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Influence of grape processing technology on the characteristics of the obtained distillates

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Abstract. In the production of wine distillates, the factors influencing their composition, respectively their quality, can be divided into the following directions: composition of grapes (as raw material), the technology for its processing and alcoholic fermentation to obtain wine material, as well as the method of distillation of the wine material to derive a distillate. Each of these factors is important for the production of quality wine distillate and significantly affects the concentration of chemical substances that determine its aromatic and flavour profile. The present study was carried out with Muscat Ottonel grapes, a raw material typical for the production of Muscat brandies, through double batch distillation. The grapes are processed and vinified according to three different technological schemes. It is established their influence on both the chemical composition of the wine materials and the received distillate fractions, typical for batch distillation.

1 Introduction

In recent years, there has been an increased consumer interest in higher-quality products, in particular high-alcohol beverages. Consumers tend to get quality, limited edition products with their own identity, even if they are at a higher cost. In practice, the widespread use of batch distillation methods is noticeable, which are a tool for achieving distinctive, high-quality distilled beverages. A drive to modernize and optimize the existing apparatus for batch distillation with improvements allowing monitoring, control and management of the technological process is noticed. The variety of volatile components and the difference in their concentration, as well as the quality of the wine distillate, is mainly due to the raw material, the fermentation method and the distillation process, which includes both - equipment and method [1, 2, 3, 4, 5, 6]. The aim of the present work is to investigate the influence of the vinification method on the chemical composition of both the wine materials and the resulting distillates. Use A4 paper size (210 × 297 mm) and adjust the margins to those shown in Table 1. The final printed area will be 172 ×252 mm.

2 Materials and methods

For the realization of the task, Muscat Ottonel grapes were used, which were vinified in three different ways (Fig. 1).

In scheme 1 - 50 kg of the grape mash is macerated for about 6 hours, after which it is drained and pressed to obtain grape juice, which is subjected to alcoholic fermentation.

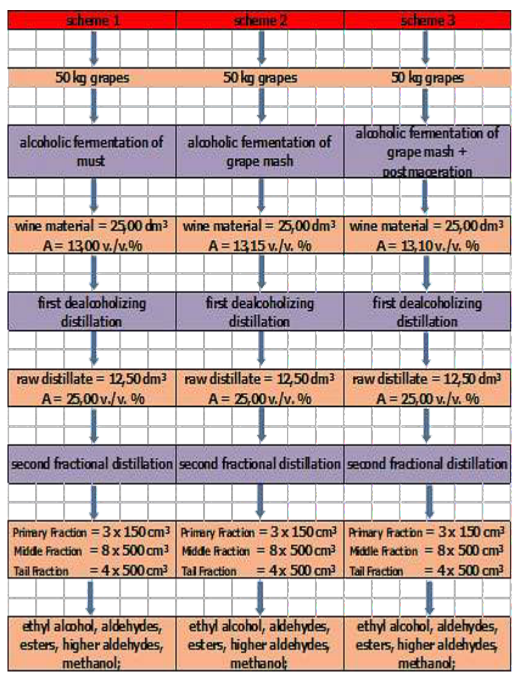

Fig. 1. Scheme of the experiments

In scheme 2 - 50 kg of the grape mash is directly subjected to alcoholic fermentation. After the end of alcoholic fermentation, the young wine is drained and pressed.

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In scheme 3 - 50 kg of the grape mash is directly subjected to alcoholic fermentation. After the end of the alcoholic fermentation, when the wine is dry, it is not drained, but macerated for another 5 d with the solid parts. Draining and pressing follows.

The obtained three wine materials under different vinification schemes are analyzed for the content of ethyl alcohol, aldehydes, esters, higher alcohols and methyl alcohol. Each of the three wine materials is subjected to a two-fold batch distillation carried out under the same conditions.

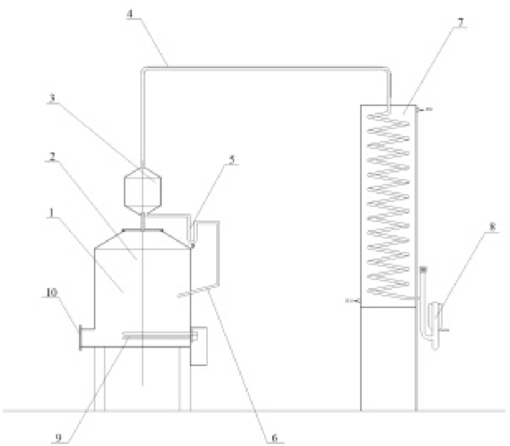

Fig. 2. Apparatus for double batch distillation: 1-distillation vessel; 2-hatch; 3-air dephlegmator; 4-pipeline; 5-hydraulic shutter; 6-pipeline; 7-coil cooler; 8-barrette; 9-electric heater; 10-hatch;

The double distillation is carried out with a distillation apparatus shown in Fig. 2, which consists of a distillation vessel (1), which is loaded with wine material and raw distillate for distillation through a hatch (2), and through another hatch (10) the de-alcoholised residue is removed. The heating to carry out the process is done by an electric heater (9). The resulting vapours as a result of heating and boiling are strengthened by an air dephlegmator (3), then transported through a pipeline (4), cooled in a coil cooler (7) and the cooled distillate flows through the barrette (8). The condensate obtained after dephlegmation is returned to the distillation vessel through a pipeline (6), which is equipped with a hydraulic shutter (5). The resulting distillate fractions are analyzed for the content of ethyl alcohol, aldehydes, esters, higher alcohols and methyl alcohol using standard methods of analysis [7].

3 Results and discussion

Table 1 shows the analytical data on the concentration of volatile substances of the three wine materials intended for the production of wine distillate, vinified according to the three different technological schemes. The concentration of ethyl alcohol, aldehydes, total esters, higher alcohols and methyl alcohol for the three wine materials were investigated.

Table 1. Chemical composition of the obtained wine materials depending on the method of vinification.

	Alcoholic fermentation of must	**Alcoholic fermentation of grape mash**	**Alcoholic fermentation of grape mash + post maceration**
Alcohol of the wine material, v/v.%	13.00	13.15	13.10
Aldehydes of the wine material, mg/dm^3	13.06	10.35	10.90
Total esters of the wine material mg/dm^3	89.00	129.60	151.00
Higher alcohols of the wine material mg/dm^3	193.40	220.50	231.40
Methyl alcohol of the wine material, mg/dm^3	104.60	165.00	196.00

The amount of fermentable sugars in grapes is mainly contained in its pulp, while the outer shell of the grape grain contains a smaller amount of monosaccharides, but in a concentration similar to that in its pulp [8]. On the basis of these facts, it can be expected that the amount of ethyl alcohol will not be significantly affected by the time of maceration the must with the solid parts. This is also confirmed by the results in Table 1, where the ethyl alcohol content is similar in the three wine materials and is around 13.00 vol.%.

The content of aldehydes in the three wine materials is relatively equal. Grape skins contain minimal amounts of aldehydes [9]. In the must-only vinification scheme, a slight increase in the value of aldehydes was observed - 13.06 mg/dm^3 compared to the values in the other two vinification schemes, namely 10.35 mg/dm^3 and 10.90 mg/dm^3. It can be assumed that the presence of more phenolic substances, which are known for their antioxidant capacity, in the two schemes with a longer contact of the liquid with the solid parts, leads to the prevention of oxidation of the must and a lower value of the amount of aldehydes in these two vinification schemes.

Analytical data from Table 1 shows that the amount of esters in scheme 1 is 89.00 mg/dm^3, scheme 2 has a value of 129.60 mg/dm^3 or an increase of 45.60%, and scheme 3 has a value of 151.00 mg/dm^3 or an increase of 69.70% compared to scheme 1 i.e. as the duration of contact time between the liquid phase and the solid parts increases, so does the amount of esters in the wine materials. This is most likely due, on the one hand, to the amount of ethyl acetate that is formed by the contaminating microorganisms found on the skins of the grapes, and on the other hand to the pleasant-smelling esters that are produced by the cultured yeast strain and are released intensively during post-maceration.

In scheme 1, the amount of higher alcohols is 193.40 mg/dm^3, in scheme 2 a value of 220.50 mg/dm^3 or an increase of 14.00 % is observed, and in scheme 3 a value of 231.40 mg/dm^3 is observed or an increase of 19.70% compared to scheme 1. This increase is most likely due to the increased amount of biomass that is formed when the alcoholic fermentation process is intensified, as is the case when grape mash is subjected to fermentation.

The amounts of methyl alcohol differ significantly in the three wine materials obtained by different vinification methods. In scheme 1, the value of methyl alcohol is 104.60 mg/dm^3, in scheme 2 the value of methyl alcohol is 165.00 mg/dm^3, which is a 57.70% increase in the quantity compared to scheme 1. In the vinification according to scheme 3 the value of methyl alcohol is 196.00 mg/dm^3, which is an increase in its quantity of 87.40% compared to scheme 1 and 18.80% compared to scheme 2. Methyl alcohol is obtained as a result of hydrolysis of pectin, under the action of pectolytic enzymes. Pectin is mainly contained in the skins of grapes [10]. It can be concluded that probably the large increase in the amount of methyl alcohol in the vinification schemes with longer contact of the skins with the liquid phase is precisely the result of the prolonged maceration.

The results of the implementation of the experimental schemes help to formulate the following conclusions:

- The vinification scheme has a significant influence on the chemical composition of the obtained wine materials.
- The most significant influence is on the content of higher alcohols, methyl alcohol and esters.
- The fermentation of grape mash leads to an increase in the content of higher alcohols, methyl alcohol and esters in the wine material by 14.00%, 57.70% and 45.60% respectively, and the fermentation of grape mash with subsequent post-maceration by 19.70% respectively, 87.40% and 69.70%.
- The scheme of cold maceration of the grape mash with subsequent draining and alcoholic fermentation of must only has a lower content of total esters, higher alcohols and methyl alcohol compared to the wine materials obtained by the other two vinification schemes. For this reason, we consider must fermentation to be the most suitable for the production of wine material with a lower content of impurities.

In Fig. 3, it is observed that there is no significant difference in the concentration of ethyl alcohol comparing the primary fractions of the distillates obtained in the three different ways of vinification. The same trend was observed in the mean and tail fractions of the three different schemes.

In Fig. 4 it is observed that there is a certain difference in the concentration of aldehydes comparing the primary fractions of the distillates obtained in the three different ways of vinification. The value of aldehydes in the primary fraction of scheme 1 (fermented must) is 5.40% higher compared to scheme 2 (fermented mash) and by 15.00% compared to scheme 3 (the distillation of wine material obtained during mash fermentation with subsequent post-maceration).

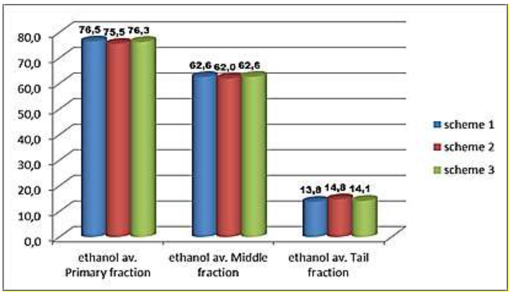

Fig. 3. Changes in the concentration of ethyl alcohol in the three fractions during the distillation process depending on the vinification method

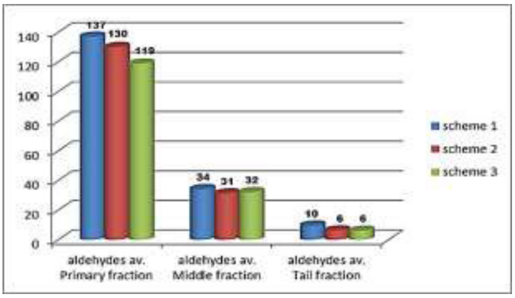

Fig. 4. Changes in the concentration of aldehydes in the three fractions during the distillation process depending on the vinification method

Similar amounts of aldehydes were observed in the middle and tail fractions of the distillates obtained during vinification according to the three different schemes. The higher amount of aldehydes in scheme 1 compared to scheme 2 and scheme 3 is most likely due to the increased amount of aldehydes in the wine material vinified with the least contact time between the liquid phase and the solid parts.

Fig. 5 shows that there is a difference in the concentration of total esters comparing the primary fractions of the distillates obtained in the three different ways of vinification. The value of total esters in the primary fraction during the distillation of wine material obtained during must fermentation (scheme 1) is the lowest.

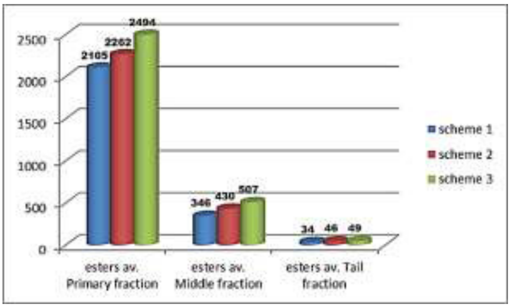

Fig. 5. Changes in the concentration of total esters in the three fractions during the distillation process depending on the vinification method

In the primary fractions during distillations of wine material obtained during mash fermentation (scheme 2) and mash with post-maceration (scheme 3) increase by about 7.5% and 18.5%, respectively. This increase is explained by the longer contact of the liquid phase with the solid parts in these two fermentation methods. In the average fractions of the distillates obtained during vinification according to the three different schemes, the same trend is observed as in the first fractions, namely the amount of total esters in scheme 3 is 18.00% greater than their amount in scheme 2 and by 46.50 % more than their amount in scheme 1. The amount of total esters in the tail fractions of the distillates obtained by the three vinification schemes is too small and can be said to be approximately similar. The higher amount of total esters in scheme 3 compared to the other two schemes is due to the increased amount of total esters in the wine material vinified with the longest contact between the liquid phase and the solid parts.

In Fig. 6 it is observed that there is a difference in the concentration of higher alcohols comparing the primary fractions of the distillates obtained in the three different ways of vinification. The same trend is observed in their middle fractions, and similar values of higher alcohols are observed in the tail fractions of the distillates obtained by three different vinification schemes.

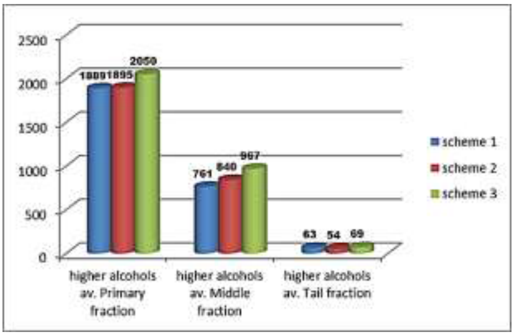

Fig. 6. Change in the concentration of higher alcohols in the three fractions during the distillation process depending on the vinification method

In the middle fraction of the distillate obtained according to scheme 1, the value of higher alcohols is 761.00 mg/dm^3, the value of higher alcohols according to scheme 2 is 840.00 mg/dm^3, and according to scheme 3 the value of higher alcohols is 967.00 mg/dm^3. That is, about 15.00% increase in the amount of higher alcohols is observed comparing scheme 2 and 3 and about 10.00% comparing scheme 1 and 2.

The higher amount of higher alcohols in schemes 2 and 3 compared to scheme 1 is most likely due to the increased amount of higher alcohols in the wine materials vinified with the solid parts.

In Fig. 7, it is observed that there is a difference in the concentration of methyl alcohol comparing the primary fractions of the distillates obtained in the three different ways of vinification. The same tendency is observed in their middle fractions, and in the tail fractions of the distillates obtained by three different vinification schemes, similar is observed.

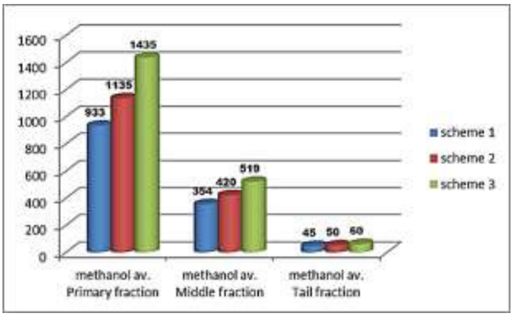

Fig. 7. Changes in the concentration of methanol in the three fractions during the distillation process depending on the vinification method

The greater amount of methyl alcohol in schemes 2 and 3 compared to scheme 1 is due to its increased amount in the wine materials vinified with the solid parts.

Methyl alcohol does not have a negative impact on the organoleptic properties of the wine distillate, but there is a permitted permissible rate for its content in grape brandies up to 2.00 mg/dm^3 a.a., which must be observed. In the three schemes of vinification, the value of methyl alcohol in the average fractions of the wine distillate, equated to absolute alcohol, is within the standard values of methyl alcohol.

The quality of the distillate is determined by the state of the middle fraction during the distillation of wine material. In the middle fraction of the distillate obtained according to scheme 1, the value of methyl alcohol is 354.00 mg/dm^3, the value of higher alcohols according to scheme 2 is 420.00 mg/dm^3, and according to scheme 3 the value of higher alcohols is 519.00 mg/dm^3. That is, about 23.50% increase in the amount of methyl alcohol is observed comparing scheme 2 and 3 and about 18.50% comparing scheme 1 and 2.

4 Conclusion

The vinification scheme has a significant impact on the chemical composition of the obtained distillates.

The most significant influence is on the content of higher alcohols, methyl alcohol and esters. The fermentation of grape mash leads to an increase in the content of higher alcohols, methyl alcohol and esters in the middle fraction by 10.00%, 18.50% and 24.00% respectively, and the fermentation of grape mash with subsequent post-maceration by 27.00% respectively %, 45.50 % and 46.50 %.

The scheme of insisting the grape mash cold with subsequent draining and alcoholic fermentation of must only has a lower content of total esters, higher alcohols and methyl alcohol compared to distillates obtained by the other two vinification schemes. For this reason, must fermentation is best suited to produce a wine distillate with a lower content of impurities.

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