

THE ROSÉ WINE MARKET AND THE ADAPTATION OF WINE PRODUCTION TO CLIMATE CHANGE

[https://doi.org/ 10.15673/fst.v19i4.3305](https://doi.org/10.15673/fst.v19i4.3305)

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Cite as Vancouver style citation

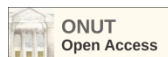
Tkachenko D., Manoli T., Nikitina Y. The rosé wine market and the adaptation of wine production to climate change. Food Science and Technology. 2025;19(4):104-120.
[https://doi.org/ 10.15673/fst.v19i4.3305](https://doi.org/10.15673/fst.v19i4.3305)

Цитування згідно ДСТУ 8302:2015

Tkachenko D., Manoli T., Nikitina Y. The rosé wine market and the adaptation of wine production to climate change // Food Science and Technology. 2025. Vol. 19, Issue 4. P. 104-120.
[https://doi.org/ 10.15673/fst.v19i4.3305](https://doi.org/10.15673/fst.v19i4.3305)

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Abstract. The article provides a comprehensive analytical review of the current state and prospects for the development of the rosé wine market in global and Ukrainian dimensions, taking into account the impact of climate change. Based on data from international organisations, specialised studies and market reviews, the dynamics of production, consumption and export are systematised, leading regions and segments are identified, and key pricing factors are outlined. The theoretical and practical part of the study covers the classification of rosé wine styles, the role of colour as a sensory and marketing marker, as well as technological approaches that determine organoleptic properties (short-term maceration, the Saignée method, whole bunch pressing). The impact of climate change on the agronomic and chemical characteristics of grapes is analysed separately — changes in temperature, moisture deficit, frequency of extreme weather events and consequences for sugar-acid balance, aromatic structure and yield stability. The article evaluates adaptation strategies: selection of varieties and rootstocks, precision irrigation, shade and canopy management practices, as well as winemaking innovations (fermentation control, micro-oxygenation, membrane technologies for purification), which reduce the negative effects of climate change and preserve the stylistic integrity of the product. An analysis of the Ukrainian online market reveals trends towards diversification of offerings, growth in premium positions, and the development of sparkling and non-alcoholic alternatives. It was concluded that the integration of scientifically based agricultural technologies, support for institutional initiatives and a targeted marketing strategy are key factors in increasing the competitiveness of the segment and forming the national identity of Ukrainian rosé wines.

Keywords: rosé wines, climate change, global market, pricing, rosé wine styles, colour, rosé wine market, style, technological techniques.

Introduction. Formulation of the problem

Over the past few decades, rosé wines have gained widespread recognition and have become one of the key categories in the global wine sector. The growing popularity of this wine category is due to changing consumer preferences, increased interest in mid-range and premium wines, and the development of wine tourism. At the same time, global climate change is creating new challenges for the wine industry, affecting grape growing, wine styles and production processes.

Changes in the phenological phases of grapevine development, rising average annual temperatures, changes in precipitation patterns and an increase in the frequency of extreme weather events directly affect the yield and quality of grapes, which in turn affects the organoleptic characteristics of the final product. In this regard, adapting winemaking to climate change is becoming a strategic task for producers.

Current areas of research in this field include the impact of climatic factors on the characteristics of rosé wines, the introduction of innovative agricultural technologies, the adaptation of vineyard varietal composition, and the optimisation of production processes. This article examines the current state of the rosé wine market, the main trends in its development, and the measures taken by winemakers to minimise the impact of climate change on the quality and stability of wine products.

Presentation of the main material.

Global production of rosé wines shows a steady upward trend. According to the International Organisation of Vine and Wine (OIV), production of this category of wine has grown by 25% over the last two decades. While at the beginning of the 21st century,

rosé wines accounted for 6-7% of global wine production, in recent years this figure has exceeded 8%.

In 2021, the ten largest producing countries accounted for almost 90% of global rosé wine production, with the three leading countries – France (6.5 million hl), Spain (3.7 million hl) and the United States (3.4 million hl) – accounting for two-thirds of the total volume. The main producers remain countries in the Northern Hemisphere, in particular France, whose share of global rosé wine production has reached 32% in recent years. At the same time, there has been significant growth in production in Southern Hemisphere countries such as Chile and South Africa.

The increase in global consumption of rosé wines is primarily due to growing demand in the United Kingdom, Germany and the United States. France remains the main market, accounting for more than a third of global demand.

In 2022, global consumption of rosé wine stabilised at 19.6 million hectolitres, showing slight growth (0.5%) after a decline in 2020–2021. Despite an overall decline in still wine consumption (by 2.6% in 2022), the share of rosé wine in its structure continues to grow and currently accounts for 10% of global volume. The main markets remain Western European countries (in particular France, Germany, Italy) and the United States, which together account for 78% of global consumption. However, the market is gradually diversifying: the role of Central and Eastern Europe, Oceania, Brazil and Canada as growth areas is increasing [1].

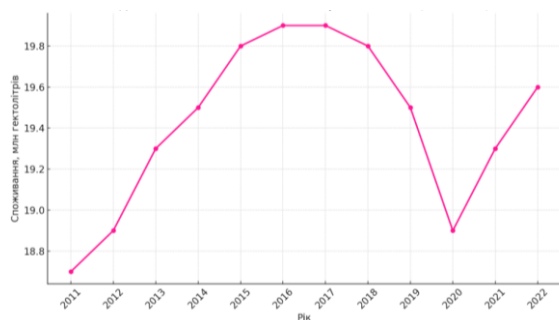


Fig. 1. Dynamics of global rosé wine consumption in 2011–2022.

The graph in Figure 1 shows the dynamics of global rosé wine consumption in 2011–2022. It can be seen that after growing to a peak in 2019 (almost 20 million hectolitres), there was a decline in 2020–2021, but in 2022 the market began to recover. This indicates the relative stability of the rosé wine category compared to other still wines.

Global exports of rosé wines remained stable in 2022 at 10.9 million hectolitres. Spain is the leader in terms of export volume (38%), ahead of France (18%). At the same time, total export sales increased to €2.4 billion, which is €0.3 billion more than in 2021.

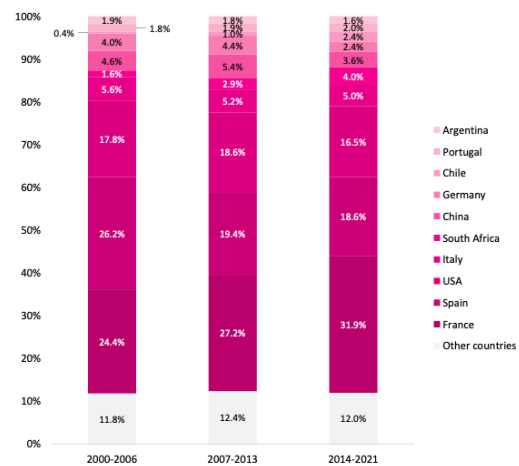


Fig. 2. Distribution of global rosé wine production by country

The global rosé wine market is showing dynamic growth, as confirmed by analytical studies conducted in more than 30 countries [2]. According to forecasts, the average annual growth rate of this segment will be 5.5% in the period up to 2033. As of 2023, global demand for rosé wines was estimated at \$3.27 billion, and this figure is expected to reach \$5.59 billion by the end of 2033.

Young consumers, who prefer light, fresh drinks with pronounced gastronomic versatility, play a significant role in the growing popularity of rosé wines. Rosé wine combines the elegance of red wine aromas with the crispness and freshness of white wine, which contributes to its widespread use both as a standalone drink and in combination with various dishes, including seafood, poultry, salads and spicy dishes.

In 2024, the value of the rosé wine export market exceeded €2.7 billion. France and Spain remain the leading exporters in terms of volume, while the United States is showing steady export growth thanks to the introduction of innovative production styles.

Overall, analysts note that rosé wine continues to strengthen its position in the global market thanks to its unique organoleptic profile, refreshing taste and high adaptability to modern consumer preferences.

The pricing of rosé wines around the world depends on a number of factors, including grape quality, region of production, winemaking methods, and the producer's marketing strategy. In general, rosé wines can be classified into the following categories:

1. Table rosé wines: mass production, affordable prices, approximately €3 to €10 per bottle. Main production regions: Languedoc, Côtes du Rhône.
2. Winery rosé wines: produced directly at wineries in accordance with certain quality standards, prices range from €10 to €20 per bottle. Top regions: Provence, Corsica.
3. High-quality rosé wines: prestigious brands with meticulous production methods, prices start at €20 per

bottle. Top regions: Côtes de Provence, Bandol. Some wines from local producers are offered in the price range of 35-52 euros (Domaines Ott Château Romassan Bandol Rosé) or even 87-130 euros (Château d'Esclans Garrus Rosé) [3].

4. Certified rosé wines: organic production requires specific and often more expensive agricultural techniques. The average price of organic wines is between €12 and €25 [4].

The article "Rose Wine Market: Anything but Colour?" examines current trends in the rose wine market, emphasising that its value is determined not only by colour but also by a number of other factors. The authors analyse how marketing strategies, consumer preferences and innovations in production affect the perception and price of rose wine. In particular, the role of branding, packaging design and origin story in shaping the added value of the product is emphasised. Changes in consumer demand are also considered, in particular the growing popularity of rosé wine among young people and in new markets. The study points to the need for a comprehensive approach to analysing the rosé wine market, taking into account both traditional and new factors that influence its value [5].

Factors influencing the cost of rosé wine:

- Grape quality: high-quality grapes increase the cost of production.

- Region of production: renowned wine-producing regions, such as Provence, can set higher prices due to their reputation and demand. Rosé champagne, representing sparkling wine from the Champagne region, often commands a premium price due to the region's reputation and traditional production method. Vintage rosé champagne: typically more expensive due to the quality of the raw materials and ageing potential. Prices often start at €60-70 and can exceed €17 per bottle from renowned Champagne houses. Examples include Dom Pérignon Rosé, Louis Roederer Cristal Rosé and Krug Rosé. Prices for these prestigious cuvées can range from €260 to over €430 [3].

- Production methods: traditional and organic methods can increase costs and, accordingly, the price of the final product.

- Marketing and brand: well-known brands and effective marketing strategies can increase the cost of wine.

In 2022, global consumption of rosé wines stabilised at 19.6 million hectolitres, representing 10% of total still wine consumption. The main consumers are France (33%), Germany (11%) and the United States (11%). Rosé wine production in 2021 amounted to 21.8 million hectolitres, down 5.8% from the previous year, mainly due to a 1.6 million hectolitre reduction in France. France remains the leading producer (30% of the total volume), followed by Spain (21%), the United States and Italy (10% each) [6,7].

Impact of tariffs and logistical problems on pricing:

In April 2025, the US administration introduced tariffs on wine imports: 10% on Australian wines, 20% on European wines and 30% on South African wines. These tariffs could lead to higher prices for consumers and financial difficulties for importers. In addition, logistical problems such as raw material shortages and rising production costs are contributing to higher wine prices [7,8].

After analysing the rosé wine market in Ukraine, specifically the range offered by one of the largest online retailers, ROZETKA, we can identify the main trends and product categories that shape current consumer choices in the rosé wine segment.

As of April 2025, the ROZETKA platform offers over a thousand types of rosé wines of various types, countries of origin, alcohol content, and price ranges. All products can be classified into several main categories: still wines, sparkling wines (including champagne and prosecco), semi-sweet and semi-dry wines, as well as non-alcoholic alternatives and gift sets.

1. Still rosé wines

This category is represented by samples from various countries, including Portugal, New Zealand, Italy, and Ukraine. Examples include:

Wines from various countries

Casa Clara Ermo Alfrocheiro (Portugal) — a red wine made from the indigenous Alfrocheiro grape variety, dry (i.e. with a minimum residual sugar content of up to 4 g/l), with an alcohol content of 12.5% vol.

IWI Sauvignon Rose Marlborough (New Zealand) — a dry rosé wine (residual sugar up to 4 g/l), produced in the famous Marlborough wine region, with an alcohol content of 12.5% vol.

Capela DOC Aragonês (Portugal) — a dry red wine made from the Aragonês (Tempranillo) grape variety, labelled as DOC (Denominação de Origem Controlada — a controlled designation of origin that guarantees the quality and geographical origin of the wine), with an alcohol content of 12.5% vol.

2. Sparkling wines and champagne

Veuve Clicquot Ponsardin Rose Brut (France) — classic pink Brut champagne (dry sparkling wine with a sugar content of up to 12 g/l), alcohol content 12.5% vol.

Murviedro Cava Brut Organic Rose (Spain) — sparkling rosé wine of the Cava Brut category, produced using organic methods; alcohol content 12% vol.

Astoria Prosecco Spumante DOC Rose (Italy) — DOC Prosecco sparkling wine (Denominazione di Origine Controllata — controlled designation of origin), rosé, Extra Dry category (residual sugar 12–17 g/l), alcohol content 11% vol.

3. Semi-sweet and semi-dry wines

LETIZIA Sangiovese Rosato IGT Puglia (Italy) — semi-sweet rosé wine made from Sangiovese grapes, IGT category (Indicazione Geografica Tipica — typical

geographical indication, intermediate quality level between table wine and DOC), alcohol content 9.5% vol.

Yellow Tail Pink Moscato (Australia) – a pink wine made from Muscat grape varieties, semi-sweet category (residual sugar 18–45 g/l), light in structure.

Chateau Chizay Rose with grapefruit (Ukraine) – a flavoured rosé wine from a Ukrainian producer, semi-sweet, with an alcohol content of 10.5% vol.

4. Non-alcoholic rosé wines

Against the backdrop of growing interest in alternative alcohol-free wine consumption, the website offers the following options:

Freixenet Alcohol Free Sparkling Rosé (Spain) – a sparkling non-alcoholic rosé wine produced by Freixenet. The Alcohol Free category means that the ethyl alcohol content does not exceed 0.5% ABV, which allows it to be classified as a non-alcoholic wine. It has a fresh, fruity style.

Rondel Zero Rosé (Spain) – a sparkling rosé wine from the Rondel brand. The Zero label also indicates the absence of alcohol (up to 0.5% vol.), which corresponds to the category of non-alcoholic sparkling wines. It is characterised by its lightness and fruity aromas.

5. Gift sets

Brut Buro “For Her” (Ukraine) – a Brut category sparkling rosé wine (dry with a sugar content of up to 12 g/l), 11% ABV. Available in a gift format.

Radacini Metier Rosé (Moldova) – wine from Moldovan producer Radacini Wines. Style – dry rosé, with an alcohol content of 12% vol. Presented in gift packaging, aimed at the premium segment.

Thus, the range of rosé wines on the Ukrainian market, represented by the ROZETKA website, demonstrates a high level of diversity in both taste characteristics and product types, satisfying the demands of various target consumer groups. The growing popularity of sparkling and non-alcoholic wines, as well as the expansion of the premium segment,

indicates an evolution in taste preferences and an increase in wine consumption culture in Ukraine [9].

The pricing policy for Ukrainian rosé wines varies significantly depending on the product category (still or sparkling wines) and sales channels. For the purposes of analysis, we monitored the most popular online stores specializing in the distribution of wine products in Ukraine.

Table 1 shows the distribution of price ranges for rosé wines of different categories and their share in the total assortment (in percent) in the largest online stores and retail chains.

Data analysis (Table 1) shows that the largest number of Ukrainian rosé wines are concentrated on the ROZETKA marketplace (12.4%) and in the specialised online store Vynolovy (14.5%). At the same time, in the premium segment (Goodwine, Vyno.ua), the range is significantly narrower, but prices are higher.

Sparkling wines and PetNats demonstrate a wider price range (from 159 to 1607 UAH depending on the point of sale), while still wines are more stable in price (90–1020 UAH). This indicates different levels of positioning for Ukrainian rosé wines on the market: from mass-market, affordable offerings at large retailers to more niche and premium offerings at specialised stores.

Ukrainian rosé wines are made from a variety of grape varieties, such as Pinot Noir, Cabernet Sauvignon, Syrah and others. The styles vary from dry to semi-sweet, with an emphasis on freshness, fruitiness and balance of taste [10].

An analysis of the range of Ukrainian rosé wines on the ROZETKA platform shows positive dynamics in the development of domestic winemaking. The growing number of producers, the expansion of the variety range and the improvement in product quality testify to the competitiveness of Ukrainian wines on the domestic market. Further development of this segment will contribute to strengthening Ukraine's position in the global wine arena.

Table 1. Pricing policy for Ukrainian rosé wines depending on category and sales channels.

Wine category	Vinarnya online store	Vinolovy online store for Ukrainian craft wines	Vino.ua - Vitis Group online store	Goodwine	ROZETKA	Silpo
	Number of offers with a capacity of 0.75 litres without discount (% of total number of Ukrainian wine offers)					
	39 (17,9%)	60 (14,5%)	34 (10,8%)	9 (8,8%)	114 (12,4%)	35 (15,7)
Wines saturated with carbon dioxide (sparkling, PetNat, etc.)	330 – 950 UAH	280 – 970 UAH	176 – 1607 UAH	488 UAH	159 - 1279 UAH	179 – 557 UAH
Still wines	315 – 960 UAH	130 – 1020 UAH	270 – 483 UAH	418 – 759 UAH	90 – 494 UAH	109 – 719 UAH

Modern styles of rosé wines.

Rosé wines, or rosés, are a separate category of wines that combine the characteristics of both white and red wines. Their style is determined by production technology, grape variety, residual sugar level, and regional traditions. Scientific literature distinguishes several main styles of rosé wines, each with its own characteristics.

1. Dry rosé wines

Dry rosé wines are characterised by low residual sugar content (up to 4 g/dm³) and high acidity. They usually have a light pink colour and a fresh fruity aroma. This style is popular in France, especially in Provence, where Grenache, Syrah and Cinsault varieties are used. The production technology involves brief contact between the must and the grape skins, which allows for a delicate colour and aroma. [11]

2. Semi-dry and semi-sweet rosé wines

These wines have a higher residual sugar content (4 to 45 g/dm³), which gives them softness and fruitiness. They are often made from grape varieties rich in aromatic compounds, such as Muscat or Zinfandel. The production technology may include cooling the must to stop fermentation at the desired sugar level. [11]

3. Sparkling rosé wines

Sparkling rosé wines are produced using the classic or tank method, using red grape varieties such as Pinot Noir. They are characterised by fine bubbles, freshness and an elegant aroma. Research into the effect of technology on the quality of Pinot Noir sparkling rosé wines has shown that the choice of yeast and ageing conditions have a significant impact on the organoleptic properties of the wine. [11]

4. Dessert rosé wines

Dessert rosé wines have a high sugar content (over 45 g/dm³) and are often made using grape varieties prone to sugar accumulation, such as Muscat. They have a rich aroma and taste, with notes of tropical fruits, flowers and honey. The production technology involves stopping fermentation by cooling or adding alcohol to preserve the natural sugar of the grapes. [11]

5. Fortified rosé wines

Fortified rosé wines are produced by adding alcohol to must or partially fermented wine, which stops fermentation and preserves the residual sugar. These wines have a higher alcohol content (14–20% ABV) and can vary in sweetness. They are characterised by a rich flavour and aroma, with notes of dried fruit, caramel and spices. [12]

One of the classic styles of rosé wine is dry rosé, produced mainly in France, Italy, Spain and the United States. Grenache, Syrah, Cinsault, Mourvèdre and Pinot Noir grape varieties are commonly used to make it. The main method of production involves short maceration (from a few hours to 24 hours), which gives the wine a delicate pink hue and an exquisite aromatic profile with notes of red berries, citrus and flowers. The most famous

examples of this style are wines from Provence (France), which are characterised by dryness, light minerality and freshness.

Semi-dry and semi-sweet rosé wines are common in Germany, Austria and the United States. They are made with residual sugar content, which provides a balanced taste with bright fruit expression. Particularly popular in this segment are wines based on the White Zinfandel grape variety from California, which have a characteristic strawberry aroma and soft acidity.

Sweet rosé wines are less common and are represented, in particular, by Muscat wines (e.g. Brachetto d'Acqui from Italy). Their production is based on the use of grapes with a high natural sugar content, as well as stopping fermentation to preserve the natural sweetness. Such wines are characterised by distinct notes of ripe fruit, flowers and honey.

Sparkling rosé wines are a separate category, produced both by the traditional method of secondary fermentation in the bottle (e.g. rosé champagnes and Franciacorta) and by the Charmat method (Prosecco Rosé). They are characterised by bright acidity, fine bubbles and a complex aromatic profile.

Rosé wines are also distinguished by style: Provençal style wines are light in colour, high in acidity and have aromas of citrus and white flowers. Tavel style: rich wines with deep colour, pronounced tannins and aromas of red berries. Rosado: Spanish style of rosé wines, which can range from light to more structured, often with pronounced fruitiness [13].

Thus, the variety of rosé wine styles is determined by both technological and natural climatic factors, which provides a wide choice for consumers and contributes to the high popularity of this category of wines worldwide.

In 1999, the world's only research centre dedicated exclusively to the production of rosé wines, the Centre du Rosé (hereinafter referred to as the Centre), was established in Provence. Through its activities, the Centre seeks to strengthen the status of rosé wine by demonstrating its connection to the terroir and refining the production process. The Centre works in 15 areas, focusing on both applied and fundamental research programmes in the chain “from the vineyard to the consumer's table” [14]. In the scientific article “Connaissance et maîtrise de la couleur des vins Rosés” (Knowledge and control of the colour of rosé wines), prepared by researchers from the Centre for Research and Experimentation on Rosé Wine (Centre du Rosé) and the French Institute of Viticulture and Oenology (IFV), discusses the diversity of colours in rosé wines and the factors that influence them [15].

Every year, the Centre examines more than 600 samples of commercial rosé wines from France and other countries, provided by the Union of French Oenologists. The results of the analyses show significant colour variation, from almost white to pale

red. There is a geographical colour gradient: the lightest wines usually come from northern regions, while the more saturated ones come from southern regions.

The main stage that determines the colour of wine is the contact between the grape skin and the juice. The three key factors in this process — duration, temperature and mechanical action — have a decisive influence on the intensity and hue of the colour. Laboratory macerations are used to assess colour potential, allowing winemakers to predict the future colour of the must. Other stages of winemaking, such as yeast strain selection, clarification, and sulphitation, can also influence the final colour, but to a lesser extent [16].

Colour is one of the first sensory indicators that shapes the consumer's perception of wine. In the category of rosé wines, colour is particularly important because it determines expectations regarding taste, aroma and even region of origin. The Centre du Rosé in France conducted a large-scale study on the classification of rosé wines by colour type, using quantitative and qualitative analysis methods [16].

The study analysed 331 samples of rosé wine from different regions of France. Spectrophotometric methods were used to measure colour in the visible spectrum (400–700 nm), and colour coordinates were calculated in the CIELab model (L^* , a^* , b^*). Cluster analysis (k-means method) was used to identify typical colour groups. As a result of the classification, six main colour types and eight additional colours were identified [16,17].

1. “Litchi” — very light, greyish-pink hue.
2. “Pomelo” — light orange, typical for Provence wines.
3. “Abricot” — warm pink, moderate intensity.
4. “Pastèque” — bright pink with reddish tones.
5. “Groseille” — rich red-pink.
6. “Grenade” — dark ruby, the most intense.

Lighter colours (lychee, pomelo) dominate in wines from Provence, while darker colours (pomegranate, redcurrant) are characteristic of south-western France. About 70% of wines fall into the intermediate zone between “pomelo” and “redcurrant” [18,19].

Parallels with Ukraine. Ukrainian winemaking, particularly in the regions of Zakarpattia and Odesa, already has the potential to produce rosé wines of various colour styles. The use of colour typology will allow winemakers to:

- standardise the appearance of their products,
- expand the terminology used on wine labels,
- strengthen the connection between colour and wine style in consumer perception.

Professor Bilko M. V. notes that as of 2019, Ukrainian consumers preferred salmon and raspberry-pink wines. The scientist divides rosé wines into two types according to style: European and domestic. The

European style is characterised by a phenolic content of 290–478 mg/dm³, including 6–44 mg/dm³ of colouring agents. The domestic style has a higher mass concentration of phenolic substances — 532–726 mg/dm³, including colouring substances — 50.6–64.5 mg/dm³ [20].

The methodology proposed by the French Centre du Rosé is an effective tool for the visual standardisation of rosé wines. Its application in Ukraine will contribute to the development of a high-quality rosé wine culture, taking into account the local characteristics of the terroir and varietal composition.

In today's world, manufacturers and suppliers of auxiliary materials also distinguish several style classifications depending on the technological modes of the process and the preparations used in the production of rosé wines. The main parameters that determine the style of rosé wine include the method of maceration, the duration of contact between the must and the skins, the fermentation temperature, the types and concentration of yeast, and the use of stabilisers and antioxidants.

In addition, the classification may take into account regional characteristics of winemaking (a combination of natural and anthropogenic factors: climatic conditions, soil types, traditional technologies and local grape varieties), the organoleptic characteristics of the final product (colour intensity, aromatic profile, acidity level), and the use of certain grape varieties. Innovative approaches to fermentation, such as the use of controlled micro-oxygenation or specialised yeast strains, also have a significant impact on the final style of rosé wine [21].

The stylistic diversity of rosé wines is determined not only by grape varieties and natural conditions, but also by the technological regimes used, the use of yeast cultures and auxiliary materials. Table 2 shows the classification of the main styles of rosé wines, developed on the basis of recommendations from leading international manufacturers of oenological preparations (Enartis, Aeb-group).

Analysis of the data (Table 2) shows that modern producers distinguish several key styles of rosé wine. In particular:

- Fruit Driven Rosé and Floral styles are focused on light, fresh wines with a distinct fruit or floral profile, characterised by medium alcohol content (11–13%) and short maceration;
- Reserve Rich Rosé and Provençal Thiolic Rosé are more complex styles, with longer maceration, partial contact with wood, higher alcohol content (13–14.5%) and a rich aroma and flavour profile;
- The styles offered by the Aeb-group (Amylic, Thiolic-spicy, Fruity) emphasise the role of different fermentation temperatures and maceration times in the formation of specific aromas (essential, thiolic, berry).

Table 2. Classification of styles depending on the technological modes of the process and the preparations used

Style	Key features
Enartis (Italy)	
FRUIT DRIVEN ROSE	Aromatic profile – a distinct fruity bouquet with notes of strawberry, raspberry, cherry, pomegranate, watermelon, peach or tropical fruits. Often accompanied by light floral nuances. Colour – from light pink to rich salmon or coral, depending on the grape variety and maceration method. Taste characteristics – bright, juicy taste with dominant fruit notes, moderate acidity and well-balanced sweetness. Production method: involves medium-term maceration or the Saignée method, recommended fermentation temperature is 16-18°C. Grape varieties: Grenache, Syrah, Merlot, Cabernet Franc, Tempranillo and Pinot Noir are most commonly used, providing a pronounced fruit profile. Alcohol content – medium (11-13%), which helps to preserve the lightness and freshness of the wine. Use of auxiliary materials – fermentation additives may be used to enhance fruitiness, as well as stabilisers to preserve colour and aroma. Food pairing – pairs well with light appetisers, salads, seafood, white meat and Asian dishes, and can also serve as a refreshing aperitif.
“RESERVE” RICH ROSE	Aromatic profile – complex, rich bouquet combining ripe red berries (strawberry, raspberry, blackcurrant), caramelised fruit, dried flowers, spicy and vanilla notes formed as a result of ageing. Colour – deep pink or copper-salmon hue, resulting from longer maceration and partial contact with wood during ageing. Taste characteristics – multi-layered, rounded taste with pronounced texture, balanced acidity, velvety structure and a long, complex aftertaste. Often contains notes of spices, nuts or honey, which appear as a result of ageing in barrels. Production method – medium-length maceration, recommended fermentation temperature – 16-17°C. The winemaking process may include fermentation and ageing in oak barrels (French or American oak) for several months, which contributes to the development of complex flavour characteristics. Grape varieties – varieties with high ageing potential are usually used, such as Grenache, Mourvèdre, Syrah, Cabernet Sauvignon and Tempranillo. Alcohol content – moderate or high (13-14.5%), which provides a pronounced structure and depth of flavour. Use of auxiliary materials – specialised yeast strains may be used to enhance the complexity of the aroma, as well as tannins and stabilisers to improve texture and preserve sensory characteristics during ageing. Food pairing – pairs well with aged cheeses, game dishes, smoked meats, and exquisite Mediterranean and French cuisine. The Reserve Rich Rosé style is characterised by complexity, structure and deep aromatic properties, making it an exceptional choice among premium aged rosé wines.
FLORAL	Aromatic profile – a pronounced floral bouquet with dominant notes of rose, lilac, violet, peony, orange blossom or lavender. There may be light shades of white and yellow flowers, as well as delicate fruity nuances (lychee, pear, citrus) that blend harmoniously with the main aromatic spectrum. Colour – light pink or pale salmon hue, achieved through minimal contact of the must with the grape skins or direct pressing. Taste characteristics – refined, light, with moderate acidity, soft texture and elegant structure. The wine has a long, delicate aftertaste with floral and honey notes. Production method – short maceration (2 to 6 hours) or direct pressing to preserve the delicate aromatic compounds. Fermentation – short maceration, recommended fermentation temperature – 12-14°C. Grape varieties – the most characteristic for this style are varieties rich in terpenes, in particular Pinot Gris, as well as Grenache and Syrah from certain regions. Alcohol content - medium (11-13%), which allows for a balance between freshness and aromatic expression. Use of auxiliary materials - fermentation additives may be used to emphasise floral notes, as well as stabilisers to preserve colour and aroma during storage. Food pairing – goes well with Asian cuisine, white fish dishes, light salads, fruit desserts, and can also serve as a refreshing aperitif. The «Floral» style in rosé wine production is characterised by refinement, elegance and a pronounced floral aroma, making it attractive to consumers who appreciate delicate and aromatically expressive wines.

PROVENÇAL THIOLIC ROSÉ	The aromatic profile is intense and expressive, dominated by thiol compounds that form bright notes of tropical fruits (passion fruit, grapefruit, guava), citrus fruits (lime, lemon zest), as well as light nuances of freshly cut grass and nettles. Additionally, subtle mineral tones and notes of white flowers may be present. The colour is light pink, salmon or pale onion, which is characteristic of Provence wines. This is achieved through delicate pressing and minimal contact of the must with the grape skins. The taste characteristics are fresh, crisp, with high acidity and clearly defined minerality. The wine has a light body but is well structured, with a long, citrusy-fruity aftertaste. Production method: short maceration or whole bunch pressing, stabilisation (maceration on the must sediment), recommended fermentation temperature 14-16°C. Grape varieties – Grenache, Syrah, Rolle and Cinsault are most commonly used, as they have the potential to synthesise thiol aromas under the right technological conditions. Alcohol content – medium (12-13%), maintaining a balance between freshness and aromatic intensity. Use of auxiliary materials – specific yeast preparations may be used to enhance thiol aromas, as well as antioxidants (e.g. SO ₂ or glutathione) to prevent aroma loss during production and storage. Food pairing – pairs well with seafood, sushi, sashimi, Mediterranean cuisine, and light salads with citrus dressings. The Provençal Thiolic Rosé style is characterised by high aromatic intensity, freshness and minerality, making it a typical representative of modern Provençal rosé wines, focused on maximising the expression of thiol compounds and elegance of taste.
Aeb-group (Italy)	
AMYLIC ROSÉ	Aromatic profile – light, fresh, with distinct notes of tropical fruits (banana, papaya) and hints of cotton candy. Formed due to the high content of esters (isoamyl acetate, hexyl acetate, phenylethyl acetate). Colour – pale pink or almost transparent, due to rapid pressing of whole bunches and minimal contact of the must with the skins. Taste characteristics – light body, high acidity, crisp, with a refreshing fruity aftertaste. Production method – rapid pressing of whole bunches, fermentation at low temperatures (14–16°C) to preserve essential aromas. Grape varieties – unripe grapes are used to preserve acidity and form characteristic amyl notes. Alcohol content – low or medium (11–12%). Use of auxiliary materials – yeast may be used to stimulate the formation of amyl esters. Food pairing – goes well with light salads, fruit appetisers, young cheeses, and white fish dishes. General characteristics – the «Amylic Rosé» style is distinguished by its bright fruitiness, high freshness and lightness, and is intended for young consumption.
THIOLIC-SPICY ROSÉ	Aromatic profile – intense, dominated by citrus and tropical fruits (grapefruit, passion fruit, guava), complemented by notes of white pulp and light hints of spices. The aroma is associated with glycosylated terpenes and thiol precursors. Colour – light pink, with delicate salmon hues. Taste characteristics – medium body, balanced flavour with pleasant freshness, well-defined fruity-spicy harmony. Production method: pellicular maceration of the pulp (2–6 hours at 10–14°C) to extract aromatic precursors and preserve the light colour. Fermentation at 16–18°C. Grape varieties: ripe grapes with a high content of aromatic precursors. Alcohol content – medium (12–13%). Use of auxiliary materials – antioxidants may be used to stabilise aromas. Food pairing – goes well with Mediterranean appetisers, citrus salads, and Asian dishes with spices. General characteristics – Thiolic-Spicy Rosé has a distinct aromatic profile, combining fruitiness and spiciness, which makes it a bright and modern style of rosé wine.
FRUITY ROSÉ	Aromatic profile – rich, rounded, dominated by berry notes: strawberry, raspberry, rose petals. Colour – deep pink, rich. Taste characteristics – well-structured, with a rounded taste and berry aftertaste; less acidic than amyl styles. Production method – maceration of the pulp for 2 to 48 hours at 16–18°C; fermentation at relatively high temperatures (20–25°C) to enhance berry aromas. Grape varieties – ripe grapes, which allow the development of fruity aromas. Alcohol content – medium to high (12.5–13.5%). Use of auxiliary materials – yeast may be used to enhance the evolution of berry aromas. Food pairing – suitable for grilled red meat dishes, berry desserts, pasta with tomato sauce. General characteristics – the «Fruity Rosé» style is distinguished by its rich colour, roundness and bright berry aroma, creating a more complete and gastronomic rosé wine.

Thus, this classification demonstrates that the technological parameters of the process (maceration duration, fermentation temperature, use of fermentation preparations or stabilisers) directly determine the sensory profile of the final product, allowing the creation of both light aperitif wines and structured wines with ageing potential.

Climate change and its impact on rosé wines. The impact of climate change on winemaking.

In recent years, grape growers and winemakers have faced a new challenge that significantly affects approaches to grape growing, winemaking techniques and wine styles, particularly rosé wines: climate change. For example, over the past 30 years, the average temperature in the south of France has risen by 1.5 degrees Celsius [22]. This impact is particularly noticeable in regions with narrow specialisation. One such example is Provence, where 89% of production is rosé wine.

Global climate change is having an increasingly significant impact on the agricultural sector, particularly viticulture and winemaking. The production of rosé wines, which are characterised by high requirements for acid balance, aroma and colour profile, is particularly sensitive. Climate perturbations, which are now considered to be long-term changes in temperature and weather conditions, are harming viticulture in several ways.

For example, in traditionally arid regions such as California, Washington, Oregon in the United States, Spain, and even Bordeaux, fires burn vineyards, threaten human life and buildings, and contaminate unaffected grapes with smoke [23].

Wine companies are working with scientists and equipment manufacturers to develop technologies to remove smoky aromas, such as highly selective membrane filtration, which is offered by California-based Mavrik North America, a leading provider of innovative filtration equipment solutions. Wines pass through the company's selective membranes two to four times to remove all traces of contamination.

The cost of treating 1 decalitre ranges from 1 to 2 US dollars [24]. However, a universally accessible solution has not yet been found.

Drought, combined with a reduction in rainfall and annual snow cover, means that when rain finally falls, but runs off the "concrete-like" soil instead of penetrating deep into the root system, and increased evaporation due to high temperatures, is forcing a rethink of some viticultural practices even in regions with conservative views. Recently, the appellations of Pessac-Léognan, Pomerol and Saint-Émilion in Bordeaux were granted permission to irrigate after heat waves and low rainfall threatened grapevines with water stress [25].

The abnormal heat of recent years has had a significant impact on wine quality. Warm conditions

accelerate grape development. Rapid ripening shifts harvest dates from the cooler autumn period in August to one of the hottest parts of the year, causing a potential increase in the volume fraction of ethyl alcohol, a decrease in the mass concentration of titratable acids, an increase in pH and a decrease in flavour complexity. It also increases the energy costs of maintaining temperature conditions during grape processing [52].

Recent research has made progress in conserving water resources. Innovations in soil moisture monitoring, controlled by computers and phone apps, combined with improved drip irrigation techniques, are helping wineries conserve resources by accurately determining the amount of water needed for irrigation. Converting old viable vineyards to dry farming can also save water while improving wine quality, as yields decline and flavours become more concentrated [53].

An article by Luigino Barisan et al. examines in detail the impact of agronomic factors on the environmental sustainability of winemaking, using rosé wine as an example. Particular attention is paid to the M4 rootstock, which demonstrates higher water use efficiency and adaptability to climate change. Wines made from this rootstock have a smaller carbon footprint due to reduced irrigation and agrotechnical intervention requirements. The M4 rootstock is positioned as promising for sustainable viticulture in the context of global warming [26, 27].

To protect grapes from intense direct sunlight in Australia, a unique kaolin-based sunscreen has been developed and introduced into production, which is sprayed on the bunches [28, 29]. Other methods of protecting grapes, especially thin-skinned varieties such as Pinot Noir, involve the use of shade cloths in small vineyards and a focus on canopy management to cover the bunches with foliage to provide shade for the berries.

Heat is not the only consequence of climate change. Many winemakers emphasise that the main problem is extremely unpredictable weather. Heavy rains, especially during the harvest period, frosts and hail in atypical regions that have not previously suffered from these phenomena, take producers by surprise, causing great damage to vineyards. Increased humidity contributes to the emergence of new pests and diseases. Warm winters are also a significant problem, contributing to earlier bud break, and as soon as the warming period ends, severe frost can destroy them.

Responding to climate change by introducing new viticultural technologies, adapting by planting more heat-resistant grape varieties on new rootstocks, or moving vineyards further north and up into the mountains are solutions for producers that require significant capital investment and are not available to many. Small wineries can budget for smartphone apps that use smart farming technologies to improve vineyard efficiency and warn of weather changes, combined with

hail nets or frost sprinklers if such adversities become common enough to justify the expense.

Legislative nuances stand in the way of innovation. New World winemakers face fewer restrictions on cultivation rules and can change grape varieties more quickly. In contrast, winemakers in Europe must comply with centuries-old laws on appellations and practices, and therefore have less flexibility.

Climate is a significant component of terroir, which is why several wine-producing regions are now on the verge of an identity crisis. Wines characterised by delicacy, freshness and sometimes, as a sign of typicality, a lower volume percentage of ethyl alcohol, such as Riesling in the Moselle Valley and Pinot Noir in Burgundy, face the challenge of preserving the historical profile that has made them recognisable, famous and valuable [54].

Significant climate change not only affects viticultural practices, but also calls into question the use of certain winemaking techniques. For example, the Saignée method, which is used both to produce rosé wines and to improve the quality of red wines, is becoming less relevant in regions where rosé wines are traditionally produced, or requires rethinking in its application, due to the increase in sugar concentration and the decrease in titratable acidity. Transpiration problems in recent years have led to the emergence of small, concentrated berries, which also require a slightly different winemaking process, involving careful sorting of the berries and very delicate pressing to avoid the extraction of tannins and, as a result, bitterness.

Elizabeth Gabay, author of *Rosé*, Understanding the pink wine revolution, points out that earlier harvesting is an option that can preserve characteristic acidity, but with the risk of losing fruit flavours in the profile [30]. She also notes that the fight against climate change will affect rosé styles. Currently, dry, ephemerally pale, summery pink has attracted the market's attention, but a "split" in style may occur. Two directions for the future of rosé: a continued thirst for pale pink — simple and fresh, sold in larger volumes and at a relatively low price — and a market for aged rosé, which is becoming more complex and taking on a rich colour palette.

A comprehensive approach to problem solving may be the answer to climate change through the promotion of various new varieties and winemaking methods. Various varieties can be considered for rosé production, including hybrids and disease-resistant varieties, as well as many local varieties that naturally retain acidity in hot weather and are suitable for producing interesting rosé wines. Some experts suggest that innovative wood options for fermentation and ageing, including cherry and acacia, may influence the «rosé style» [31].

Rising temperatures alter the chemical composition of grapes: sugar content increases and

acidity decreases, leading to higher alcohol content in wines. This also affects the aromatic profile, reducing freshness and increasing the intensity of ripe fruit notes. Unstable weather conditions make it difficult to plan the harvest, which is critical for rosé wines, where the timing of the grape harvest determines the colour and aroma.

Climate change is also causing a shift in the aromatic profile of rosé wines. Instead of the pronounced notes of fresh red berries (strawberries, raspberries) characteristic of traditional examples, tones of overripe fruit, jam and even caramelised hints are becoming increasingly common. This transformation significantly reduces the quality of the product in the eyes of consumers who prefer a light, refreshing style of wine.

Technological adaptations in the production of rosé wines

There are several technological solutions for producing rosé wines:

- short maceration
- the Saignée method
- pressing whole bunches
- co-fermentation of must obtained from red and white grape varieties
- there is also a method used mainly outside the EU (except for the production of rosé champagne), in which rosé wine is made by blending red and white wines.

The technological technique of short maceration for the production of rosé wines.

Maceration is an important stage in winemaking technology, which involves the extraction of colour, aromatic components and phenolic compounds from grape skins during interaction with the juice. A distinctive feature of rosé wine production is the use of short maceration, which allows for an optimal balance between colour intensity and flavour character without significantly affecting the tannins.

The maceration process for rosé wines lasts from several hours to several days, usually within 6–12 hours, which is significantly shorter than for red wines, where this stage lasts longer. The duration of maceration determines the colour intensity and aromatic profile of the final product, which varies from light pink to more saturated shades [32].

The main stages of the technological process in the production of rosé wines by short maceration are grape crushing: grapes used for rosé wine production are mechanically pressed or crushed to obtain juice that comes into contact with the skins. In the second stage of maceration, the juice, together with the skins, is kept in special containers, such as vats or presses. The interaction of the juice with the skins for a short time ensures the extraction of colour and aromatic compounds that form the lightness and freshness of taste characteristic of rosé wine [32]. Controlling the temperature and duration of maceration allows the

intensity of colour and aroma to be adjusted. Then pressing begins: after the maceration process is complete, the juice is separated from the skins by pressing, which allows purified juice to be obtained for further fermentation. And at the final stage, fermentation takes place: the resulting juice is fermented at a controlled temperature, which ensures the preservation of the delicate aromatic and taste characteristics characteristic of rosé wine [33].

Thus, short-term maceration is the main technological technique in the production of rosé wines, which allows obtaining wines with moderate colour intensity and a pronounced fruity aroma, while preserving their lightness and freshness.

The “saignée method” technological technique for the production of rosé wines

The saignée method (from the French saignée, meaning “bleeding”) is one of the popular technological techniques for the production of rosé wines, which consists in partially bleeding the juice from the red wine production process in the early stages of fermentation. This method allows you to obtain wines with a more intense colour and rich aroma, while preserving the characteristic freshness and lightness inherent in rosé wines [34].

In the Saignée method, the juice that comes from the first pressing of the grapes, after crushing and initial maceration (usually from a few hours to a few days), is partially drained to reduce the amount of liquid that will remain in contact with the skins. This makes the maceration process more intense for the rest of the juice, which is used to make red wine, while the drained juice is used to make rosé wine [35].

The main stages of the Saignée method: in the first stage, the grapes are crushed and macerated: after harvesting, the berries are crushed and the juice comes into contact with the skins, allowing the extraction of colouring substances, aromatic components and tannins. The duration of this stage may vary, but for the Saignée method, this process is usually limited to a few hours or a day. In the second stage, part of the juice is drained: after a certain period of maceration, part of the juice is drained from the skins and poured into separate containers for further fermentation as rosé wine. Draining reduces the amount of juice in contact with the skins, thereby increasing the concentration of extracted components in the remaining juice intended for red wine production. After draining, pressing begins: the residual juice used for red wine production is further pressed to obtain the required volume of liquid. And at the final stage, fermentation takes place: the drained juice for making rosé wine undergoes fermentation at a controlled temperature, which helps to preserve the freshness and fruity aromas characteristic of this type of wine [36].

Advantages of the Saignée method: The Saignée method produces rosé wines that are more colourful and

aromatic than those produced using traditional maceration, while retaining their lightness and finesse. In addition, this method is cost-effective for winemakers, as it allows them to produce both red and rosé wines from a single batch of grapes, and also provides a higher level of extraction in red wines due to the draining of part of the juice [37].

Thus, the Saignée method is an important technological technique in the production of rosé wines, which allows wines with high aromatic and colour intensity to be obtained while preserving their lightness and characteristic freshness.

The technological technique of whole cluster pressing for the production of rosé wines

Whole cluster pressing is one of the traditional technological techniques used in the production of rosé wines, which consists of processing grapes without prior crushing. This method minimises the extraction of tannins and phenolic compounds from the grape skins, while preserving the lightness, freshness and aromatic purity of the wine. Whole bunch pressing is mainly used for the production of wines from high-quality grape varieties and is an important step in the production of wines with a delicate and refined taste.

Whole cluster pressing differs from the traditional method, where grapes are crushed to obtain juice. In this case, the grapes are harvested and fed into the press without prior crushing. This allows for juice with less intense colour and less tannins compared to methods where grapes are crushed or macerated.

Whole cluster pressing technology

The process begins with the harvesting of grapes — either manually or mechanically, with the mandatory selection of ripe and healthy berries. Next, the whole clusters are sent to the press, where they are crushed without prior crushing. This separates the juice from the solid parts with minimal contact with the skin, reducing the extraction of tannins and phenolic compounds. The resulting juice is lighter in colour, retains its freshness, fruity aroma and delicate taste, which is important for the production of rosé wine. After pressing, the must undergoes controlled fermentation at low temperatures to preserve the aromatic purity and lightness of the style [39].

Whole cluster pressing is particularly valued in the production of high-quality rosé wines. It allows for the production of a clear, fresh and balanced wine with a refined colour and pronounced fruity notes, avoiding the harshness associated with excessive extraction. This style is characterised by elegance and suitability for consumption at a young age [51].

The technological technique of co-fermentation of must obtained from red and white grape varieties for the production of rosé wines

Co-fermentation of must obtained from red and white grape varieties is one of the innovative technological techniques used in the production of rosé

wines. Co-fermentation is usually aimed at ensuring the optimal combination of the properties of both red and white grape varieties, which enhances the flavour and aroma of the finished product.

The co-fermentation method involves the use of must obtained by mixing the juice of red and white grape varieties before the fermentation process begins. This technique allows for the production of rosé wines that combine the lightness and fruitiness of white wines with the aromatic and colour characteristics of red varieties. Co-fermentation can also be used to create wines with a softer colour, as white varieties help to reduce the intensity of the colour that normally occurs during the maceration of red varieties [50].

The main stages of co-fermentation technology: as in previous methods, the grapes are harvested: both red and white grape varieties are used for co-fermentation, which are harvested simultaneously or during a period that allows the optimal balance of acidity and sugar to be maintained. An important stage is the careful sorting of the berries to avoid damaged or unripe grapes. Usually, white grapes are pressed without contact with the skins, while red grapes may remain in contact with the skins for some time to extract colour and aromatic components. The juices obtained from red and white varieties are blended before fermentation begins. This blending allows the desired level of colour and aroma characteristic of rosé wines to be achieved, but with the lightness and freshness typical of white wines. The blended must is fermented at a controlled temperature in the range of 16–20 °C. This stage is important for preserving aromatic purity and freshness. Fermentation can last from a few days to several weeks, depending on the desired characteristics of the wine. After fermentation is complete, the must is aged in special containers, such as steel tanks or wooden barrels, to improve its structural and organoleptic properties. After ageing, the wine is filtered to remove yeast residues and other particles [49].

One of the main advantages of the co-fermentation method is the ability to create wines with a harmonious structure and a rich aromatic profile. Blending red and white grape varieties allows the properties of each variety to be combined while retaining the lightness and bright fruitiness characteristic of rosé wines. This method also produces wines with a more delicate colour, ranging from pale pink to light coral, depending on the proportions of the varieties used.

Co-fermentation allows winemakers to create wines with excellent acidity, which enhances their freshness and ageing potential, as well as intense aromas ranging from fruity to floral notes. In addition, this method is cost-effective as it allows different grape varieties to be used to create a single product without the need for additional maceration or blending of different batches of wine.

The technology of co-fermentation of must obtained from red and white grape varieties is an important tool in the production of rosé wines, allowing to achieve an optimal balance of colour, aroma and taste. This method makes it possible to create wines with a refined and balanced flavour profile, while retaining their characteristic freshness and lightness, making them ideal for consumption at a young age.

The technological technique of blending red and white wines to produce rosé wines outside the EU

The method of producing rosé wines by blending red and white wines is a technique used mainly outside the European Union, particularly in New World countries such as Australia, the United States, South Africa and some other regions. The exception is the production of rosé champagne, where this process is regulated by strict standards. This method is an alternative to traditional techniques such as maceration or co-fermentation of must [41].

The method of blending red and white wines involves combining already produced wines (red and white) before filtration and packaging. This allows the desired colour and taste characteristics to be achieved without the need for additional maceration or fermentation stages. An important advantage of this method is the speed and simplicity of the process, which allows producers to obtain finished wine in a shorter time.

The main stages of the blending technology are as follows:

- Production of red and white wine: First, red and white wines are produced separately using traditional methods for each type. Red wine undergoes maceration and fermentation with the skins to extract colour and tannins, while white wine is made from white grapes that have not been in contact with the skins.
- Blending of wines: Once both wines have completed the fermentation and ageing process, they are blended in the required proportions to achieve the desired colour, taste and aroma. Blending can be carried out both between different batches of the same year and between different vintages.
- Filtration and stabilisation: After blending, the wine is filtered to remove yeast residues and solid particles. The wine can then be stabilised through additional processing steps to prevent sediment formation and ensure clarity.
- After stabilisation, the wine is bottled and ready for sale. As the blending method is quick and simple, it can be used to produce large volumes of wine [42].

The method of blending red and white wines is cost-effective because it allows you to obtain a finished wine without the need for additional fermentation and maceration steps, which reduces time and resource costs. Blending already produced wines allows you to precisely control the level of colour, taste and aroma,

which is especially important for obtaining a stable and predictable end product.

This method also makes it possible to produce wines with a more intense colour and a greater aromatic profile compared to traditional methods of making rosé wines, such as maceration or co-fermentation. Blending wines allows you to quickly obtain wine with the desired characteristics, making this process popular in countries where there is a demand for mass production.

However, it is important to note that the method of blending red and white wines has certain limitations. Since this process does not involve the influence of red grape skins on the juice during fermentation, which is characteristic of traditional methods of rosé wine production, the result may be less intense in terms of colour and aromatic characteristics. In addition, this method does not allow for the same depth and structure of wine that can be achieved through more complex technologies such as maceration or co-fermentation.

An interesting project is the cross-border cooperation between French and Italian winemakers. Two major global competitors are seeking to work together to raise the profile of this category of wines by creating great rosé wines. The alliance envisages the production of wines that can be aged for years, like the most prestigious whites and reds, rather than consumed immediately, like the vast majority of rosés around the world. One of the leaders of this movement, Philippe Gigal (president of the French association Rosés de Terroir and owner of Château d'Aquéria in the Tavel appellation), expects that such diversification of offerings will enable producers to highlight their terroir, positioning themselves as a highly valued niche market, and the creation of a micro-market for rosés capable of ageing for a decade is now an idea that can be seriously considered [43].

Rosé wine is traditionally considered a young, fresh wine intended for consumption shortly after production. According to analysts, today's market is expanding due to the growing category of aged wines. In particular, producers are experimenting with the length of ageing in the bottle, allowing the wine to develop greater complexity while retaining the refreshing acidity characteristic of the style, and in the Bandol region, winemakers are introducing the production of wines designed to be aged for several years. Such wines demonstrate depth of flavour with evolving notes of dried fruit, herbs and even a savoury umami character. Given that rosé wine producers in France and Italy are uniting under the umbrella of Rosés de Terroir, this category is likely to grow in the future [44].

Thus, the choice of technological approach to rosé wine production is determined by the desired sensory characteristics of the final product, economic factors and regional winemaking traditions. Each method has its own advantages and limitations that affect the quality and style of the resulting wine.

The quality of rosé wines depends largely on their phenolic composition, in particular tannins, anthocyanins and their derivatives, which determine their perceived colour and its change during storage periods. In rosé wine, which is produced with very short maceration, only a limited amount of colouring substances is extracted from the grape skins into the must. However, the lack of stable anthocyanin-phenolic complexes and the predominance of monomeric anthocyanins often lead to a decrease in colour stability. Bilko M.V. notes [20] that the main problem in rosé wine technology is their susceptibility to oxidation, which manifests itself in the destabilisation of organoleptic indicators and is a consequence of oxidative processes accompanied by the appearance of unpleasant yellow, orange or brown hues in the colour, loss of aroma and harmony of taste. The colour stability of rosé wines can depend on various factors, including grape variety, maceration time and the molar ratio between anthocyanins and tannins (extracted from berries or added during winemaking). In addition, dissolved oxygen and reactions involving the above-mentioned phenolic compounds can play a significant role in colour evolution. High concentrations of anthocyanins can lead to a sharp loss of colour due to oxidation; an excess of polyphenols can also negatively affect the aroma of wines due to the possible formation of quinones, which can oxidise volatile compounds and varietal aromas, such as thiols, leading to aromatic losses. Such changes in the life of wine are mainly caused by enzymatic and chemical oxidation, exacerbated by the undesirable influence of oxygen during winemaking processes or through the gradual entry of oxygen through the cork.

To preserve the colour and aroma of rosé wines, the following measures are taken:

- use of antioxidants such as gallic tannin and glutathione;
- minimisation of contact with oxygen at all stages of production;
- non-thermal technologies, such as ultrasound or membrane filtration, to remove unwanted impurities [55].

To produce an exquisite rosé wine with an attractive colour, delicate aromas and a refreshing, harmonious taste, it is not enough to choose the right time to harvest the grapes in order to find the ideal compromise between mass acid concentration, potential ethyl alcohol content, technological ripening of phenolic substances and prepare the wine for fermentation and vinification under optimal conditions. It is equally important to take all necessary measures to protect the colour and aromatic components at all stages of the wine's life cycle from significant degradation, based on the most well-known production philosophies and modern technological practices based on studied parameters that can determine the desired end result [46].

Table 3 presents the influencing factors, technological practices and auxiliary materials that ensure the quality of rosé wine at different stages of production, contribute to its style and lay the foundation for its development and viability, in particular, influence the preservation of aroma and colour [47].

Table 3. Some factors affecting the quality of rosé wine

Production stages	Factors	Auxiliary materials
Grape harvesting and transport	Grape variety, ripeness and sanitary condition	To prevent the action of oxidising enzymes and control the oxygen level in wine materials, it is advisable to use antioxidants. In particular, complex preparations containing metabisulphite, gallic tannin and ascorbic acid are effective. An alternative approach is to use bioprotection based on Metschnikowia yeast, which is especially important in cases of combine harvesting or bulk transportation.
Maceration	Duration, temperature, extraction modes of phenolic/colouring substances and aroma precursors	Sulphur dioxide, addition of enzymes to improve the extraction of aromatic and colouring substances and/or clarification of the wort
Obtaining must	Pressing and fractionation modes for separating polyphenolic fractions	Sulphur dioxide, inert gas, glutathione-based preparations, gallic tannin.
Clarification of must	Control of temperature and duration for the extraction of aroma precursors; removal of oxidised and oxidation-prone compounds; acidity adjustment. The clarity of the clarified must is 80–200 NTU (Nephelometric Turbidity Units, an indicator of the clarity of must or wine measured by a nephelometer) depending on the style of wine.	Biological protection in case of stabilisation; polyphenol management: plant-based protein in combination with bentonite or silica gel, bentonite + PVP (polyvinylpyrrolidone — a sorbent used to remove phenolic compounds and stabilise wine colour); complex preparations consisting of bentonite + PVP + plant-derived protein or chitosan + plant-derived protein.
Alcoholic fermentation	«Nutritional status of the must» (nutrient content), vinification temperature, yeast strain	Pure yeast cultures (specially selected yeast strains that ensure controlled alcoholic fermentation and the formation of the desired aromatic profile) to reveal a specific aromatic style. Nutrients to strengthen yeast cell membranes during rehydration, ensuring optimal fermentation kinetics and revealing the aromatic profile. Oak alternative as an antioxidant.
Decanting wine materials from complete yeast sediment	Decanting period (up to 5 days after the end of fermentation)	Tannins with antioxidant activity, sulphitation regimes
Sur lie Aging on yeast sediment (French: sur lie) is a technological method of aging wine on a thin layer of yeast to give it a complex aroma and taste.	Aging period and battonage regimes, storage temperature (10-15°C) and microbiological status.	Sulphur dioxide, an oak alternative, as an antioxidant. Use of inactivated yeast as an alternative to natural yeast.
Processing before bottling	Susceptibility to cloudiness, dose selection for stabilising wine materials. Processing and filtration modes.	Sulphur dioxide, inert gases during the transfer of wine materials, bentonite + plant-based proteins, preparations based on polyaspartate or CMC (carboxymethylcellulose — a stabiliser used to prevent tartar crystallisation) to stabilise against tartar crystal precipitation.
Bottling	Filling machine and filtration modes, corking methods, bottle glass colour	Sulphur dioxide, inert gases.
Storage of finished products	Temperature, humidity, light exposure	

Table 3 focuses on the use of antioxidants and bioprotective agents to prevent the oxidation of phenolic compounds, regulate the extraction of aroma precursors, optimise the clarity of must, and stabilise wine materials before bottling.

The use of modern technological approaches (enzyme preparations, pure yeast cultures, oak alternatives, inactivated yeast) ensures the formation of the desired aromatic style of rosé wine and increases its viability during storage

Conclusion

1. The global and national market for rosé wines is showing stable positive dynamics. The growth in production and consumption worldwide is driven by changing consumer preferences, the popularity of light and fresh wines, the development of wine tourism, and improvements in product quality. In Ukraine, there has been an expansion in the range of rosé wines, including sparkling and non-alcoholic wines, the formation of a premium segment, and a growth in the culture of consumption.

2. The technological practices of rosé wine production determine their style, colour and aromatic profile. Key quality factors include the duration and

temperature of maceration, the choice of yeast strain, the level of oxidation control, and the use of antioxidants, bioprotective agents and stabilisers. The classification of modern rosé wine styles (Fruit Driven, Provençal, Floral, Reserve, etc.) demonstrates that controlling technological parameters allows for the targeted formation of the desired sensory profile and style of the product.

3. Climate change has a significant impact on viticulture and winemaking, altering the chemical composition of grapes, ripening times, acidity and aromatic structure. Adapting to these challenges requires the implementation of comprehensive solutions – the selection of resistant varieties and rootstocks, the optimisation of irrigation, the use of shade systems and smart farming technologies, and the use of antioxidants and the latest stabilisation methods during production.

4. The integration of innovative technologies and adaptive practices in winemaking will ensure the sustainability of rosé wine production, preserve their sensory characteristics and increase their competitiveness in the global market. The further development of the rosé wine segment in Ukraine should be based on a combination of scientific approaches, marketing orientation and environmental responsibility.

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РИНОК РОЖЕВИХ ВИН ТА АДАПТАЦІЯ ВИНОРІБСТВА ДО КЛІМАТИЧНИХ ЗМІН

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Анотація. У статті проведено комплексний аналітичний огляд сучасного стану та перспектив розвитку ринку рожевих вин у світовому й українському вимірах з урахуванням впливу кліматичних змін. На основі даних міжнародних організацій, профільних досліджень і ринкових оглядів систематизовано динаміку виробництва, споживання та експорту, виокремлено провідні регіони й сегменти та окреслено ключові чинники ціноутворення. Теоретично-практична частина дослідження охоплює класифікацію стилів рожевих вин, роль кольору як сенсорного й маркетингового маркера, а також технологічні підходи, що детермінують органолептику (короткочасна мацерація, метод Сен'є, пресування цілими гронами). Окремо проаналізовано вплив кліматичних змін на агрономічні та хімічні показники винограду — зміни температурного режиму, дефіцит вологи, частота екстремальних погодних явищ і наслідки для цукро-кислотного балансу, ароматичної структури та стабільності урожаїв. У статті оцінено адаптаційні стратегії: селекційний підбір сортів і підщеп, точне зрошення, тінюві й крона-менеджментні практики, а також виноробні інновації (контроль ферментації, мікрооксигенація, мембранні технології для очищення), які дозволяють знижувати негативні ефекти кліматичних змін та зберігати стилістичну цілісність продукції. На прикладі аналізу асортименту українського онлайн-ринку виявлено тенденції до диверсифікації пропозицій, зростання преміальних позицій і розвитку ігристих та безалкогольних альтернатив. Зроблено висновок, що інтеграція науково обґрунтованих агротехнологій, підтримка інституційних ініціатив і орієнтована маркетингова стратегія є ключовими чинниками підвищення конкурентоспроможності сегмента та формування національної ідентичності українських рожевих вин.

Ключові слова: рожеві вина, кліматичні зміни, світовий ринок, ціноутворення, стилі рожевих вин, колір, ринок рожевих вин, стиль, технологічні прийоми.