TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 67, Issue Special II, Jully, 2024

RESEARCH REGARDING SUSTAINABLE PRACTICES AND RISK MANAGEMENT IN FERMENTATIVE INDUSTRY

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Abstract: *In the context of climate change, the whole world needs to change and fermentative industry must change too. As the concept of sustainability surrounds us more often, on a day-to-day basis, the need to incorporate it into our factories and research becomes more important. This research incorporates the key concept of sustainability through its values into fermentative industry, using climate change in our favor. In Romania, the viticultural areas are renown, yet the climate change had made its impact. Characterized at some level by unpredictability, despite the trend of high temperatures during winters, there are cases where optimal temperatures for ICEWINES were reached. With a risk management system alongside, the wine industry can reach a new segment of clients providing quality and sustainable wines.*
Key words *Sustainability, fermentative industry, ice wine, Romania, risk management.*

1. INTRODUCTION

1.1. Sustainability

As the world is changing, technology is changing too, and so is the environment. There is no secret that for the last few decades, the concept of global warming is the center of attention when it comes to developing new technologies and new strategies. The United Nations has its own program to minimize the impact we have on our planet, both in personal lives and in industries, too. In 1987, the United Nations Brundtland Commission decided on defining the sustainability concept as “meeting the needs of the present without compromising the ability of future generations to meet their own needs”. This program is orientated towards 17 goals, which are proven to help both processes of developing, but also to improve the experience of living [1].

1.2 The technologies of wine making

When it comes to wine making, there are various technologies known, depending on the assortment to be obtained. We have both classical and innovative technologies. We have technologies for classical wines and for special ones.

One technology in particular that can be implemented during this change in climate is Ice wine Technology.

This technology has several requirements to be implemented. They may vary from country to country, thus for Romania they are:

- The temperature of -8°C must be reached for 3 consecutive days;
- The grapes must be healthy, without contamination with Botrytis Cinerea (grey mold).
- The grapes must be harvested and processed frozen;
- The sugar levels must be above 360g for one kilogram of grapes.

As these requirements are fulfilled, the technology can be adapted for the producer to obtain a quality wine, together with a good report between quality-production price.

If we talk about the buyer experience, the actual consumer generation is orientated towards unique experiences, which puts these special liqueurs above the classical ones, when it comes to the decisional process of buying [2].

1.3 Sustainability in wineries

In viticulture, sustainability refers to the application of environmentally friendly, socially responsible, and economically viable practices in grape growing and wine production. It involves balancing the needs of the vineyard ecosystem, the surrounding environment, and the well-being of the communities involved; production encompasses several key areas according to the UN 17 goals [1]:

- Soil Management;
- Water Conservation;
- Biodiversity Preservation;
- Integrated Pest Management (IPM);
- Energy Efficiency;
- Waste Management;
- Social Responsibility;
- Carbon Footprint Reduction;
- Certification Programs.

2. THE TECHNOLOGIES OF ICEWINES – AN. OPTION FOR CLIMATE CHANGE

2.1 Climate change in Romania

As stated before, the problem of climate change and its effects concerns every part of society, including industries. Many changes were made to have the ability to make the customer happy. In a world where there is a constant need for innovation, progress and unicity, industry must keep up with the trend, making compromises on the sustainable side.

In present days, when the focus is on preservation also, the producers must innovate and use their resources and Ice wine may be the answer in the wine industry.

As the climate changed, even though is a tendency towards global warming, this tendency comes with extreme variations unpredictable in the long term.

In Romania, like in many other countries, climate change is a real issue, which affects all sectors of life. It manifests in more than one way, such as: temperature increase, precipitation patterns, extreme weather events, water resources.

When it comes to temperature, the trend is towards longer hotter summers, with extreme differences from day to night. The winter days are fewer, with warmer temperatures, and with delays. It is known that in Romania, the winter months are December, January and February, yet the current trend is that the temperatures drop below 0℃ Celsius, after January 1st.

However, isolated cases have shown that colder temperatures can occur. In 2022, in Vrancea county, a known vineyard area, temperatures below -8℃ Celsius, have been achieved around Christmas.

If we talk about precipitation patterns and extreme weather events, the country deals with fewer rain days, and those tend to be stormy days. Drought is more frequent and it affects more and more of the country, among the diminution of water resources [3].

2.2 Sustainable icewine practices

Icewine, through its specific technology, can be the answer in using climate change in our benefit. Ice wine, on its own, is a unique experience, both when it comes to making it and tasting it, so it is the answer to the client's need: unicity. However, there are various ways to create this product in a sustainable way such as:

- Vineyard Management;
- Biodiversity Conservation;
- Water Conservation;
- Energy Efficiency;
- Waste Management;
- Social Responsibility;
- Certification Programs.

Sustainable practices in the vineyards have the main focal point on scaling down the use of synthetic pesticides and fertilizers, minimizing water consumption and protecting soil health. Integrated pest management techniques covering cropping and composting are commonly employed to promote natural pest control, enhance soil fertility and reduce erosion. [4]

Maintaining biodiversity is crucial for sustainable icewine production. Vineyards are implementing measures such as creating wildlife corridors, preserving native plants and protecting water sources to support a balanced ecosystem.

Encouraging beneficial insects and using natural pest control methods help reduce the

need for chemical interventions. Water is a precious resource, and sustainable icewine production involves efficient water management. Techniques like drip irrigation and moisture sensors can be used to optimize water usage, reducing waste and minimizing environmental impact. Wineries can employ energy-efficient practices to reduce their carbon footprint, including renewable energy sources such as solar power, implementing energy-efficient lighting and equipment, and optimizing winery operations to minimize energy consumption. Sustainable practices focus on reducing waste and promoting recycling.

Wineries can implement composting programs for grape pomace and other organic waste. Packaging materials should be selected with consideration for recyclability and environmental impact.

Sustainable icewine production also considers the social aspects of the industry. Fair labor practices, worker safety, and engagement with local communities are important considerations. Some wineries actively participate in community initiatives and support social causes. Various certification programs exist that set sustainability standards for vineyards and wineries. These programs assess and verify sustainable practices and provide guidelines for continuous improvement. Examples include organic certification, biodynamic certification, and sustainable wine certifications. [5]

3. THE RESEARCH METHODOLOGY (METHODS AND TOOLS)

Research was conducted in 2020, to obtain icewine, in Panciu town, Vrancea county, Romania. The area is known for its quality wines and for its winemaking culture.

The goal of the research was to determine if the area was suitable for sustainable ice wine making.

To conduct the research, the following steps were taken:

- Icewine technology research. As the country is not a notorious producer of ice wines, all the technologies known had to be consulted;
- Creating and adopting proper technology. The proper technology for the area and for the grape type had to be created and implemented. Sustainable practices were taken into consideration, too;
- Implementing the technology and recording the results. Starting from the begging of the year, temperatures were measured and recorded, all the unnecessary treatments were carried out and the vineyard was carefully taken care of and observed until December, when harvesting time came. The principles of sustainability were applied in production too.

3.1 Icewine technology used

In the graphics below it can be observed the technology used for the icewine process. It is shown that local varieties were used for the research, and a differential technology was used for red and white wines. On the other hand, the march was processed to obtain the subproduct, and nothing has been lost, but transformed. The classical machines were used to press the grapes and the harvesting was made manually, using special shears.

The grapes were collected carefully, in such manner that quality control was also made on the field.

The grapes that were attacked were removed. The pressing part was made on the field, as the temperature of the grapes had to be below freezing. The fermentation process was made in wood recipients for plastic-free technology, but for flavor reasons too. Also, wooden barrels were a wonderful way to preserve the tradition and ensure the social impact too. [6]

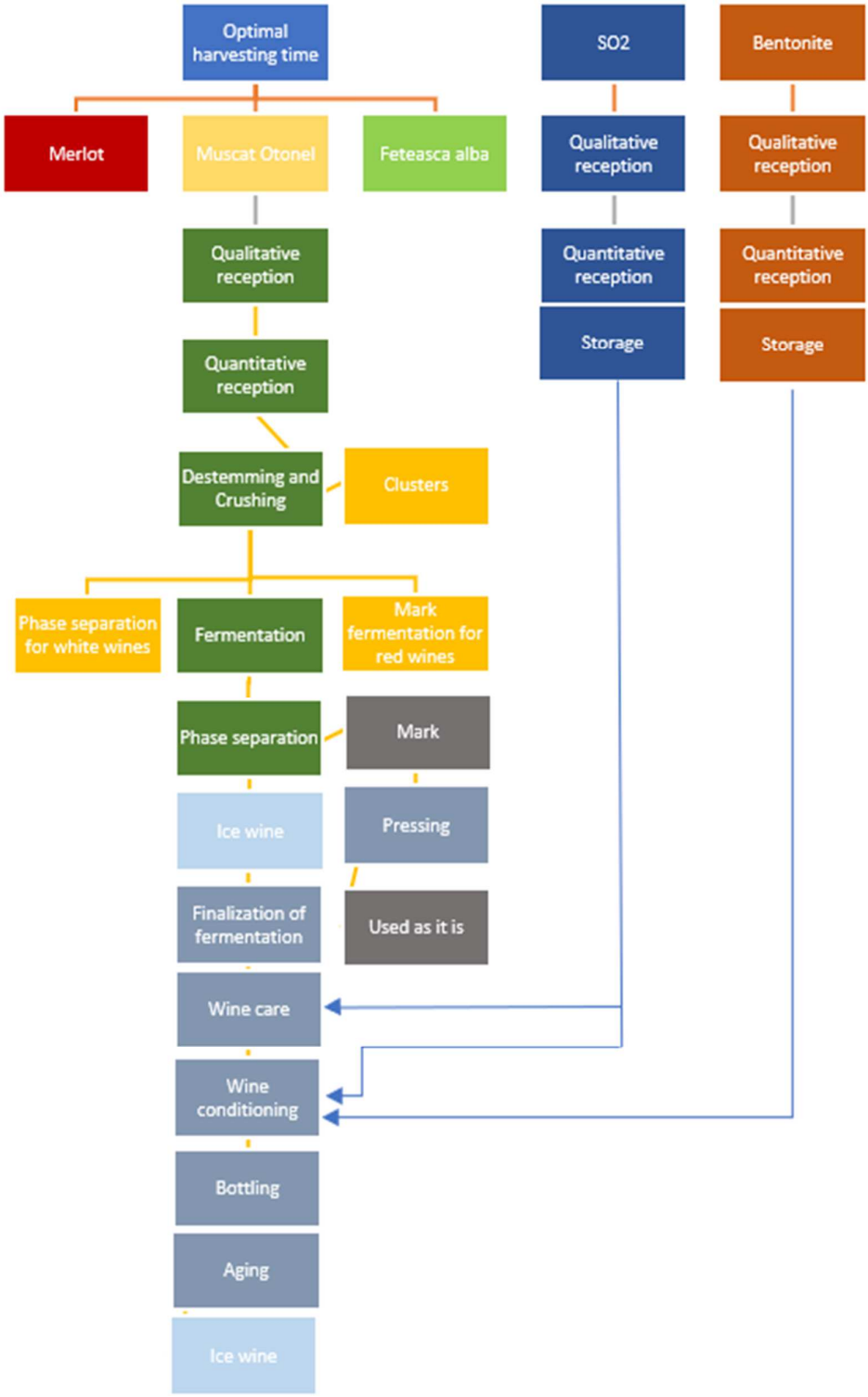

Fig. 1. The technological scheme of Ice wine production for three varieties of grapes.

For packaging were chosen only glass bottles with reusable corks, and the label was made from reused paper. The design was chosen in such a manner that it helps the consumer identify the flavors with ease.

The fermentation process of Ice wines takes up to a few months, which may cause a need for warmer temperatures so the yeast continues its process. However, the situation can be resolved by either using renewable energy sources or like

in our case, using a space south orientated, with one or non-exterior walls, in a building already heated.

The quality of wine was observed from the optimal harvest moment, until the dosing in bottles and aging. [7]

3.2 Sustainable vineyard practices

When it came to vineyard practices, the vineyard was carefully observed throughout all the year.

The chemical treatments for the specific vineyard were stopped and the affected grapes

were manually removed. Ultrasounds were used to keep away the wildlife during the colder months, to prevent damage to the culture.

The vineyard was chosen to be closer to the processing area, to remove the need for transportation, so the CO2 footprint was also diminished.

3.3 Quality of Ice wines

The quality of Ice wines was followed since the beginning of the winemaking process through grape analysis, followed by wine analysis.

Parameters such as grape quality, sugar levels, grape health, pH, were checked at the beginning of the winemaking process, followed by final product parameter checking (Table 1).

For the final product, the quality markers checked were sugar levels, alcohol levels, pH, acidity. Another parameter taken in consideration was the color and shade parameter, checked with the help of UV-VIS spectrometry (Table 2).

The absorbance ability in UV- VIS was also taken in observation (as presented in Figures 1 and 2).

Table 1

Grape quality parameters

Parameters	Merlot	Feteasca Alba	Muscat Ottonel
Istr	0.96	0.91	0.98
Ib	96	72	43
Ir	1.92	1.3	2.28
Sugar (Brix)	27	25	30
pH	3.4	3.15	3
Weight	83.56	33.73	105.68
Seed/Skin report	2.98/8.34	0.83/4.06	1.36/5.71

Table 2

Icewine quality parameters

Parameter	Merlot	Feteasca Alba	Muscat Ottonel
pH	3.26	3.74	3.82
Acidity levels	7	5.9	5.7
Alc. %	15.72	15.98	13.92
Dry substance %	13.3	13.3	12.9
IPT mg/L	4.68	1.83	0.21
IC	2.88	0.18	0.39
Shade (N)	1.17	13	2.3

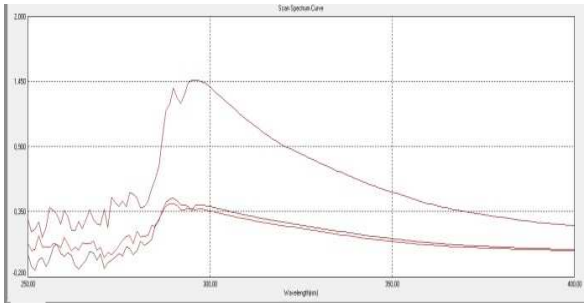

Fig. 2. UV absorbance for the icewines (1) (a capture).

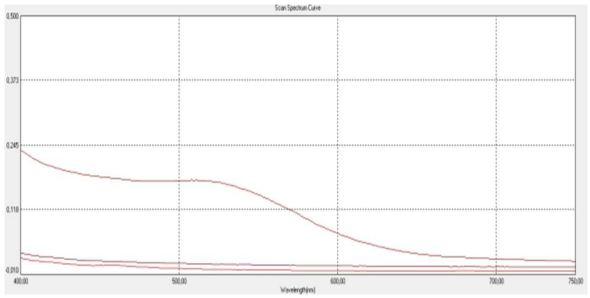

Fig. 3. UV absorbance for the icewines (2) (a capture).

3.4 Optimal temperature reaching

As mentioned before, one of the most important pain points for Ice wine making, in Romania, is the reaching of negative temperatures.

According to the National Meteorological Station, the optimal temperature for harvesting the grapes to obtain the icewines was reached on 22, 23, and 24 December 2021 [4]. As the procedure states, the grapes were collected and processed on the morning of 24th December, around 7 AM, as it was still below freezing [3].

3.5 Risk management systems

With such a delicate product comes big responsibility and for this was chosen a strategy that allows as much control on the risk factors, as it can be. Starting from the classical risk management diagram presented below, the next steps must be mentioned:

- Risk factors identifying;
- Risk evaluation;
- Establishing risk solving manners;
- Establishing the Critical Control Points;
- Establishing Critical Control Limits.

Based on these steps, a strategy was formed so the product obtained can be a quality one, no matter the perspective [8-10].

In the next tables are presented the risk factors that were identified, same as the risk evaluation made by authors.

The risk categories were evaluated using color coding, starting from green for lower risks, yellow for medium risk and red for higher class risk. They were evaluated from 2 perspectives: chances of happening and solvability.

Table 3

Risk factors for icewine production.

Risk type	Risk
Biological	Vegetable residue from cords and leaves. Bugs and insects that use the grapes to feed as there are no other sources due to freezing temperatures. Human contamination due to direct work.
Physical	As there are metals used for the vines, metal parts can be found in the harvest. Parts from machines can broke, so the metals or plastic parts can be found in the marc.
Chemical	Due to previous treatments, the vines can still be contaminated or suffer from cross contamination. Also, if snow occurs, it can suffer from pollution due to air pollution. Human error can occur and chemical dosing can be mistaken. The wooden barrels can be previously treated, and the substances can interact with wine.
Mineral	Dust residue was found on the grapes. Also stones and dirt can be collected during the harvest. If there is snow, it can be polluted with dust and dirt residue.

Table 4

Risk type evaluation for icewine production.

Risk type	Risk evaluation	Reasoning
Biological		Biological contamination at any part of the technological process can lead to permanent damage to the wines. Mold infestation through vegetable cords and leaves can occur and damage the whole production.
Physical		Physical risks are a class of risk that are high, but easily fixable. Metal detectors can be installed.
Chemical		Same as biological risks, chemical ones are particularly important. They can lead to a loss of the production, either by human error at misdoing the SO_2 and bentonite levels, but from the risk of losing the potential certification for sustainability due to chemical residue from the soil.
Mineral		The mineral class of risk presents a lower impact on the product. It can easily be avoided by a rigorous quality control.

The critical control Points were chosen based on the technological scheme as it follows [10-13]:

- Optimal Harvesting time;
- Reception;
- Crushing;
- Fermentation.

Another management strategy that was applied was Ishikawa. Designed to show the potential causes of a specific event, it represents the perfect method to ensure the quality of the icewines through all its steps. As icewines require specific conditions to be created, these specific conditions are the main parameters to be considered in the process of creating the diagram. [9]

As seen in the next diagram (Figure 4), the main factors that influence the product icewine, are as it follows:

Climate;

- Viticultural practices;

- Raw material (Harvest);
- Harvesting methods;
- Quality control for the raw material;
- Processing technique.

The climate is the important aspect to be considered when we think about the factors that influence the process of icewine making. As one of the characteristics needed to proclaim a wine, icewine is that the raw materials to be exposed for three consecutive days to at least -8°C, not fulfilling this results in the loss of the product from the beginning of the process.

As the main goal was to prove that quality and sustainable icewines can be produced, the viticultural practices represent a very important practice. On their own, they must respect the sustainability principles so that the raw materials are according to standards. A simple error among the viticultural practices results in losing one of the two characteristics: quality and sustainable product.

The harvest too, is crucial in the technological process of icewine making. As stated in the beginning of the paper, it must have certain attributes such as zero infestation to grey mold and high levels of sugar.

Harvesting methods are equally important, as they need to be done at freezing time too. Same as for the climate, not fulfilling this characteristic, leads to the loss of the title icewine.

If the harvest passes all the checkpoints mentioned before, its quality control is still a "must". It's often the case that the raw materials meet a general standard of quality at harvesting times, still, for these specialties, extra measures are needed.

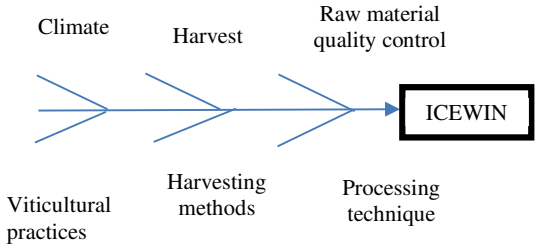

Fig. 4. Ishikawa diagram created for the research of icewine production.

As a single grape seed affected can alter the whole production, rigorous quality control must be implemented. In addition, special attention will be given to the supply chain management for raw material quality control [14].

The last parameter considered one of the six that are responsible for the sustainable icewine making, the technology used for the processing must implement sustainable practices too.

4. RESULTS

After finishing the research, the results are as follows: quality ice wines are obtained in sustainable ways in Panciu viticultural area (Romania). The wines are eligible for quality certification programs, both for geographical indications and sustainable practices. The risk management system used and its implementation were successful.

5. CONCLUSIONS

Even though the research was conducted on smaller samples, the results showed that sustainable practices can be incorporated into fermentative industry.

Despite climate change, wine making technologies can be upgraded and used in such manner to obtain quality wines, with special properties.

Risk management systems are a useful resource for engineers that want to use everything to their advantage and who want to offer consumers their best products, without affecting their future [15].

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Cercetare privind practicile sustenabile si managementul riscului din industria fermentativă

In contextul schimbărilor climatice, întreaga lume trebuie să se chimbe, și industria fermentativă, de asemenea, Cum contexul sustenabilității ne înconjoară din ce în ce mai mult, și în viața de zi cu zi, nevoia de a-l integra în industrie și cercetare a devenit tot mai pregnantă. Această cercetare incorporează conceptul cheie al sustenabilității prin valorile sale, în cazul industriei fermentative, în contextual actual al schimbărilor climatice. În România, ariile viticole sunt recunoscute, cu toate acestea, schimbările climatice își fac resimțită prezența. Caracterizate la un anumit nivel de impredictibilitate, contrar trendului cu temperaturi ridicate pe timpul iernii, există situații în care se ating temperaturile optime pentru producerea icewine (vin de gheață). Alături de un sistem de management al riscului bine pus la punct, industria poate atinge un nou segment de consumatori, oferind vinuri calitative și sustenabile.

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