

RESEARCH REGARDING THE INFLUENCE OF CLIMATIC FACTORS ON THE QUALITY OF RED WINES FROM RĂTEȘTI, SATU MARE VINEYARD

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ABSTRACT

The main climatic factors influencing the physiological and biochemical processes that take place during the growth, formation, and ripening of grapes are temperature, humidity, and duration of sun exposure. Grape varieties react differently to temperature variations, and in the context of global warming, the possibility of producing quality red wines has expanded to new wine-growing areas in northern Romania. Light is another important factor, especially in red wine production. Humidity and rainfall allow grapes to grow during the summer and accumulate sugars, mineral salts, and acidity in the grape berries. The study attempts to present the influence of these factors throughout 2024 on the quality of red wines from the Rătești vineyard in Satu Mare.

INTRODUCTION

Beltiug Commune, located in Satu Mare County, is a rural community with deep-rooted traditions, situated in the north-west of Romania. It comprises the villages of Beltiug (the administrative center), Rătești, Bolda, Ghirisa, Giungi, and Șandra. Its favorable geographical position, rich viticultural history, cultural heritage, and the socio-economic transformations over time give this area special significance for studying the interaction between the environment, culture, and rural development.

The commune is located in the southern part of Satu Mare County, near the Crasna River, at the junction between the Crasna Plain and the western slopes of the Codru Hills. It lies approximately 35 kilometers from the municipality of Satu Mare, along the European route E81. The administrative territory covers about 11,703 hectares, of which roughly 897 hectares are designated as built-up area, the remainder consisting of agricultural land and pastures.

The region is characterized by a moderately temperate-continental climate, with warm summers and cold winters, yet without notable climatic extremes. During the cold season, approximately 50–60 days record temperatures below zero degrees Celsius. The average annual precipitation is around 600 mm, concentrated mainly in the spring and summer seasons. The high number of sunny days and relatively low cloud cover provide favorable conditions for viticulture.

The earliest documented references to Beltiug date back to 1216, recorded in the ecclesiastical registers of Oradea, confirming the settlement's significant historical status. In the 15th century, the estate came under the ownership of the

noble Drágfi family, which added the name “Beltiug.” In the modern era, the agricultural lands and viticultural potential were intensively exploited, contributing to the locality’s economic development. (Balasz et al, 2021)

The practice of vine cultivation in the area has deep roots. Local sources mention that the hills surrounding Beltiug and the village of Rătești were used for vineyards as early as the 18th century. The colonization with Swabian settlers, initiated by Count Károlyi Sándor, stimulated the expansion of vineyards and the development of enduring oenological traditions. After 1989, following socio-economic changes, a considerable part of the vineyard area was either abandoned or fragmented and cultivated on a family scale. In recent decades, initiatives have been launched to revitalize the sector, among which the Nachbil Winery stands out for combining tradition with modern technologies.

Rătești village is one of the most important viticultural localities within Beltiug Commune, being part of the vineyard landscape of the Sătmăr Hills. The fertile soils and specific microclimate provide favorable conditions for cultivating noble grape varieties, suitable for both white and red wines. Moreover, the traditional wine cellars used for wine storage represent a distinctive feature of the local architecture and cultural heritage.

Beltiug preserves a remarkable cultural heritage, which includes historic religious edifices and traditional structures. A notable example is the Roman Catholic church in the center of the commune, built in 1481, considered one of the oldest places of worship in the area and holding exceptional aesthetic and symbolic value. The commune also features numerous cellars carved into the hillsides, serving both viticultural purposes and tourist and cultural activities. Among the emblematic events are the Wine Festival and the “Sătmăr Wine Route” project, which promote the region’s winemaking traditions and attract visitors. (Balasz et al, 2021)

The region faces challenges typical of rural areas: the reduction of vineyard surfaces after 1989, labor migration, underdeveloped infrastructure, and the need to modernize agricultural and viticultural technologies. Nevertheless, there are promising prospects for economic revitalization through the valorization of viticultural potential, the promotion of rural tourism, and the improvement of wine quality. Recent initiatives, such as the activity of the Nachbil Winery and the involvement of other local producers, are key factors in the recovery and diversification of the rural economy (Burdea, 2021)

MATERIAL AND METHODS

During 2024, the following climatic characteristics were recorded in the Rătești-Nachbil vineyard: daily temperature, daily maximum and minimum temperatures, daily relative humidity, precipitation in millimeters, annual maximum and minimum precipitation, cloud cover, wind speed in km/h, and daily wind direction. The data were analyzed to determine the minimum, maximum, and average temperatures for each month, the monthly average precipitation, the number of sunny days, and the average wind speed. Physico-chemical characteristics of red wines from Rătești vineyard was determinate according with OIV methods: total acidity OIV-MA-AS313-01, volatile acidity OIV-MA-AS313-02 and alcohol content pycnometry method OIV-MA-AS312-01A (Compendium of International Methods of Wine and Must Analyses, 2021).

RESULTS AND DISCUSSION

The annual average temperature is 10 °C, the total precipitation is 780 mm, and the oenoclimatic index of 4899 indicates favorable conditions for cultivating red grape varieties and achieving good results in red winemaking (Tab. 1)

Table 1
Climatic Description of the Rătești Vineyard – Satu Mare (Hodor et al., 2010)

Latitude	Altitude	Annual Average Temperature (°C)	Total Annual Precipitation (mm)	Total from April 1 – October 30			Oenoclimatic Index $A = T + I - (P - 250)$
				T	I	P	
				Temperature (°C)	Effective Sunshine Hours (h)	Precipitation (mm)	
4758	145	10	780	3708	1314	373	4899

Throughout 2024, the data were recorded and summarized in Figure 1.

The graph shows that the highest temperatures were recorded in July and August, approaching 40 °C; the largest amounts of precipitation occurred in September, after the harvest period; the highest humidity levels were observed during the winter months of January–February and December; and the strongest winds were also recorded in the winter period, specifically January–February 2024 and December 2024–January 2025. The number of sunny days compared to cloudy days was higher throughout 2024.

Considering the climatic conditions required for producing high-quality wines—namely, that during grape ripening until harvest there should be no excessive temperatures, low humidity, no abundant precipitation, no early frosts, and no hail during grape formation—we will further analyze the monthly intervals of March–May, when grapes form, and June–August, when grapes reach ripening and maturity.

In April 2024, the temperature values recorded in Rătești showed moderate variations, with daily averages ranging between 10–15 °C, while maximum temperatures frequently exceeded 20 °C during the second half of the month. Minimum values were generally between 5–8 °C, with slight decreases at the beginning of the period. This month was characterized by a gradual temperature increase, typical for the transition to the warm season.

Precipitation amounts were relatively low but irregularly distributed, with short rainfall events occurring around April 6th, 13th, and 26th. For the rest of the month, the days were mostly clear or partly cloudy, and wind speeds remained low to moderate. These weather conditions favored the onset of vine vegetation and the accumulation of heat required for early phenological development.

In May 2024, higher temperatures were recorded, with maximum values often reaching 25–28 °C, and minimums remaining around 10–12 °C. However, the graph shows a more pronounced temperature fluctuation, alternating warm periods with brief cooling episodes

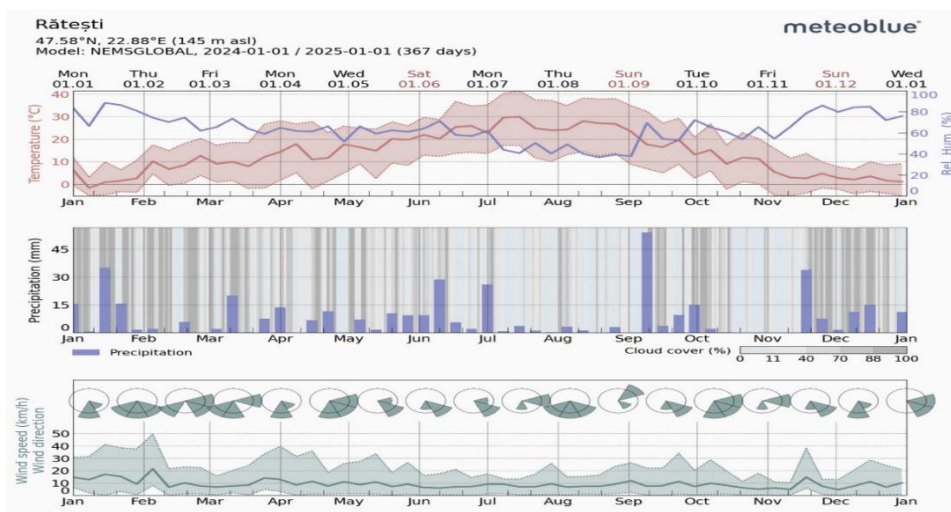


Figure 1. Climatic Data for the Rătești – Satu Mare Vineyard, January 1, 2024 – January 1, 2025 (Source: www.meteoblue.com)

Precipitation was slightly more significant than in April, with rainfall events recorded at the beginning and end of the month. Cloud cover ranged between 30–70 %, and wind intensity slightly increased compared to the previous month. Overall, May was warmer and more thermally stable, with moderate atmospheric humidity, favorable for vegetative growth processes. In summary, the climatic conditions recorded during April–May 2024 in the Rătești vineyard were favorable for vine development, without extreme drought or excessive rainfall events. (Fig.2)

Table 2 presents the average maximum and minimum air temperatures recorded in April, May, and June. The average maximum temperature increases from 20.59 °C in April to 24.61 °C in May and 28.43 °C in June. Similarly, the average minimum temperature rises from 6.57 °C in April to 10.65 °C in May and 14.7 °C in June, showing a clear warming trend during the spring months.

Table 2
Average Maximum and Minimum Air Temperatures in April, May, and June

MAXIMUM			MINIMUM		
April	May	June	April	May	June
20.59 °C	24.61 °C	28.43 °C	6.57 °C	10.65 °C	14.7 °C

During the vegetative growth period, a negative temperature was recorded on April 22, and near-freezing temperatures occurred on seven days throughout April. These low temperatures can negatively affect grape quality by damaging buds and flowers: spring frost impacts vine buds and flowers, which are highly sensitive to low temperatures, leading to reduced yields or even complete crop loss. Extremely low temperatures can halt plant growth, preventing the normal development of shoots and grape clusters.

Late frosts, occurring after the vine has started growing, can cause significant losses in grape production. Cellular-level damage: Frost causes cellular damage within plant tissues, affecting the health and vitality of the vine. (Tab. 3)

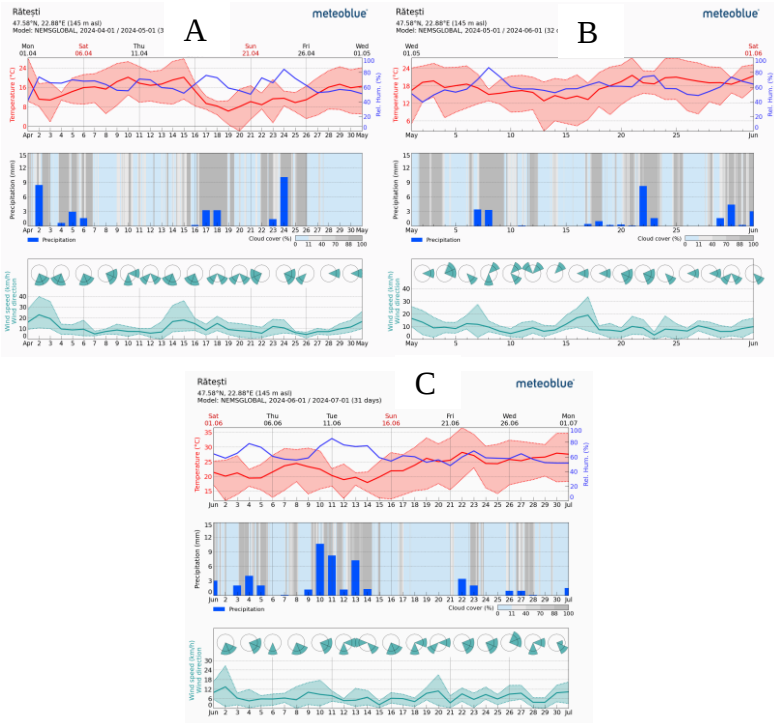


Figure 2. Climatic Data for the Rătești – Satu Mare Vineyard: A – April, B – May, C – June (Source: www.meteoblue.com)

Table 3
Absolute Maximum and Minimum Temperatures in April, May, and June

ABSOLUTE MAXIMUM			ABSOLUTE MINIMUM		
April	May	June	April	May	June
28 °C	29 °C	35 °C	-1 °C	5 °C	9 °C

The three Meteoblue diagrams present a 14-day multi-model weather forecast for Rătești, focusing on key meteorological variables: temperature, precipitation and cloud cover, wind. These forecast graphs provide a comprehensive outlook of upcoming weather in Rătești, including temperature highs and lows, chances of precipitation, cloud coverage, and wind conditions.They are useful for planning agricultural activities. (Fig. 3)

During the grape ripening period—July, August, and early September—the grapes were exposed to high temperatures, with maxima of 39 °C in July, 38 °C in August, and 35 °C in September. (Tab.4)

The chemical constituents of grapes that are important for the quality of red wines form during this period. Very high temperatures can have negative effects on organic acids, leading to their degradation along with some aroma compounds. As a result, the wines may lose typicity, character, and fruitiness. Some anthocyanin pigments can deteriorate through oxidative processes occurring in the grape skins when environmental temperatures are very high (Popa A., 2016).

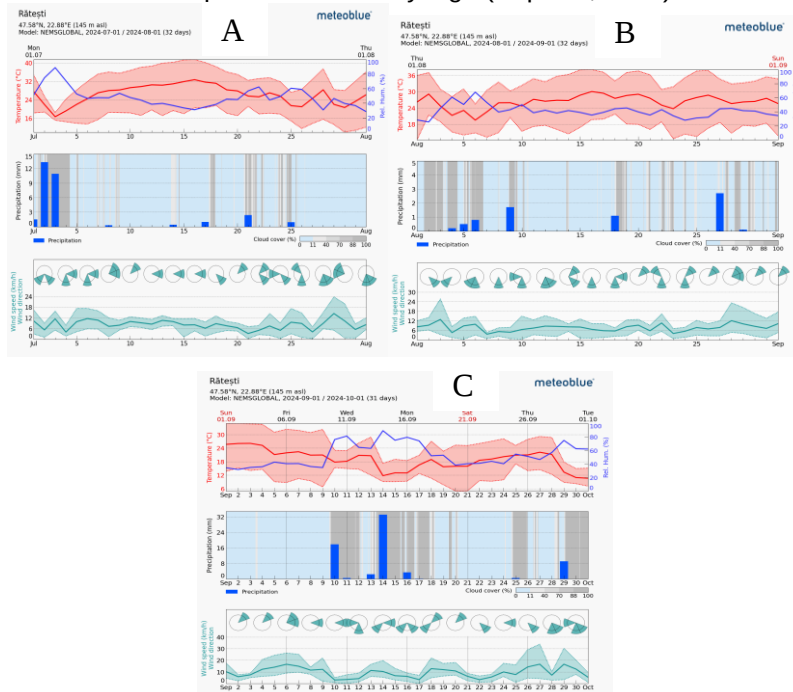


Figure 3. Climatic Data for the Rătești – Satu Mare Vineyard: A – July, B – August, C – September (Source: www.meteoblue.com)

Table 4
Average Maximum and Minimum Air Temperatures in July, August, and September

MAXIMUM			MINIMUM		
July	August	September	July	August	September
31.62 °C	32.67 °C	25.7 °C	16.56 °C	14.96 °C	12.12 °C

The differences between absolute maximum and minimum temperatures for July–September were 29 °C for July, 28 °C for August, and 30 °C for September, falling within optimal ranges for producing high-quality wines. Relative humidity did not drop below 40 % at the beginning of August and ranged between 40 % and 60 % during July–September, with slight peaks approaching 80 % on rainy days in early July and mid-September.

Overall, the soil water regime was favorable, preventing thermal and water stress for the vines cultivated in the Rătești – Satu Mare vineyard. (Tab. 5)

Table 5

Absolute Maximum and Minimum Temperatures in July, August, and September

ABSOLUTE MAXIMUM			ABSOLUTE MINIMUM		
July	August	September	July	August	September
39 °C	38 °C	35 °C	10 °C	10 °C	5 °C

Characterization of Red Wines Produced in the Rătești Vineyard, 2024

In both vineyards included in the study, the total acidity of the red wines recorded similar values, ranging between 10 and 12 g/L of tartaric acid. These values are characteristic of high-quality wines suitable for aging. Total acidity consists of all the acids present in the wine, both in free and bound forms. Nevertheless, the total acidity is higher in wines from the Rătești vineyard compared to other Romanian wines, giving them a distinctive typicity and authenticity. The higher values are also attributed to the freshness of the wines produced. (Tab. 6)

Table 6

Total Acidity, Volatile Acidity, and Alcohol Content of Wines from the Nachbil Winery

Nachbil Winery	Total Acidity (g/L tartaric acid)	Volatile Acidity (g/L tartaric acid)	Alcohol Content (Vol %)
Syrah	11	1,8	14,5
Merlot	10	1,1	13,5
Burgund Mare	12	1,6	13
Cabernet Sauvignon	11,6	1,3	13,5

The volatile acidity is higher compared to red wines obtained from other vineyards. Volatile acids, formed during fermentation processes, increase throughout the entire fermentation period. When expressed as tartaric acid, the values remain within the normal limits for high-quality red wines. Another important aspect is the fixed acidity, calculated as the difference between total acidity and volatile acidity. High levels of fixed acidity indicate wines that are more resistant to various diseases that may occur during aging and maturation, ensuring better long-term preservation. (Tab. 7)

Table 7

Total Acidity, Volatile Acidity, and Alcohol Content of Wines from the Teodor Winery

Teodor Winery	Total Acidity (g/L tartaric acid)	Volatile Acidity (g/L tartaric acid)	Alcohol Content (Vol %)
Feteasca Neagra	11,2	2,4	12.7
Pinot Noir	10,7	1,8	13,3
Cabernet Sauvignon	12	1,2	13,5
Cadarca Roșie	10,2	1,3	12.5

The alcohol content is high in all analyzed wines, ranging from 12.5 vol% in *Cadarcă Roșie, Teodor* to 14.5 vol% in *Syrah* from Nachbil. The elevated alcohol content is due to the high sugar concentration accumulated in the red grapes at veraison, as well as to a properly managed alcoholic fermentation process without interruptions. The indigenous and selected yeasts used during fermentation predominantly yield dry red wines with a high potential for aging

CONCLUSIONS

By correlating the climatic data with the physicochemical characteristics of the red wines produced, we can conclude that the red grape varieties cultivated in the Rătești vineyard accumulate valuable compounds in significant quantities.

Through proper winemaking technologies—using both selected and indigenous yeasts and by maintaining strict control over alcoholic fermentation—it is possible to produce wines that are typical of the Rătești vineyard, with high aging potential and long maturation capacity.

The phenomena of global warming have made it possible for a region in north-western Romania, which 20 years ago offered suitable conditions only for white grape varieties, to become favorable for the cultivation of red grape varieties.

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REFERENCES

Balasz A., Domjan L., Csengeri E. R. 2021. *Carte podgoriilor sătmărene și a vinurilor nobile Satu Mare*. Editura Locală, Satu Mare. ISBN 978-973-0-35836-0.

Burdea R. O. 2021. *Condiții de calitate pentru soiurile de struguri negri pentru vinuri roșii din Transilvania în vederea încadrării în D.O.C.* Teză de doctorat, Universitatea de Științe Agricole și Medicină Veterinară, Cluj-Napoca.

Compendium of International Methods of Wine and Must Analyses. 2021. *International Organisation of Vine and Wine (OIV)*, Paris.

Hodor D., Pop N., Babeș A., Călugăr A., Ciobanu F. 2010. *Climate suitability of Rătești–Beltiug viticulture area to cultivate varieties of grapes for red wines*. *Bulletin UASVM Horticulture*, 67(1), 1843–5254 (Print), 1843–5394 (Online).

Popa A. 2016. *Secretul vinului bun*. Editura Alma, Craiova, pp. 127–136.