Assessment of the Technological Suitability of the "Kepez" Grape Variety for Quality Wine Production

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ABSTRACT

The purpose of this study is to comprehensively evaluate the technological suitability of the local "Kepez" grape variety for wine production. Microvinification products "Kepez" variety are analyzed for juice yield, sugar-accumulation, titratable acidity and pH indicators, phenolic potential, anthocyanins and color parameters. The results show that the variety is promising for red or red-pink style wines with medium-high sugar potential, balanced acidity, color intensity and phenolic designation. The study provides practical stable rules for technological planning, selection of optimal maceration regimes and quality preservation on an industrial scale.

Keywords: Kepez grape variety, technological suitability, phenolic substances, color intensity, acidity, microvinification, wine quality

INTRODUCTION

In recent years, market competition in the winemaking industry has been determined not only by the volume of product production, but more by the technological "performance" of the grape variety, that is, the ability to provide stable and high quality indicators during the processing of raw materials. In this regard, in order to select local grape varieties and expand their application possibilities on an industrial scale, it is necessary to conduct a systematic and scientifically substantiated assessment of the main technological parameters such as sugar-acidity balance, phenolic potential, color formation ability, oxidation resistance and fermentation stability.

Expanding the scientific and technical database on the "Kepez" grape variety, which is distinguished by its local adaptation potential and agrotechnical advantages, and especially substantiating its technological suitability for quality wine production based on quantitative indicators, is of urgent scientific and practical importance. The limitations of existing research necessitate the systematization of technological approaches for the purposeful use of this variety in winemaking.[1,2]

This study is an applied scientific study aimed at assessing the technological suitability of the "Kepez" grape variety under microvinification conditions, and serves to determine the potential capabilities of the variety in wine production and optimize technological decisions.

The basis of the study: To identify and optimize the main factors and technological indicators that ensure the suitability of the "Kepez" variety for wine production.

Tasks: 1. Measurement of juice and grape raw material indicators; 2. Microvinification; 3. Evaluation of phenolic and color parameters; 4. Instructions for the technological decision tree (maceration/fermentation).[3]

MATERIALS AND METHODS

Raw materials and sampling

The "Kepez" grape variety used in the study was selected under technological ripeness conditions, with an optimal balance of sugar-accumulation and titratable acidity products. Grapes were harvested manually and three replicate samples were formed for each technological batch. During sampling, clays were sorted into clays, mechanically visually or technologically cleaned, and clays with characteristics and technologically unsuitable clays were isolated from the study. The samples were exhibited in cooled conditions until analysis.[4]

Main physicochemical indicators of juice

The main technological parameters ensuring the quality of grape juices were determined by the following methods:

• Total sugar yield – measured by refractometric method in °Brix and expressed in g/L equivalent;

• pH indicator – determined with a calibrated electronic pH-meter;

• Titratable acidity (TA) – determined by standard titration method and expressed as tartaric acid equivalent (g/L);

• Juice yield – calculated as the ratio of juice obtained after pressing to grape yield in additional percentage;

• Assimilated nitrogen (AN) – determined by enzymatic or spectrophotometric methods in mg/L, depending on the available laboratories.

Microvinification protocol

Grape processing was carried out by laboratory microvinification method. The technological process was carried out in stages:

1. crushing and destemming of grape berries;

2. application of a standard dose of SO_2 adopted for the study to obtain the consumption of oxidation;

3. inoculation with selected active dry wine yeast;

4. production of the fermentation process in the temperature range of 24–26°C (for red wine style);

5. The maceration process can take place for 5–7 days, during which daily mechanical unloading ("punch-down") is applied;

6. pressing operation after maceration;

7. completion of the main fermentation with stabilization of densities;

8. sedimentation and initial stabilization are carried out.

Analysis of phenolic determination and color indicators

The phenolic and color properties of the obtained wine samples were evaluated by the following methods:[5,6,7]

• The content of total phenolic substances – determined by purposeful determination and qualitative acid equivalent (GAE, mg/L) using the Folin–Ciocalu reagent;

• The spectrum of anthocyanin spectra – performed by the pH-differential method or, alternatively, by the photometric method;

• The sum of color-intensive optical densities (A_{420} + A_{520}, with the addition of A_{620} if necessary) was calculated;[8]

• Tannin precipitation – assessed by methylcellulose method and spectrophotometric approach according to laboratory data.

Statistical processing

All analyses were performed at least three times and presented as mean ± standard deviation (SD). Statistical significance between different technological indicators was assessed at $p < 0.05$, and one-way analysis of variance (ANOVA) and appropriate post-hoc tests were applied as necessary.[9,10]

Research

Sugar-acidity balance of raw materials and juice yield

The juice indicators determined before the microvinification process for the "Kepez" grape variety demonstrated compliance with the technological range accepted for the production of quality wine (Table 1). The level of sugar content was high enough for normal alcohol formation, and the pH indicator was recorded in a controlled interval in terms of ensuring microbiological stability. At the same time, the high juice yield confirms the technological efficiency of the variety.[11,12]

Table 1. Initial indicators of "Kepez" grape juice

Indicator	**Mean ± SD**
Sugar, °Brix	22.0 ± 0.4
Titratable acidity, g/L	6.1 ± 0.3
pH	3.35 ± 0.05
Juice yield, %	72 ± 2
YANA, mg/L	160 ± 15

Comment: The combined effect of sugar accumulation and titratable acidity (TA) in the "Kepez" grape variety forms a balanced profile; this creates a suitable technological basis for both dry and semi-dry wine styles.

Fermentation dynamics and main wine indicators

During microvinification, the fermentation process demonstrated stability, a decrease in residual sugar to a minimum level and volatile acidity within the normative limits were observed. These indicators confirm the technological suitability of the "Kepez" variety in terms of fermentation and the fact that alcoholic fermentation can be carried out in a controlled manner. The obtained results indicate that the variety has a stable fermentation potential even under industrial conditions.

Phenolic potential and color formation

Phenolic substances and anthocyanins are considered the main components that determine the structural, color and longevity properties of red wines. Analyses conducted on the "Kepez" variety showed that the amount of total phenolics and color intensity show a tendency to increase with the extension of the maceration time. However, excessive maceration can lead to increased tannins hardness and sensory imbalance, which highlights the importance of optimizing the technological process.[13,14,15]

Table 2. Phenolic colors of microvinification wine

Parameter	Mean ± SD
Total phenolics (GAE), mg/L	1750 ± 90
Anthocyanins, mg/L	320 ± 25
Color intensity (CI)	8.5 ± 0.6
Tannins, g/L	2.1 ± 0.2

DISCUSSION

According to the results of the conducted research, the technological suitability of the "Kepez" grape variety for the production of quality wine can be assessed in three main functional blocks: sugar-acidity balance, phenolic and color potential, as well as the controllability of technological processes.[16,17]

Technological interpretation of sugar-acidity balance

The sugar content of the "Kepez" variety at a level of approximately 22 °Brix has a sufficiently high potential for optimal alcohol formation and minimizes the need for additional saccharification. The presence of titratable acidity at the level of ~6 g/L creates conditions for maintaining sensory balance in wine, especially the formation of freshness of taste and structured mouthfeel. The change in pH in the range of 3.3–3.4 is considered favorable both in terms of stabilizing anthocyanins and ensuring microbiological safety. These indicators justify the use of the "Kepez" variety as a suitable raw material for various technological styles, especially dry red wines.[18,19,20]

Evaluation of phenolic and color potential

The amount of phenolic substances and anthocyanins clearly reveals the color-forming ability of the "Kepez" variety in the red wine style. The adequate level of color intensity is an important advantage in terms of both aesthetic and market requirements. At the same time, the results obtained show that a short or medium-term maceration regime (approximately 5–7 days) is more appropriate for optimizing phenolic extraction. Long-term maceration can potentially lead to an excessive increase in tannins and an increase in taste harshness, which negatively affects the balanced sensory profile. In this regard, the controlled realization of the phenolic potential for the "Kepez" variety acts as one of the main technological priorities.[21]

Technological management and risk optimization

A number of technological risks and their management mechanisms have been identified to maintain the stable quality of wines produced from the "Kepez" variety on an industrial scale. Low levels of assimilable nitrogen (ANN) increase the risk of fermentation slowing down or stopping, in which case the use of nutrient supplements or mixed inoculation strategies is considered appropriate. In cases where the pH tends to increase, proper control of the SO_2 dose and technological correction of acidity are necessary to maintain the microbiological stability of the wine. On the other hand, the risk of oxidation is especially prominent during the pressing and maceration stages, and to reduce this risk, the application of reductive processing methods, the use of an inert gas environment, gentle pressing, and controlled phenolic extraction are recommended.[22]

Overall, the discussion shows that the technological mapping approach for the "Kepez" grape variety (variety → targeted wine style → maceration strategy → fermentation mode → stabilization measures) acts as an effective tool and allows for the scientific planning of quality wine production on both a laboratory and industrial scale.

CONCLUSIONS AND RECOMMENDATIONS

The results of the conducted research show that the local "Kepez" grape variety has high technological prospects for the production of quality wine. Analysis of the physicochemical and biochemical indicators of the variety revealed the following main advantages:

• balanced sugar-acidity profile, which allows the formation of a harmonious taste and structure in wine;

• sufficient phenolic and color potential for red wine styles, which increases the aesthetic and market attractiveness of the product;

• the stability of the fermentation process under microvinification conditions confirms the suitability of the variety for industrial-scale processing and indicates that technological risks are manageable.

Practical recommendations: In order to produce quality wine from the “Kepez” grape variety, it is considered advisable to apply a controlled maceration regime for 5–7 days at a temperature range of 24–26°C. The use of reductive technologies to minimize oxidation risks, regular monitoring of assimilable nitrogen (AN) during fermentation, as well as technological optimization of pH and titratable acidity (TA) significantly contribute to maintaining stable wine quality.[23]

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