perception that causes roughness in the oral cavity	Tannic acid from 0% (Min) to 0.5% (Max) in 5% ethanol
Flavor persistence	The time of persistence of taste and retronasal aroma in the mouth	Different cheeses from Primosale (Min) to Gorgonzola (Max)
Overall liking	The overall satisfaction and pleasure derived from cheese tasting [Hedonic only]	

Table S2. Prosecco wine's DA descriptors and references.

Descriptors	Definition	References
Color	The shades of white wine, from white to straw yellow	White wine color scale from Verdicchio (Min) to Passito (Max)
Effervescence	The little chain bubbles that rise from the bottom of the glass to the surface	Different Prosecco from still (Min) to sparkling (Max)
Apple	Flavor of apples tested from the retronasal route	Fresh apples 1cm slices (Granny Smith, Golden, Stark)
Fruity	Flavor of banana, pear, and pineapple tested from the retronasal route	Fresh banana, pear, pineapple, 1cm slices
Floreal	Flavor reminiscent of white flowers tested from the retronasal route	Dried acacia and jasmine petals
Aroma intensity	Defined as the total intensity of the perceived aroma from the retronasal route	Different white wines from table (Min) to Gewurztraminer (Max)
Lemon	The aroma associated with the cut lemon tested from the retronasal route	Lemon juice and skin pieces (Max); Water (Min)
Bitter	The fundamental taste perceived in the presence of caffeine	Caffeine from 0% (Min) to 0.1% (Max) in 5% ethanol
Acid	The fundamental taste perceived in the presence of acids	Citric acid from 0% (Min) to 0.1% (Max) in 5% ethanol
Sapidity	Intensity of savory taste, primarily influenced by saltiness.	NaCl from 0% (Min) to 0.5% (Max) in water
Sweet	The fundamental taste perceived in the presence of sugar	Sucrose from 0% (Min) to 5.0% (Max) in 5% ethanol
Astringency	Tactile perception that causes roughness in the oral cavity	Tannic acid 0% (Min) to 0.5% (Max) in 5% ethanol
Effervescence (mouth)	Tactile perception, at the level of the oral cavity, generated by the carbon dioxide of the cider	Water from still (Min) to Sparkling (Max)
Flavor persistence	The time of persistence of taste and retronasal aroma in the mouth	Different white wines from table (Min) to Passito (Max)
Overall liking	The overall satisfaction and pleasure derived from wine tasting [Hedonic only].	

Table S3. Descriptors of Analytical and Hedonic pairing assessments.

Descriptor	Definition	References
Flavor	The overall impression derived from the combined taste and aroma (from the retronasal route) attributes of wine and cheese pairing.	White wines (still, semi-sparkling and sparkling) paired with mozzarella, Motasio, and Parmigiano cheeses. Low: Still wine with mozzarella High: Sparkling wine with Parmigiano
Sourness	The simultaneous perception of wine and cheese acidity during the pairing.	Lactic acid and Citric acid from 0% (Min) to 0.1%+0.1% (Max) in 5% ethanol
Mouthfeel	The integrated tactile sensation that conveys the combined structure and body of the wine and cheese pairing in the mouth, encompassing aspects such as creaminess, smoothness, and overall texture.	White wines (still, semi-sparkling and sparkling) paired with mozzarella, Motasio, and Parmigiano cheeses. Low: Still wine with mozzarella High: Sparkling wine with Parmigiano
Taste_intensity	The collective strength of the taste perception from the wine/ cheese pairing. Time is measured in minutes. Duration of flavor after swallowing the samples.	White wines (still, semi-sparkling and sparkling) paired with mozzarella, Motasio, and Parmigiano cheeses. Low: Still wine with mozzarella High: Sparkling wine with Parmigiano
Overall liking	The general evaluation or overall pleasure derived from the joint sensory experience of tasting the wine and cheese together, taking into consideration all assessed aspects [Hedonic only]	

Table S4. ANOVA by cheese (A) and wine (B). Values are expressed as mean ± standard deviation.

	Differences in pairing (same wine, different cheese)				Differences in pairing (same cheese, different wines)			
	Mean category			P	Mean category			P
	Still wine	Semi-sparkling wine	Sparkling wine		Fresh cheese	Medium cheese	Hard cheese	
Hedonic evaluation								
Flavor	6.93 ± 1.62^{a}	6.70 ± 1.67^{a}	6.86 ± 1.79^{a}	0.188	7.13 ± 1.62^{a}	6.45 ± 1.64^{b}	6.92 ± 1.75^{a}	0.000
Sour	4.94 ± 1.93^{a}	5.12 ± 2.03^{ab}	5.44 ± 1.94^{b}	0.002	4.99 ± 2.12^{a}	5.13 ± 1.77^{ab}	5.39 ± 2.01^{b}	0.022
Mouthfeel	5.26 ± 1.91^{a}	5.33 ± 1.86^{a}	5.51 ± 1.89^{a}	0.181	6.02 ± 1.78^{a}	5.03 ± 1.68^{b}	5.05 ± 2.02^{b}	0.000
Taste_intensity	6.08 ± 1.81^{a}	6.01 ± 1.92^{a}	6.13 ± 1.78^{a}	0.682	5.15 ± 1.77^{a}	6.11 ± 1.65^{b}	6.96 ± 1.62^{c}	0.000
Overall liking	6.77 ± 1.74^{a}	6.76 ± 1.86^{a}	6.83 ± 1.76^{a}	0.853	6. 99 ± 1.61^{a}	6.30 ± 1.78^{b}	7.06 ± 1.87^{a}	0.000
Panel Evaluation								
Flavor	7.07 ± 0.99^{b}	7.33 ± 1.09^{b}	8.04 ± 1.08^{a}	0.000	6.76 ± 0.80^{b}	7.11 ± 0.74^{b}	8.57 ± 0.88^{a}	0.000
Sour	4.33 ± 0.95^{b}	5.50 ± 0.90^{a}	5.85 ± 1.43^{a}	0.000	6.39 ± 1.20^{a}	4.54 ± 0.86^{b}	4.76 ± 0.89^{b}	0.000
Mouthfeel	3.87 ± 1.37^{c}	4.98 ± 1.01^{b}	6.18 ± 1.06^{a}	0.000	3.96 ± 1.40^{b}	5.43 ± 0.63^{a}	5.65 ± 1.65^{a}	0.000
Taste_intensity	5.51 ± 0.92^{c}	7.17 ± 1.04^{b}	8.20 ± 0.86^{a}	0.000	6.25 ± 1.28^{b}	7.13 ± 1.03^{a}	7.51 ± 1.67^{a}	0.000

Means not sharing a letter within a row are significantly different (P < 0.05). ANOVA and Tukey–Kramer tests are used to test statistically significant differences in means. Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium cheese; "3" to seasoned cheese.

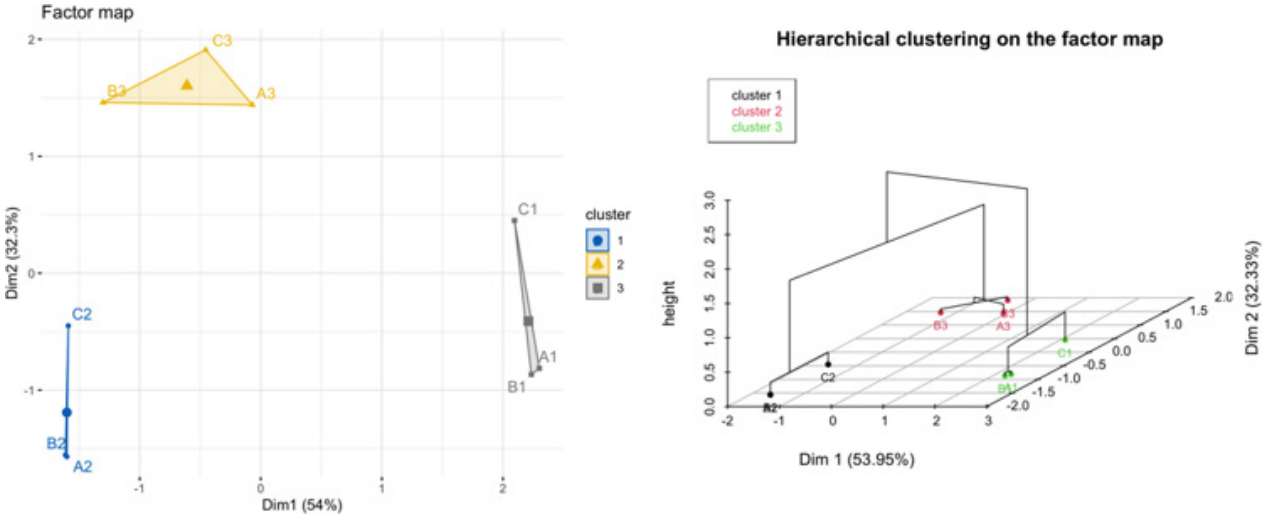

Figure S1. Hierarchical Clustering on Principal Components (HCPC) on hedonic attributes. Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium cheese; "3" to seasoned cheese.

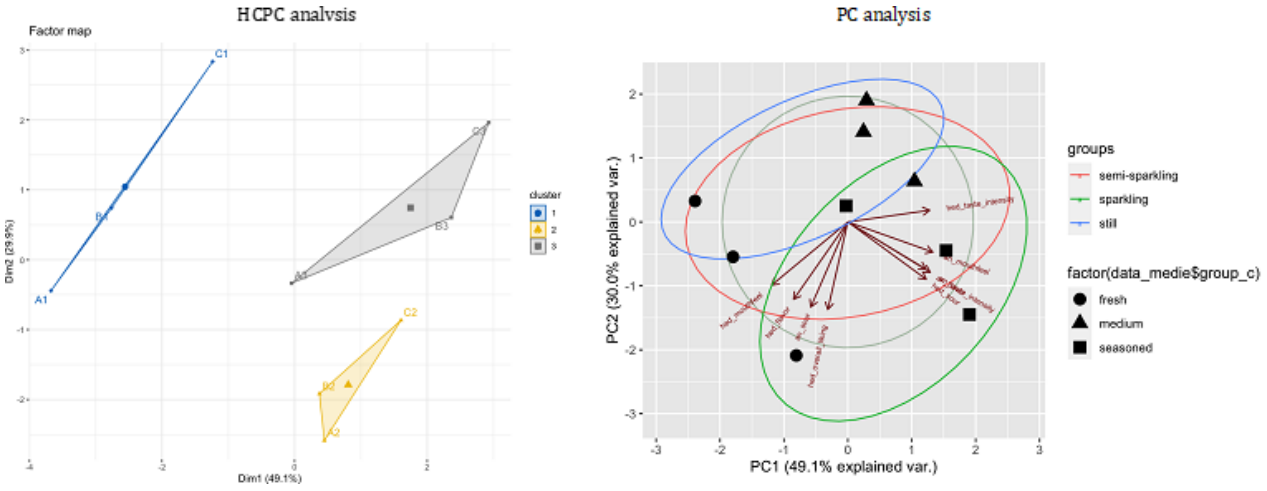

Figure S2. Hierarchical Clustering on Principal Components (HCPC) on analytical evaluation (by panel) and consumers' preferences (A) compared to PC analysis (B). Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium cheese; "3" to seasoned cheese.

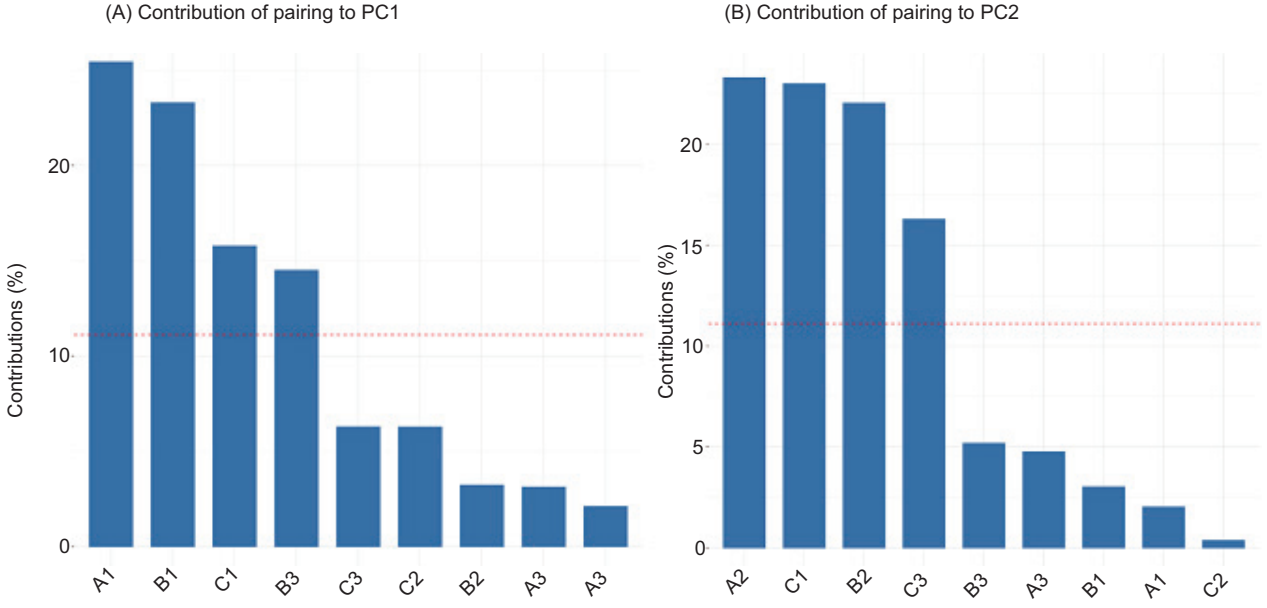

Figure S3. Contribution of pairings to PC1 (A) and PC2 (B) on hedonic data. Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium cheese; "3" to seasoned cheese.

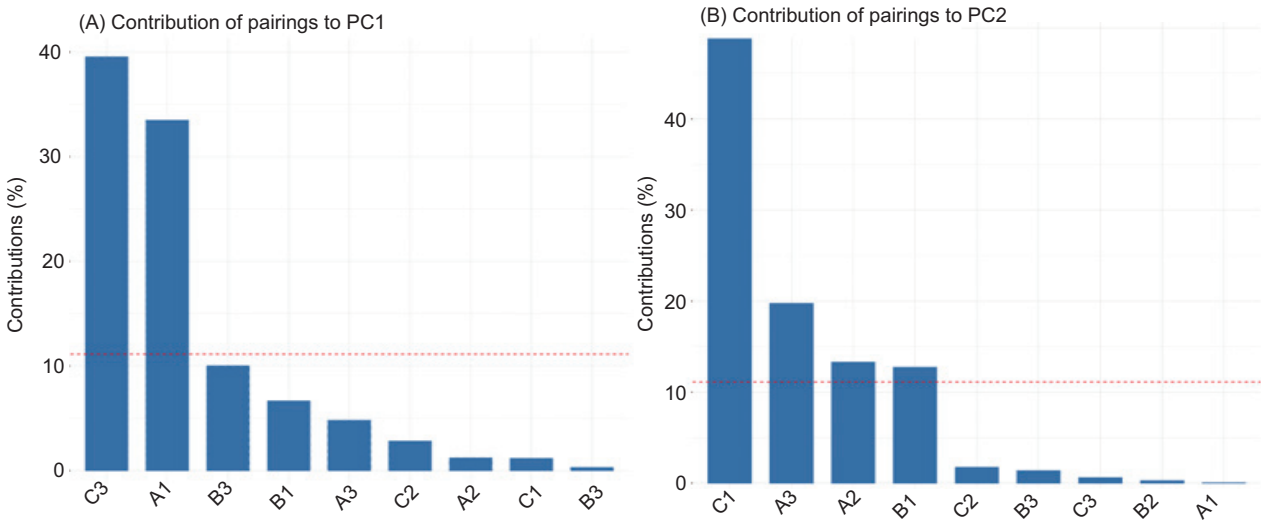

Figure S4. Contribution of pairings to PC1 (A) and PC2 (B) on analytical panel data. Letters and numbers are used to define the pairings. Namely, "A" refers to pairings with still wines; "B" to semi-sparkling wines; "C" to sparkling wines; "1" to fresh cheese pairings; "2" to medium cheese; "3" to seasoned cheese.