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# PROBLEMS, PROSPECTS OF PET-NAT PRODUCTION TECHNOLOGY IN UKRAINE

*Summary*. The popularity of Pét-Nat sparkling wine produced using Ancestrale technology is growing worldwide. Purpose of the work: to determine consumer awareness and prospects for Pét-Nat production in Ukraine; to investigate the use of different yeast strains during fermentation to improve wine quality; physicochemical, organoleptic indicators of wine quality. Scientific novelty: for the first time, the technology of production of sparkling wines of the Pét-Nat type from grape varieties grown in Ukrainian conditions and the quality indicators of the finished product were studied. Conclusions: the survey proved that consumers prefer still wines, but 14 % chose Pét-Nat, and producers noted problems with technology, wine quality. The highest score by organoleptic was received by a wine sample made with the EnartisFerm PERLAGE yeast strain; the lowest score was received by a sample made with the APRO-FERM SHAMP yeast strain, due to weaker perlage and signs of oxidation. Scientific research has allowed us to improve the technology, improve the quality of Pét-Nat sparkling wine by using certain types of yeast in the fermentation process, and make this range more competitive on the market and understandable to the consumer.

*Keywords*: sparkling wine, Pét-Nat, technology improvement, parameters, sensory analysis, OIV methodology.

*Statement of the problem*. The analysis of problems in the production and promotion of Ukrainian sparkling wines of the Pét-Nat type on the market is of great importance, since the industry has the raw materials and production capabilities to create authentic wines with a unique character. Ukrainian consumers prefer such sparkling wines for their vigor, drinkability and expressiveness, but note such disadvantages of Pét-Nat as the presence of sediment, dull color, specific undesirable aromas. Winemakers have identified technological barriers in the production of Pét-Nat wines: excessive accumulation of sediment and problems with the quality of this type of drink. Therefore, the issue of improving the technological aspects of the production of sparkling wines of the Pét-Nat category from grape raw materials of the Ukrainian terroir, as well as improving the quality indicators of the finished product, in particular using progressive methods of sensory analysis, is very relevant today.

*Analysis of recent research*. Wine is a matter of taste and a sign of cultural identity. More than any other alcoholic beverage, wine is associated with politeness and restraint [1–4]. Over the past decade, a new modern historical and social phenomenon has emerged: wine is produced, sold, and consumed in more countries and by a greater variety of people than in any other period in history [5–8].

Until recently, the culture of wine consumption in Ukraine differed from that of other European countries [9–11]. Unfortunately, the Ukrainian consumer approaches the choice of wine less rationally than Europeans. For the modern Ukrainian consumer, the appearance of the bottle and its cost are important. Few people pay attention to the composition, grape variety, aging, etc. These selection criteria are used only by particularly sophisticated buyers, who to a greater extent prefer imported products [12; 13]. Given the global problems of ecology and sustainable development, the relevance of which is reaching its peak, consumers increasingly prefer “green” products [14–18].

Research into the problems and relevance of Pét-Nat production in Ukraine is relevant, as there is great potential for the production of wine products with its own unique style.

Pét-Nat is an abbreviation of Pétillant Naturel, which means "naturally sparkling" [19–26]. This is a return to the old, ancient traditions of sparkling wine production. Pét-Nat symbolizes authentic craftsmanship, mainly in small quantities. Regardless of whether it is white, red or rosé, the wines are often cloudy due to unfiltered bottling and thus visually differ from the impeccable mass-produced products of large Champagne houses.

Currently, there are no documents at the legislative level that regulate the production of Pét-Nat. We conducted an online survey on the awareness of modern Ukrainian consumers about Pét-Nat wines. More than 52 % of respondents prefer sparkling wines made using classical technology. The main advantages of Pét-Nat, which consumers identified, are freshness, lightness, and richness. The main disadvantages are sediment, turbidity, foreign atypical aromas. An online survey of Ukrainian producers of sparkling wines of the Pét-Nat type revealed the main problems of the technology: large sediment. Despite such problems, the Ukrainian producer increases the volume of Pét-Nat production from year to year and sees prospects for the development of such a drink in Ukraine.

*Formulation of the purpose of the work (task statement)*. To determine consumer awareness and prospects for the production of Pét-Nat wine in Ukraine; to investigate: the use of different yeast strains in fermentation to improve wine quality; physicochemical, organoleptic indicators of wine quality; through research, to improve the technology that allows making Pét-Nat wine a competitive range on the market.

*The main part*. The research was conducted at the Department of Wine Technology and Sensory Analysis of the Odesa National Technological University (Ukraine) and at the TM KOVACH WINERY enterprise (Kontsovo village, Uzhgorod district, Zakarpattia region).

Research materials: must and wine materials for sparkling wines from Sauvignon Blanc, Chardonnay, Merlot grapes grown in Ukraine (Zakarpattia region), produced in the micro-winery and in the production conditions of TM KOVACH WINERY (Kontsovo village, Uzhgorod district, Zakarpattia region) and various yeast races (tab. 1).

For organoleptic analysis, five samples of Pét-Nat "Ancestrale" of the 2022 harvest were presented, which were produced at the TM KOVACH WINERY enterprise (64 Turyanytsia St., Kontsovo village, Uzhgorod district, Transcarpathian region).

Pét-Nat "Ancestrale" of the 2022 harvest is a blend of Chardonnay, Sauvignon Blanc and Merlot grape varieties in equal quantities. This ratio was chosen to achieve a typical pink color, harmonious acidity and bright aroma.

The experimental samples differ in the yeast races on which fermentation was carried out (tab. 2).

To study the chemical composition of grapes, wine materials and wines, both generally accepted and specific research methods were used.

The following indicators were measured: mass concentration of titrated acids and sulfur dioxide, mass concentration of sugars.

Mass concentration of titrated acids. The method is based on titration of wine with a titrated sodium hydroxide solution to the equivalence point, which is set at pH 7.0 using the bromothymol blue indicator. The mass concentration of titrated acids (g/dm$^3$) is calculated based on the volume of titrant consumed.

Mass concentration of sulfur dioxide (mg/dm$^3$). The method is based on the oxidation of free sulfurous acid in an acidic medium to sulfuric acid using iodine. 1 % starch solution serves as an indicator. The bottle with wine is uncorked immediately before analysis to prevent loss of sulfur dioxide. In a conical flask with a capacity of 200 cm$^3$, 50 cm$^3$ of wine is measured with a pipette, 3 cm$^3$ of $H_2SO_4$ (density 1.11 g/cm$^3$), 1 cm$^3$ of starch, 1 cm$^3$ of trilon B are added and immediately titrated with a 0.01 M iodine solution until a blue color appears, which does not disappear within 30 seconds.

Table 1

Yeast characterization

| Name of yeast | Purpose of yeast | Properties of yeast |
|---|---|---|
| SIHA Aktivhefe 4 Saccharomyces cerevisiae CH 158 | Highly active dry yeast specifically for the production of sparkling wines, both in acratophores and for fermentation in bottles according to the "Méthode traditionelle". They are also suitable for the maturation of aged wines. The production of sparkling wines with a delicate bouquet while simultaneously intensifying the aroma, characteristic of the variety and terroir | Fast start of secondary fermentation. Very good cold fermentation properties. Easy yeast separation. Ferment sparkling wine with small bubbles |
| APRO-FERM SHAMP Saccharomyces bayanus | For fermentation recovery; for bottle and tank champagization (for fine sparkling wines). Gives the aroma subtle notes of nuttiness | Resistant to low pH; resistant to high $CO_2$ concentration; cold-resistant; optimal fermentation temperature 14–22 °C |
| EnartisFerm PERLAGE Saccharomyces cerevisiae ex r.f. bayanus | A strain selected for the production of sparkling wines using the traditional method. Can be successfully used in the primary fermentation of white wines. Ferments wines with a very elegant and pure aroma, reflecting the characteristics of the grape variety and the region | Resistant to high sugar and alcohol concentrations, low pH and low temperatures. Fermentation temperature 10–30 °C. Moderate fermentation rate at low temperature; high at > 15 °C. Alcohol tolerance ≤ 17 % High $SO_2$ resistance. |
| Erbslöh Oenoferm Rose | Special granulated yeast for fermenting fruity rosé or late wines. Aroma profile: complex fruity aromas, sweet floral and honey notes, soft and creamy taste. Ferments complex wines with fruity-sweet floral-honey aromas | Fast start of fermentation. Resistant to low temperatures. Fermentation temperature 17–22 °C. High nutrient requirement. For best results, more complex nutrients – VitaFerm Ultra – are required, depending on the degree of grape maturity, nutrient content and health |

Table 2

Experimental samples

| Sample number | Yeast application options |
|---|---|
| 1 | SIHA Aktivhefe 4 |
| 2 | APRO-FERM SHAMP |
| 3 | Composition: SIHA Aktivhefe 4 and APRO-FERM SHAMP |
| 4 | Composition: EnartisFerm PERLAGE and Erbslöh Oenoferm Rose |
| 5 | EnartisFerm PERLAGE |

Mass concentration of sugars. The study is carried out using a refractometer, the indicators of which are listed according to special tables. The indicator is measured in units of g/dm³.

The active acidity of the must and wine materials is measured using a pH meter.

The organoleptic tests of Pét-Nat were carried out according to the OIV international organization's scoring system (point method using a 100-point scale [5].

Online survey of Ukrainian consumers and Ukrainian producers of sparkling wines of the Pét-Nat type in Ukraine using Google Forms.

**Results of a survey of consumers and producers of sparkling wines of the Pét-Nat type in Ukraine**

During November 2023, an online survey of the modern Ukrainian consumer was conducted. More than 200 respondents took part in the survey. The purpose of the survey was to investigate the relevance of production and consumer awareness of a drink such as Pét-Nat.

Among the respondents, the majority were middle-aged people 30–50 years old (59.6 %) and young people 18–30 years old (39.2 %). The results show that an active solvent consumer interested in wine culture was involved.

Almost 2/3 of the respondents prefer still wines (62.7 %), 1/3 (29.4 %) – sparkling wines, and 6 % – consume both still and sparkling wines. Such a high rate of consumption of sparkling wines demonstrates the relevance of the development of the sparkling wine market in Ukraine.

When asked about wine taste, the majority of respondents preferred dry wines (68 %), semi-dry wines are preferred by 17 % of respondents, semi-sweet wines are preferred by 9 %, sweet and fortified wines are preferred by 2 % of respondents. Such results certainly give hope for the development of a high culture of wine consumption in Ukraine, illustrating the predominance of dry wines over drinks with residual sugar. This is also an impetus for the development of production and improvement of Pét-Nat technology.

The respondents were asked questions about the technology of sparkling wines. The Ukrainian consumer prefers sparkling wines made by classical (52 %) or tank (28 %) methods. Wines made by the Ancestral method (Pét-Nat) were preferred by 14 %. Such a low indicator demonstrates the presence of organoleptic shortcomings in Pét-Nat, which are associated with insignificant perlage and sediment in the bottle. In addition, there is a problem of high pressure in the bottle, which makes it difficult to uncork the bottle before consumption. The problems of Pét-Nat also include the impossibility of its sale due to the lack of legal registration.

Despite certain problems with Pét-Nat, the majority of respondents (78 %) know about this range of sparkling wines, but only 60 % of the total number of participants have tasted this drink. These indicators are quite high and prove the relevance of spreading the culture of Pét-Nat consumption in Ukraine.

Ukrainian craft wineries are popular and consumers have specific favorites. 85 % of respondents know one or more Pét-Nat producers in Ukraine.

In order to better understand the individuality and problem of Pét-Nat, a question was asked about the advantages and disadvantages of Pét-Nat. Among the advantages, consumers identify freshness, lightness, richness of taste, bright aromas; among the disadvantages – sediment, turbidity, foreign aromas and uncontrolled pressure.

During November 2023, an online survey of Ukrainian producers of sparkling wines of the Pét-Nat type was conducted. The purpose of the survey was to study the interest of producers in the production of Pét-Nat and consider possible problems.

13 producers participated in the survey: TM Chateau Pinot (Odesa region), My Wine (Roksolany, Odesa region), Frumushika-Nova family winery (Odesa region), Biologist (Kyiv region), Rakovetska Loza (Lviv region), Medovy Spas (Kyiv region), TM KOVACH WINERY (Zakarpattia region), Axis Wine (Lviv region), Korus wine (Kirovohrad region), DON ALEJANDRO WINERY (Odesa region), PP Vinorobnya Slyvyno (Mykolaiv region), Bohdan's vinery (Khmelnytskyi region), VinSancho (Dnipropetrovsk region).

The main reasons for starting to produce Pét-Nat, according to the producers, are: the fashion for this drink in the world; tasting Pét-Nat by Christophe Lacarin; attempts to produce a lighter, more drinkable drink; the desire to experiment.

For the production of Pét-Nat, Ukrainian producers use the following grape varieties: Pinot Blanc, Pinot Gris, Pinot Noir, Chardonnay, Aligote, Traminer, Johanniter, Zweigelt, Merlot.

Ukrainian producers are taking their first steps in the production of Pét-Nat-type wines, most of them have 3–5 seasons of production experience. The volumes of products produced from season to season increase by 30–500 % and are accompanied by a significant expansion of the range. According to the survey, the share of Pét-Nat in the total wine production of the 2023 season is from 5 to 15 %.

Producers highlight the problems of Pét-Nat production, which include the presence of sediment in the bottle, uncontrolled foaming during uncorking the bottle, difficulties in stabilizing the drink, and determining residual sugar.

Consumers showed interest in the questionnaire and asked questions to scientists and producers: Why can I sometimes not uncork a bottle without excessive foaming? Why are there sometimes atypical and unpleasant aromas? Why is there such a large amount of sediment?

Producers have formulated the following topical questions regarding the technology and prospects of Pét-Nat in Ukraine: How to choose a mechanically stable bottle? At what level of residual sugar should the drink be bottled? How to stabilize the drink? How to minimize sediment and avoid disgorging? How to produce Pét-Nat officially?

**Sensory analysis of experimental samples**

Sensory analysis of experimental samples of Pét-Nat was carried out by a group of experts, consisting of seven people, according to the OIV methodology on a 100-point scale. During the tasting, the commission determined various aspects of the wine's organoleptic properties.

The color assessment includes determining the color change, the contrast of the wine. The transparency of Pét-Nat and the level of sediment are also assessed.

When determining the aroma, the tasters assess the typicality, freshness, brightness and fruitiness of the aroma, as well as the absence of foreign aromas.

When studying the taste, the fullness, saturation and extractivity, acidity, the overall composition of taste nuances are assessed, which gives a feeling of harmony. When assessing the taste, its intensity and quality were also separately assessed.

Visually, the tasters assess the duration of the play of bubbles in the glass and the pressure in the bottle when uncorking.

The experts determine the nature and duration of the aftertaste and assess how well all the components of the wine are balanced.

The results of sensory evaluation of experimental wine samples are given in (tab. 3).

Table 3

Sensory evaluation of experimental Pét-Nat samples

| Sample number | Points |
|---|---|
| 1 | 84 |
| 2 | 81 |
| 3 | 87 |
| 4 | 92 |
| 5 | 93 |

According to tab. 3, the yeast strain SIHA Aktivhefe 4 was used to produce sample 1. According to the experts, the wine is clear, with small bubbles, persistent perlage, and the fruity aroma dominates, especially black and white currants. The aromas of fermentation are clearly expressed. The taste is relatively simple, but with balanced acidity. The aftertaste is intense and persistent. The total score is 84.

The yeast strain APRO-FERM SHAMP was used for sample 2. The experts noted that the perlage is weaker than that of sample 1, and the wine is clear. The aroma is dominated by signs of oxidation and fermentation, with pronounced fruity notes, including raspberry and white currant. The intensity and freshness of the taste are less than that of sample 1. The experts noted the presence of the aroma of the malolactic fermentation process. Total score 81.

The composition of the following yeast strains was used to produce sample 3: SIHA Aktivhefe 4 and APRO-FERM SHAMP. The experts noted a good level of perlage. The wine is less transparent

than samples 1 and 2. The wine is characterized by bright fruity aromas of red apple and raspberry. The aroma is clean, the taste is bright, harmonious acidity and an intense aftertaste. Total score 87.

The composition of the following yeast strains was used to produce sample 4: EnartisFerm PERLAGE and Erbslöh Oenoferm Rose. The wine is characterized by persistent perlage. The drink is transparent. Unlike the previous samples, floral aromas dominate, especially iris. The acidity is lower and the taste is not as intense. The drink is balanced, harmonious. The aftertaste is long and pleasant. Total score 92.

For sample 5, the EnartisFerm PERLAGE yeast strain was used. It was found that the transparency and perlage of sample 5 did not differ from the previous samples. In the aroma, experts found notes of pink peach, strawberry and barberry. The aroma is fresh and clean. The taste is simple and clear. Long-lasting and intense aftertaste. Total score 93.

**Improving the technology of sparkling wines of the Pét-Nat type**

The experimental samples of Pét-Nat "Ancestrale" were produced from grapes of the Sauvignon Blanc, Merlot and Chardonnay varieties of the 2022 harvest from the terroir in the village of Pistryalovo, Mukachevo. The harvest was carried out manually in dry weather at 5 a.m. to avoid heating the berries.

Crushing was carried out immediately after grape harvest on a crusher with a comb separator with simultaneous sulphiting at a rate of 10 g/dm³. Must separation was carried out using a stainless steel sieve for gravity-flow must selection. Must quality indicators are given in (tab. 4).

Table 4

Must quality indicators

| Indicator name | Points | | |
|---|---|---|---|
| | Sauvignon Blanc | Chardonnay | Merlot |
| Mass concentration of sugar, g/dm³ | 200 | 195 | 215 |
| Active acidity | 2.9 | 2.9 | 3.1 |
| Mass concentration of titrated acids, g/dm³ | 8.2 | 7 | 7.8 |

10 % of the gravity-flow must volume is taken and sulphited to a level of 40 mg/dm³, followed by cooling and storage at 0 °C. This technological procedure must be carried out at the very beginning of crushing to avoid oxidation and the development of undesirable microflora. Under such conditions, the cooled must can be stored for a long time.

Clarification of the must was carried out using Seporit bentonite. The must was additionally aged at +3 °C for two days.

After removal from the sediment, the must was sent for primary fermentation using TM Erbslöh 'Oenoferm Rose' yeast. Rehydration was carried out for 3 hours with a gradual decrease in temperature from +38 to +18 °C. Fermentation was carried out at a controlled temperature of 15–17 °C. After fermentation, the dry wine material was removed from the yeast sediment.

The finished wine material is blended with the primary must and yeast strains according to Table 2.

Rehydration was carried out for 24 hours with a gradual decrease in temperature from +38 to +18 °C and the addition of nutrients.

The sulfite level was adjusted to 25 mg/dm³ and tannin APRO-TAN GALL ANAX was added in an amount of 5 g/dm³.

The bottling took place in sparkling wine bottles, which were sealed with crown caps. It is this combination of the bottle and crown cap that provides mechanical resistance to the increase in pressure in the bottle during fermentation.

After bottling, the experimental samples were placed in a room with a temperature of +20 °C without access to sunlight. This temperature is considered optimal for completing fermentation in

bottles. For two weeks, batonage was carried out every other day to evenly distribute the yeast in the bottle.

*Conclusions*. An analytical review of the literature revealed certain problems in the positioning and production of Pét-Nat. Oenological and food publications have formed a general vision of Pét-Nat in the world as a promising alcoholic beverage that arouses some interest among consumers and has great potential for production. One of the pressing problems is the lack of regulatory documents at the legislative level, starting with the definition of Pét-Nat and requirements for the quality of the finished product.

In order to determine the level of competitiveness of Pét-Nat on the Ukrainian market, an online survey of consumers and producers of Pét-Nat was conducted. The modern Ukrainian consumer is active and alternative. He gladly accepts such a novelty as Pét-Nat. Consumers demonstrate high awareness of modern craft winemaking. The main impressions of Pét-Nat can be distinguished: the advantages can be summarized as freshness, lightness, richness, brightness of aroma and taste. Among the shortcomings, consumers highlight sediment, turbidity, foreign aromas.

Most of the surveyed producers use pure yeast cultures, which makes Pét-Nat more stable and predictable. Almost all producers who have been producing Pét-Nat for two or more years have increased their production volumes and those who tried it for the first time were satisfied with the first experiments and intend to continue producing Pét-Nat. There is a desire for development and efforts of producers to satisfy consumer preferences and expectations, which proves the feasibility and relevance of improving the technology.

The improvement of the technology for the production of sparkling wines of the Pét-Nat type involves the selection of 10 % of the volume of gravity-flow must during crushing, sulphiting the selected must to a level of 40 mg/dm$^3$ and storing it at a temperature of 0 °C.

The main part of the wine material is processed and full fermentation is carried out. Fermented dry wine is removed from the yeast sediment. The primary must is “dosed” to a residual sugar level of 18 g/dm$^3$. Fermentation is started with a fresh yeast culture and bottled.

Samples produced using the improved technology were subjected to organoleptic tests. Among the Pét-Nat samples tasted, the highest scores were received by sample 4 – 92 points and sample 5 – 93 points, which proves the positive impact of the improved technology on the sensory profile of Pét-Nat.

The yeast preparations EnartisFerm PERLAGE and Erbslöh Oenoferm Rose had the best effect on the formation of Pét-Nat aromas. The yeast preparations SIHA Aktivhefe 4 and APRO-FERM SHAMP changed the aromatic profile of the must.The proposed improved technology makes it possible to solve the described problems for both consumers and producers, simplifying the manufacturing technology and making Pét-Nat more understandable for consumption.

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# ПРОБЛЕМИ, ПЕРСПЕКТИВИ ТЕХНОЛОГІЇ ВИРОБНИЦТВА PÉT-NAT В УКРАЇНІ

***Анотація***

Сьогодні на споживчому ринку зростає популярність ігристого вина Pét-Nat, виробленого за технологією Ancestrale. В Україні й в усьому світі відсутнє законодавче регулювання виробництва вина типу Pét-Nat. Мета роботи – визначити обізнаність споживачів і перспективи виробництва Pét-Nat в Україні; дослідити використання різних штамів дріжджів у процесі ферментації для покращення якості вина; фізико-хімічні, органолептичні показники ігристого напою. Методологія: обізнаність споживачів і виробників про Pét-Nat проводилася за допомогою онлайн-опитування; для виробництва ігристих вин використовувалася класична технологія із застосуванням різних штамів дріжджів; фізико-хімічні показники визначалися за стандартними методами; органолептичні дослідження Pét-Nat проводилися з використанням системи оцінки Міжнародної організації виноградарства та вина OIV (баловий метод). Наукова новизна: уперше вивчено технологію виробництва ігристих вин Pét-Nat із сортів винограду, вирощених в українських умовах, і показники якості готового продукту. Висновки: опитування довело, що споживачі віддають перевагу тихим винам, але 14 % обрали Pét-Nat, а виробники відзначили проблеми з технологією та якістю вина. Фізико-хімічні показники вина Pét-Nat відповідали вимогам чинного стандарту для ігристих вин. Органолептичні показники зразків Pét-Nat визначалися за допомогою методів сенсорного аналізу. Найвищий бал отримав зразок вина, виготовлений зі штамом дріжджів EnartisFerm PERLAGE (аромат рожевого персика, барбарису й тривалий післясмак), найнижчий бал отримав зразок, виготовлений зі штамом дріжджів APRO-FERM SHAMP через слабший перляж та ознаки окислення. Найбільш збалансований зразок отримано за участю композиції штамів дріжджів EnartisFerm PERLAGE й Erbslöh Oenoferm Rose з квітковими ароматами. Наукові дослідження дали змогу вдосконалити технологію, покращити якість ігристого вина Pét-Nat шляхом використання, у тому числі певних штамів дріжджів у процесі ферментації, а також зробити цей асортимент більш конкурентоспроможним на ринку та зрозумілим для споживача.

***Ключові слова*:** ігристе вино, Pét-Nat, удосконалення технології, параметри, сенсорний аналіз, методологія OIV.