Substantiation of modes and parameters of the red table sweet wine technology

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Abstract. The paper substantiates the modes and parameters of the red table sweet wine technology. It was found that the red table sweet wine material “Cahors experimental” (produced from two components: the main wine material “Ancelotta” with a volume fraction of ethyl alcohol of 14.8% and a mass concentration of sugars of 17 g/dm³, and the wine material “Syrah” with a volume fraction of ethyl alcohol of 1.2% and mass concentration of sugars 560 g/dm³) has a high quality with a high mass concentration of biologically active substances. In this case, the heat treatment of the pulp should be carried out at a temperature of 55-60 °C for no more than 2 hours; wort yield should not exceed 60 dkl/t. The mass concentration of sugars in the blend should be 110 g/dm³.

1. Introduction

Nowadays, there is a tendency to increase the demand for sweet wines with a low content of ethyl alcohol. This is due to the ease and harmony of this product.

The first experiments in the preparation of such products in our country date back to the 19th century. But due to laboriousness, large losses of raw materials, low yield of wort, the technology ceased to be applied, and dessert wines were produced mainly with the introduction of ethyl alcohol.

The development of technologies for the concentration of grape wort, stabilization and filtration make it possible to obtain today sweet wines with a low ethyl alcohol content and long-term guarantee stability.

Some brands of red sweet wines are used for religious ceremonies. These include the “Church of specific department”, “Vin Santo”, “New Jerusalem Altar”. This factor especially increases their value. However, the line of such products is very limited. Therefore, the urgent task is to expand the assortment of red sweet wines produced without the technology of fortified with ethyl alcohol.

In world practice, the technology features of dessert wines are explained by the unique climatic and political-economic environment in which they arose. Botrytized wines appeared in regions with a microclimate that contributed to the development of noble rot. The emergence of wine such as “Porto” is associated with the development of trade relations between Portugal and England due to conflicts and trade restrictions with France.

The following dessert wine technologies are distinguished:
- from grapes affected by Botrytis cinerea [1-2]. Using this technology, Tokay wines and “Sauternes” are prepared;
- from the dried grapes [3-6]. This technology provides for the drying of grapes for a certain time. In the future, dried grapes are processed and carried out the fermentation for a long time;
- boiling the wort. The technology of wort concentration is applied by means of “soft” boiling;
- icewine technology. Harvesting grapes produced in early winter. Due to the high mass concentration of sugars in the wort, fermentation is slow and stops spontaneously [7-10];
- alcoholization of the wort or pulp. Most Crimean dessert wines are produced using this technology.

In the production of red wines, the process of extracting coloring and phenolic substances from the solids of the pulp into the wort is of great importance. For this, various methods of exposure are applied: mechanical, thermal; treatment with enzyme preparations; cold maceration; complex processing of pulp with heat and vacuum, etc. It was revealed that the intensification of the extraction processes of coloring and phenolic substances allows to obtain wines of higher quality.

In the process of preparing wines of the “Cahors” type, heat treatment of pulp is most used.

2. Materials and methods
In the paper, the methods of analysis of wine materials generally accepted in wine chemistry were used.

The mass concentration of phenolic and coloring substances was determined using an Agilent Technologies chromatograph (model 1100) equipped with a G1379A flow-through vacuum degasser, 4-channel low-pressure gradient pump G13111A, G1313A automatic injector, G13116A column thermostat, and G1316A diode array detector. For carrying out the analysis, a chromatographic column 2.1 × 150 mm in size, filled with an octadecylsilyl sorbent, grain size 3.5 μm, ZORBAX-SB C-18 was used.

For carrying out the analysis, the following chromatography mode is set:
- feed rate of the mobile phase 0.25 ml/min;
- gradient chromatographic mode is presented in Table 1.

| Table 1. Gradient chromatography mode. |
|----------------------------------------|
| Time min | A% (0.6% TFA*) | B% 70 % - methanol (0.6% TFA) | C% 100 % methanol |
|-----------|----------------|-----------------------------|-----------------|
| 0         | 92             | 8                           | 0               |
| 8         | 62             | 38                          | 0               |
| 24        | 0              | 100                         | 0               |
| 24.1      | 0              | 0                           | 100             |
| 29        | 0              | 0                           | 100             |

* TFA-trifluoroacetic acid
- working pressure of the eluent 240-300 kPa;
- column thermostat temperature 45 °C;
- sample volume 2 μl;
  The detection parameters are set as follows:
- measurement scale 1.0;
- scan time 0.5 sec.
- Spectrum acquisition parameters - each peak is 190-600 nm
  Phenolic was identified by retention times of standards and spectral characteristics.

Previously, wine materials were centrifuged.

Grape processing was carried out in the conditions of the “Gurzuf” winery of the Massandra PJSC enterprise.

The control sample was the wine material for the “Vin Santo” wine, produced from the “Saperavi” and “Bastardo Magarachsky” grape varieties. During the processing, the technology of heat treatment of the pulp was used. Subsequently, for “Saperavi” wine material was used the fermentation of pulp. Wort obtained after heat treatment of pulp from the “Bastardo Magarachsky” variety was boiled in order to obtain a sugar-containing component.
In the production of wine material “Cahors experimental”, varieties “Ancelotta” and “Syrah” were used. The heat treatment of the pulp was carried out. In the production of wine material “Ancelotta” after heat treatment, fermentation of the pulp was carried out. During the fermentation process, the pulp was mixed at least five times a day. After fermentation, the pulp was directed to the separation of wort -gravity and pressing. “Syrah” wort was boiled to produce grape fruitage. From 113.0 dm$^3$ of wort taken for boiling, 51.0 dm$^3$ of grape fruitage was obtained. After that, fermentation was carried out to a volume fraction of ethyl alcohol of 1.2%.

For the production of wine materials, wort-gravity and first pressure wort (60 dkl/t) were used.

3. Results and discussions
Based on preliminary studies, we selected two grape varieties capable of accumulating more than 260 g/dm$^3$ of sugars: “Ancelotta” and “Syrah”. Due to the fact that “Ancelotta” wine materials have a very high content of coloring and phenolic substances, it was decided to prepare the main alcohol-containing component, from this variety. “Syrah” variety in our technology was used to prepare a sugar-containing component.

At the first stage of studies, the influence of the time and temperature of winefication of the pulp on the mass concentration of phenolic substances in the wort from “Ancelotta” and “Syrah” varieties was determined. The data obtained are shown in Figure 1.
Mass concentration of phenolic substances, mg/dm³
Temperature, °C
Duration of heat treatment, hour
b

Figure 1 shows that the optimal mode of heat treatment of the pulp is a temperature of 55-60 °C for no more than 2 hours. A further increase in processing time does not lead to a significant technological effect. Heat treatment of pulp at lower temperatures with a shorter contact will not allow to obtain wine material with a high content of phenolic and coloring substances.

“Ancelotta” wine material was produced with further fermentation of pulp to a mass concentration of sugars of 30 g/dm³. After removal from yeast, the volume fraction of ethyl alcohol in the wine material was 14.8%, and the mass concentration of sugars was 17 g/dm³.

When preparing a sugar-containing component from “Syrah” variety, after heat treatment of the pulp, it was self-cooled with further separation of the wort. Further, the obtained wort was boiled to a mass concentration of sugars of 580 g/dm³. Further boiling to a sugar concentration of more than 580 g/dm³ leads to a decrease in the organoleptic characteristics of wine materials due to the appearance of excessive caramel tones.

The boiled wort was fermented to a volume fraction of ethyl alcohol of 1.2%, the mass concentration of sugars was 560 g/dm³.

By blending the wine materials “Ancelotta” and “Syrah”, the sweet red wine material “Cahors experimental” was prepared. At the same time, it was found that the highest tasting grades were noted in a blend with a mass concentration of sugars of 110 g/dm³ (Figure 2).
Figure 2. Tasting grades of experimental blends at different mass concentrations of sugars.

The blend with a mass concentration of sugars of 110 g/dm$^3$ was distinguished by a bright flavour and a more subtle and harmonious taste, and as a result, from the studied samples received the highest tasting grade - 8.4 scores (Figure 2).

At the next stage of the research, the physicochemical parameters of the experimental wine materials and the control sample were determined. The data obtained are presented in Table 2.

Table 2. Physicochemical parameters of the wine materials studied.

| Sample Name                        | Volume fraction of alcohol, % | Mass concentration of sugars in terms of invert sugar, g/dm$^3$ | Mass concentration of titratable acids in terms of tartaric acid, g/dm$^3$ | Mass concentration of reduced extract, g/dm$^3$ | Mass concentration of volatile acids in terms of acetic acid, g/dm$^3$ | Mass concentration of free sulphur dioxide, mg/dm$^3$ | Mass concentration of total sulphur dioxide, mg/dm$^3$ |
|-----------------------------------|--------------------------------|---------------------------------------------------------------|-----------------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Grape sweet red wine material “Vin Santo” (control) | 9.1                           | 106                                                         | 6.5                                                                         | 22.0                                          | 0.54                                                                  | 13                                              | 104                                             |
| Red wine material “Ancelotta”     | 14.8                          | 17.0                                                        | 6.4                                                                         | 20.2                                          | 0.56                                                                  | 20                                              | 42                                              |
| Sweet red wine material “Syrah”   | 1.2                           | 558.0                                                       | 5.2                                                                         | 49.0                                          | 0.51                                                                  | 18                                              | 192                                             |
Based on the data given in Table 2, it should be noted that the volume fraction of ethyl alcohol in the experimental blend was 12.5%, the mass concentration of sugars, titratable acids fully meets the requirements of regulatory documents. Moreover, the content of volatile acids in the experimental blend is lower than in the control sample.

A research of the mass concentration of coloring substances in the studied wine materials was made. The data obtained are shown in Table 3.

Table 3. Mass concentrations of anthocyanins in the studied wine materials, mg/dm$^3$.

| Anthocyanins                                         | “Vin Santo” (control) | “Cahors experimental” |
|------------------------------------------------------|------------------------|------------------------|
| Delphinidin-3-O-glycoside                             | 32                     | 21                     |
| Cyanidin-3-O-glycoside                                | 6                      | 3                      |
| Petunidin-3-O-glycoside                               | 29                     | 23                     |
| Peonidin-3-O-glycoside                                | 18                     | 21                     |
| Malvidin-3-O-glycoside                                | 210                    | 215                    |
| Delphinidin-3-O-(6′-acetyl-glycoside)                 | 8                      | 9                      |
| Cyanidin-3-O-(6′-acetyl-glycoside)                    | 1                      | 3                      |
| Petunidin-3-O-(6′-acetyl-glycoside)                   | 1                      | 9                      |
| Delphinidin-3-O-(6′-p-coumaroyl-glycoside)            | 2                      | 16                     |
| Peonidin-3-O-(6′-acetyl-glycoside)                    | 6                      | 9                      |
| Malvidin-3-O-(6′-acetyl-glycoside)                    | 70                     | 65                     |
| Cyanidin-3-O-(6′-p-coumaroyl-glycoside)               | 0                      | 4                      |
| Petunidin-3-O-(6′-p-coumaroyl-glycoside)              | 3                      | 3                      |
| Peonidin-3-O-(6′-p-coumaroyl-glycoside)               | 4                      | 3                      |
| Malvidin-3-O-(6′-p-coumaroyl-glycoside)              | 23                     | 21                     |
| Total                                                | 413                    | 425                    |

The data presented in Table 3, indicates a higher content of anthocyanins in the experimental blend “Cahors experimental” in comparison with the control sample by 4%.

The content of Malvidin-3-O-glycoside in the studied samples slightly exceeds 50% of the total amount of anthocyanins; the content of Malvidin-3-O-(6′-acetyl-glycoside) was: 17% in “Vin Santo” and 16% in “Cahors experimental”; Petunidine-3-O-glycoside 6% for all test samples.

Mass concentrations of monomeric forms of phenolic substances were determined. The data obtained are presented in Table 4.

Table 4. Mass concentrations of monomeric forms of phenolic substances in the studied wine materials, mg/dm$^3$.

| Phenolic substances                      | “Vin Santo” (control) | “Cahors experimental” |
|-----------------------------------------|------------------------|------------------------|
| Hydroxybenzoic acids                    |                        |                        |
| Gallic acid                             | 24                     | 32                     |
| Lilac acid                              | 6                      | 7                      |
| Flavan-3-ol                             |                        |                        |
| (+)-D-Catechin                          | 40                     | 21                     |
| (-)-Epicatechin                         | 25                     | 13                     |
| Hydroxycinnamic acids                   |                        |                        |
| Kaftaric acid                           | 32                     | 71                     |
| Cutaric acid                            | 22                     | 41                     |
| Flavonols                               |                        |                        |
| Quercetin-3-O-glycoside                 | 32                     | 21                     |
Quercetin 12 14
Total 193 220

According to the data in Table 4, the mass concentration of monomeric phenolic substances in the experimental wine material is greater than in the control sample.

Oxycinnamic acids are represented in higher concentrations of monomeric phenolic substances in the studied samples. Mass concentrations of oxybenzoic acids in the experimental red sweet wine materials exceeded the control sample.

Thus, the mass concentration of anthocyanins and monomeric forms of phenolic substances in the wine material "Cahors experimental" is at a high level and exceeds the control sample.

Organoleptic characteristics of the studied wine materials are presented in Table 5.

Table 5. Organoleptic characteristics and tasting grade of experimental red sweet wine materials.

| Sample Name                              | Colour                  | Flavour                                      | Taste                                      | Tasting grade |
|------------------------------------------|-------------------------|----------------------------------------------|--------------------------------------------|---------------|
| Grape wine material "Vin Santo" (control)| intense red             | Bright, varietal with notes of cherry, morocco and violet | Full, harmonious, moderately tannin, with hints of cherry jam | 8.45          |
| Sweet red wine material "Cahors experimental" (blend) | red, with light onion shades | With hints of wild rose, wild medlar, caramel and ripe cherries | Full, harmonious, with a slight tannin in the aftertaste | 8.40          |

According to the data in Table 5, the control sample “Vin Santo” received a grade of 8.45 scores. The sample "Cahors experimental" was not significantly inferior in organoleptic qualities. By all tasting participants the presented samples were marked as high quality.

4. Conclusions

Thus, the performed studies showed that in the red table sweet wine material “Cahors experimental”, produced from “Ancelotta” and “Syrah” varieties without adding ethyl alcohol, the mass concentration of anthocyanins and monomeric forms of phenolic substances is at a high level and exceeds the control sample. Organoleptic evaluation showed that the sample "Cahors experimental" has a high-quality and is an original wine material.

The optimal modes of production technology for a new brand of red table sweet wine are: heat treatment of pulp at a temperature of 55-60 °C for no more than 2 hours; wort yield no more than 60 dkl/t; semi-dry wine material is prepared from “Ancelotta” variety; sweet wine material with a mass concentration of sugars of 560 g/dm$^3$ is prepared from “Syrah” variety. The mass concentration of sugars in the blend should be 110 g/dm$^3$.

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