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THE INFLUENCE OF THE DEGREE OF GRAPE DAMAGE ON THE QUANTITATIVE COMPOSITION OF HIGHER ALCOHOLS IN WINE

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Abstract
In this study is proved analyses of higher alcohols in wines received from both damaged and healthy grapes. The object of the study were wines made from Rkatsiteli, Budeshuri and Khikhvi grapes varieties. The control sample was wine obtained from healthy grapes. The amount of higher alcohols in wine was determined in the experimental and control samples by gas chromatography. The analysis of the obtained data showed that the amount of higher alcohols was higher in the control samples. Particular attention was paid to the influence of methanol and isoamyl alcohol concentrations on the sensory characteristics of wine. Their high amount negatively affects to the sensory characteristics of wines.
Keywords: the higher alcohol, isoamyl alcohol, gas chromatography and sensory characteristics

1. INTRODUCTION

The transformation of nitrogenous substances, first of all acid, it deaminates the amino acid in the area and synthesizes the required amino acid.
Grape damage is divided into three main categories: *biotic damage* caused by microbial infections, such as Botrytis cinerea (botrytis), fungal infections (e.g. Aspergillus, Penicillium) and bacterial contamination and *abiotic damage* caused by climatic stress (hail, sunburn, freezing) or *mechanical damage* during harvest and transportation. All of these affections on the composition of the grapes, including the sugar content, organic acids and amino acid profile, which are the main precursors of higher alcohols in wine.
It is known that higher alcohols are formed as secondary metabolites during alcoholic fermentation. Their formation is influenced by: yeast metabolism through amino acid catabolism (Ehrlich's method leads to the formation of higher alcohols); Fermentation conditions such as: temperature, pH, oxygen level and yeast strain; Chemical composition of grapes - amino acids, nitrogen compounds and metabolic components that determine the final concentration of higher alcohols. As already mentioned, the amount of higher alcohols in wine is also determined by the quality of the grapes. In damaged grapes occur the chemical changes. Microbial infections change the balance of amino acids, sugars and phenolic compounds, which affects the formation of higher alcohols during fermentation. For example, studies show that botrytized grapes have an increased glycerol content, which changes the ratio of higher alcohols due to the different consumption of nitrogen compounds by yeast.
Based on the above, the aim of our research was to study the impact of the degree of grape damage on the quantitative composition of higher alcohols in wine and its impact on the sensory characteristics of wine.

2. THE OBJECTS AND METHODS OF STUDY

As an object for study were taken healthy and diseased (gray rot, powdery mildew and mite) grape varieties such as: Rkatsiteli, Khikhviand Budeshuri sapere from the Kartli winemaking region from the collection site of the Jigauri Research Center for Viticulture and Winemaking and from Kakheti winemaking region Telavi State University's the experimental viticulture site in Gulgula village.
The vineyard was monitored at regular intervals during different phases of the vegetation.
The observation was carried out about the general condition of the leaves, bunches and vines.
During the observation were used disease identification methods established by international standards. As a result of the monitoring, various grapevine diseases were identified, including fungal and bacterial infections.
The level of disease prevalence was assessed at each monitoring stage and were identified the main risk factors influencing the spread of diseases.
Both diseased and healthy grapes were taken to the experimental laboratory of the Institute of Food Industry.
Each grape sample was divided into three parts and processed without the stem, with the stem, and without skin.

Wine was made according to the instructions using a pure yeast culture.

Grape juice was taken from both the control and experimental objects and chemical and microbiological analysis were carried out.

In grape juice were determined sugar, total acidity, pH, nitrogen and protein content. During alcoholic fermentation, the yeast growth rate and fermentation energy were determined by the gravimetric method, as well as the degree of sugar assimilation.

In the young wines received from healthy and diseased grapes were determinated the main physicochemical parameters and the content of higher alcohols using gas chromatography. The quantitative determination of higher alcohols in wine samples was carried out using the gas chromatography with FID detector. Before the injections , wine samples were first filtrated and if necessary then diluted. In the gas chromatography was performed separation of individual alcohols using temperature gradient. Compounds were detected using a flame ionization detector (FID), which allows for quantitative analysis of higher alcohols with high accuracy.

3. EXPERIMENTAL PART

In the experiment (infected with grape mites and gray rot) and control (healthy) wine samples that we studied, the amount of higher alcohols was determined; the results are presented in chromatograms 1, 2 and in the tables 1 and 2.

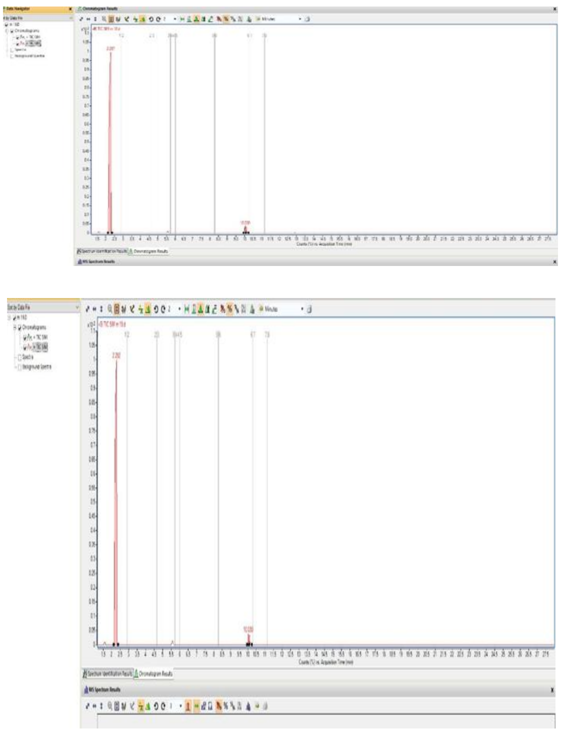

Figure 1. Total Ion Chromatogram (TIC) obtained in EI-SIM mode for the analyzed sample

The sample was analyzed using Gas Chromatography–Mass Spectrometry (GC-MS) operated in electron ionization (EI) mode with Selected Ion Monitoring (SIM). The Total Ion Chromatogram (TIC), presented in Figure 1, reveals two major peaks, indicating the presence of at least two dominant volatile compounds.

The first and most prominent peak appeared at a retention time of 2.292 minutes. This early-eluting compound is likely of low molecular weight and high volatility. The signal intensity of this peak reached approximately 1.1×10^{21}, suggesting a high relative abundance in the sample matrix.

A secondary peak, significantly smaller but clearly resolved, was observed at 10.030 minutes. This compound is likely to possess either higher molecular weight or reduced volatility compared to the compound eluting earlier.

No additional peaks of significant intensity were detected over the full scan range (0–27.5 min), implying that the analyzed sample contained a relatively simple volatile profile under the applied analytical conditions.

These findings may reflect the dominance of one or two key aroma or degradation-related compounds, potentially associated with the physiological condition of the raw material (e.g., disease impact, fermentation stage, or processing treatment). Further compound identification via mass spectral analysis is recommended for structural elucidation.

Table 1. Concentration of selected volatile compounds (mg/L) in healthy and diseased Rkatsiteli wine samples

Compound	Healthy (mg/L)	Diseased (mg/L)
Methanol	53.0	82.0
1-Propanol	15.0	17.0
Isobutanol	39.0	40.0
Butanol	9.0	16.0
Isoamyl alcohol	100.0	96.0
Isobutane	81.0	92.0
Ethyl acetate	9.0	16.0

Table 2. Concentration of selected volatile compounds (mg/L) in healthy and diseased Budeshuri Saperavi wine samples

Compound	Healthy (mg/L)	Diseased (mg/L)
Butanol	43.0	14.0
Isobutanol	47.0	49.0
Isobutanol-1	35.0	35.0
Methanol	45.0	53.0
1-Propanol	14.0	17.0
Isoamyl alcohol	80.0	59.0
Ethyl acetate	47.0	14.0

As can be seen from the chromatogram, 7 higher alcohols were analyzed in Rkatsiteli (healthy and diseased): butanol-2, isobutanol-1, methanol, propanol-1, isoamyl and ethyl acetate.
The quantitative content of higher alcohols is different in wines made from healthy and diseased grapes. Studied 7 the highest in wine obtained from diseased grapes are quantitatively higher than in the control (wine obtained from healthy grapes), for example, butanol-2 in sample 1 is 9 mg/l, and in sample 2 it is 16 mg/l. The highest concentration of these alcohols (100 mg/l) is isoamyl alcohol, 100 mg/l in healthy grapes, and 96 mg/l in diseased grapes. Isoamyl alcohol (3-methyl-1-butanol) is one of the main higher alcohols, which plays an important role in the aromatic profile and overall sensory characteristics of wine: Isoamyl alcohol gives the wine fruity (banana, plum), balsamic and slightly floral notes. It also affects the structure and balance of the taste: in medium concentrations it enhances the body of the wine, the sensory fullness and the long finish. It is also an indicator of yeast metabolism: its concentration is an indicator of yeast metabolism and indirectly reflects the conditions during fermentation. Its low concentrations are beneficial, while high concentrations (>400–500 mg/L) can be considered a defect. During aging, it can react with acetates to form esters (e.g., isoamyl acetate), which give the wine an intense banana aroma. It is also worth noting the methanol content in wine made from both healthy and damaged grapes. The methanol content in damaged grapes is higher than in healthy ones and is 82 mg/l, while in healthy ones it is 53 mg/l. The same pattern is observed in wines made from Budeshuri Sapere grapes. Excessive methanol negatively affects the quality of wine, as it is toxic, and its content is regulated by law. Other higher alcohols do not exceed the limit, and their amount is greater in damaged grapes than in healthy ones.

4. CONCLUSIONS

The study of the effect of damaged grapes on the production of higher alcohols is important from the point of view of wine quality and safety. The use of damaged grapes increases the risk of higher alcohols, especially methanol, which can affect the sensory characteristics of the wine and in some cases, regulatory compliance. Based on our analyses, it is clear that samples from damaged grapes have higher methanol concentrations (e.g., damaged Rkatsiteli – 82 mg/L, damaged Khikhvi – 71 mg/L) compared to healthy samples (e.g., healthy Budeshuri – 45 mg/L). Isoamyl alcohol levels also decrease with severe damage (e.g., damaged Khikhvi – 62 mg/L), which may be a result of inhibition of yeast metabolism or nutrient deficiency.

This may affect the aromatic and structural properties of the wine. Based on these data, it is concluded that grape damage not only increases methanol concentrations, which affect on wine safety, but also changes the balance of higher alcohols, which affects the quality and style of the wine. Therefore, control and selection of raw materials remain important in winemaking to minimize such impacts and to obtain a consistent, high-quality product.

5. REFERENCES

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