INFLUENCE OF DEALCOHOLIZATION PROCESS TEMPERATURE ON THE QUALITY OF WHITE WINE CHARDONNAY

Taran N., Soldatenco E., Vasiucovici S., Soldatenco O.

PI Scientific and Practical Institute of Horticulture and Food Technologies, Chisinau, Republic of Moldova

Vasiucovici S: stoleicova_svetlana@mail.ru

Abstract: Detailed examination of existing technologies for low-alcohol wine production has shown that process of alcohol reduction leads to significant losses of aroma compounds from wine that exert a detrimental effect on wine quality. In this article the influence of dealcoholization process temperature using vacuum distillation method on the quality of white wine Chardonnay was studied. Obtained results demonstrated the major influence of temperature 40°C on the wine quality especially a significant depletion of wine aroma.

Keywords: dealcoholization process, temperature, volatile complex, quality

Introduction

Nowadays, the reduction of ethanol level became a notable topic in wine production. The problem of ethanol reduction was for the first time recognized by OIV in 2004 when the principle of the dealcoholization of wine under certain conditions was defined. OIV in adopted resolutions delineates such definitions as: “dealcoholization”, “partial dealcoholization” and “correction of alcoholic content” in dependence of alcoholic concentration in finished product. Republic of Moldova within the Technical Regulations "Organization Wine Market" approved the regulations regarding the correction of alcoholic content in wines, whereunder a maximum reduction of 20% of the initial alcohol content is allowed. However, technical standard base regarding the definitions of wines obtained in the process of dealcoholization is not elaborated until now [1]. On the basis of studied scientific literature, several factors determined production of low-alcohol wines: economical factor, which involves receiving of profit through product diversification or reduction of excise taxes on alcoholic beverages; social factor is related to health policies, which include healthy life promotion and minimizing the social harms from alcohol consumption; environmental factor represents combating with consequences of global warming. Therefore, production of wines with low alcohol content is of interest not only from economic and social, but also from scientific point of view. Relevancy of the problem is confirmed by multiple researches made by scientists from around the world: M. Bely (France), Gonçalves F. (Portugal), Saha B. (Australia), Balanuta A. (Republic of Moldova) [2, 3, 4, 5]. Besides this, scientists have developed a great number of methods and techniques for alcohol reduction on different stages of wine production, which include the utilization of prefermentative strategies, microbiological practices as well as physical methods. Physical methods are noted for high-efficiency and possibility to control the process of ethanol removal. Process of ethanol removal should be carried out in mild conditions without significant influence on wine quality [6].

Therefore, the main purpose of the process of ethanol removal is obtaining of high quality product. Nowadays, wines with low alcoholic content are on the market, but unfortunately the influence of process of ethanol removal on physical chemical composition is not studied.

Materials and methods

Research regarding the influence of dealcoholization process using vacuum distillation on quality of obtained wines was carried out in the laboratories of "Biotechnologies and Microbiology of Wine", "Quality testing of alcoholic beverages", in the department of Microvinification at the Scientific and Practical Institute of Horticulture and Food Technologies, as well as, in the laboratory «Wine Technology» of the North Caucasian Region Research Institute of Horticulture and Viticulture from Krasnodar (Russian Federation). In the capacity of subject of research experimental batches of white wines as well as partial dealcoholized white wines from Chardonnay grape varieties with different alcohol content was used. Process of ethanol removal from wines was carried out in laboratory conditions using vacuum rotary evaporator.Physical and chemical composition (alcoholic content, titratable acidity, volatile acidity, residual sugar concentration, pH etc.) of partial dealcoholized wines was carried out using conventional and standard methods of analysis as well as using FTIR spectrometer FOSS WineScan$^{TM}SO_2$ (Denmark). Analysis of aromatic complex of dealcoholized white wines was performed using Gas chromatography–mass spectrometry method.

Results and Discussion

Temperature is one of the most important factors influencing the rate of alcohol removal from wine using vacuum distillation process. It is commonly known that, the boiling point of the alcohol under atmospheric pressure is equal to 78˚C, but conduction of alcohol removal process under high temperatures can influence the composition of obtained wines and, in consequence, the quality of the final product is substantially deteriorated [6, 7]. However, the method of vacuum distillation can significantly reduce the boiling point of the alcohol to 25-30˚C. Thus, three temperatures of 20˚C, 30˚C and 40˚C were selected in order to study the influence of temperature on process rate and composition of white and red wines. Process of alcoholic concentration reduction was carried under constant pressure (4 kPa), volume (0,5 dm^3) and operating time (45 min). The obtained results are presented in table 1.

Table 1. Influence of dealcoholization process temperature on physical- chemical composition of white wine Chardonnay

Parameter	Initial	Temperature		
		20^0C	**30^0C**	**40^0C**
Alcohol content, % vol.	13,5±0,1	13,2±0,1	10,0±0,1	4,7±0,1
Mass concentration of, g/dm^3				
-titratable acidity	6,5±0,1	6,6±0,1	7,1±0,1	10,3±0,1
-volatile acidity	0,42±0,03	0,42±0,03	0,37±0,04	0,36±0,04
-residual sugars	1,3±0,5	1,3±0,5	2,1±0,5	4,8±0,5
-tartaric acid	3,4±0,1	3,4±0,1	3,6±0,1	4,9±0,1
-malic acid	2,4±0,4	2,4±0,2	2,6±0,1	3,9±0,1

Parameter	Initial	Temperature		
		20^0C	30^0C	40^0C
-lactic acid	0,10±0,03	0,10±0,03	0,20±0,03	0,50±0,05
-citric acid	0,20±0,04	0,20±0,05	0,30±0,04	0,50±0,03
pH	3,07±0,01	3,07±0,01	3,04±0,01	2,94±0,01
Organoleptic evaluation, points	7,9±0,01	7,9±0,01	7,9±0,01	7,4±0,01

Table 1 presents the influence of temperature on chemical-physical indices of obtained wines with reduced alcohol content. Temperature 20^0C has unessential influence on chemical-physical indices, due to low rate of the dealcoholization process. In addition, unperceptible increase in the mass concentration of titratable acids in the range from 6,5 to 6,6 g/dm^3 can be observed. The concentration of volatile acids, concentration of residual sugars and the pH value remain unchanged in the process of alcohol removal. The changes of one of the most important components of the chemical composition – organic acids were studied. From obtained results, mass concentration of tartaric, malic, lactic and citric acids remains unchanged in the process of ethanol removal at the temperature of 20°C.

The chemical-physical indices of white wines with reduced alcohol content obtained at 30˚C are shown in table 1. At this temperature, the process rate increases significantly as well as efficiency of ethanol removal from wine. An increase in the mass concentration of titratable acids is observed in the process of dealcoholization in the range from 6,5 g/dm^3 to 7,1 g/dm^3. Mass concentration of residual sugars varied from 1,3 to 2,1 g/dm^3. Concentration of organic acids has changed insignificantly. pH is another index that has changed in the process of dealcoholization from 3,07 to 3,04.

Temperature of 40˚C has the greatest influence on the chemical-physical parameters of obtained wines. Mass concentration of titratable acids increased practically twofold, which is associated with an increase in the content of organic acids presented in wine. Tartaric acid content varies from 3,4 g/dm^3 to 4,9 g/dm^3, malic acid from 2,4 g/dm^3 to 3,9 g/dm^3, lactic acid from 0,1 g/dm^3 to 0,5 g/dm^3 and citric acid from 0,2 g/dm^3 to 0,5 g/dm^3. Mass concentration of volatile acids decreased significantly from 0,42 g/dm^3 to 0,36 g/dm^3. Concentration of residual sugars has increased due to significant concentration of wine from 1,3 g/dm^3 to 4,8 g/dm^3.

Sensory evaluation of obtained wines has shown the influence of temperature on wine quality. Increasing of dealcoholization process temperature leads to significant reduction of alcoholic content as well as the organoleptic properties of obtained white wines.

Volatile complex in the process of alcohol removal using different physical methods undergoes significant changes. In this regard, in the thesis the influence of temperature on volatile compounds losses was studied. Results presented in the figures 1, 2, 3 and 4 show % losses of main classes of wine's volatile compounds.

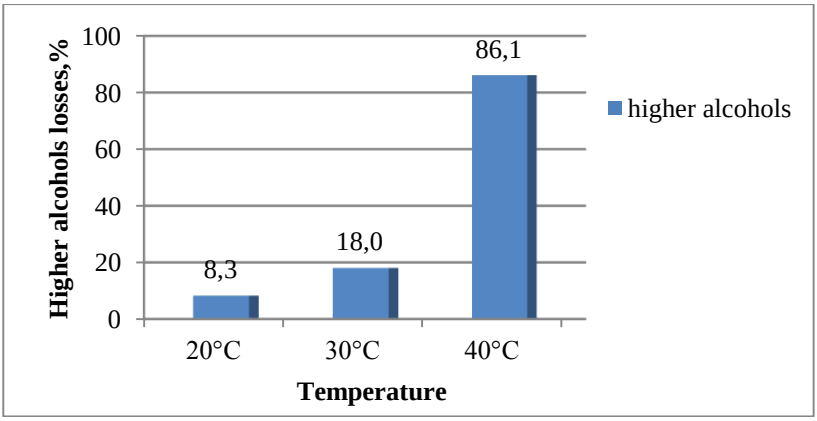

Fig.1 Influence of temperature of dealcoholization process on higher alcohols removal from wines

According to obtained results, temperature influences significantly on volatile complex of white wines. In the fig. 1 the losses of higher alcohols in the process of ethanol removal are presented. Obtained results demonstrate that at the temperature of 20°C losses of higher alcohols constitutes 8,3%, with subsequent increase of higher alcohols losses of 18,0% at the temperature of 30°C. Temperature of 40°C has the highest impact on higher alcohols losses and accounts for 86,1%.

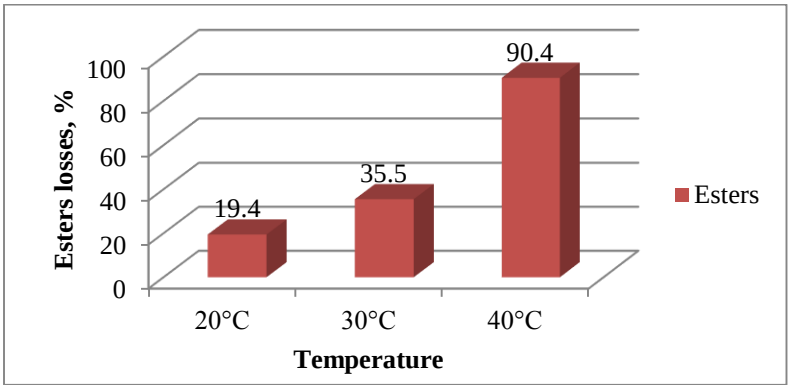

Fig.2 Influence of temperature of dealcoholization process on esters removal from wine

Esters are the most volatile wine components along with alcohol [8]. Therefore, temperature increase will exercise high impact on content of esters. Obtained results confirm the supposition made. Process of ethanol removal at the temperature of 40°C leads to practically complete removal of esters, which make up 90,4% from the total content. At the temperature of 20°C esters losses make up 19,4% and at the temperature of 30°C esters losses account for 35,5%.

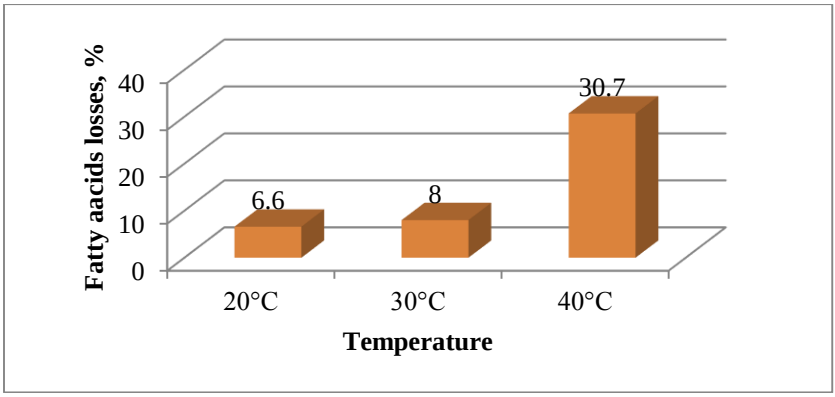

Fig. 3. Influence of temperature of dealcoholization process on acids removal from wine

Results regarding the losses of fatty acids in the dealcoholization process depending on the temperature are presented in fig. 3. Volatile acids are high boiling volatile compounds, as a result process of ethanol removal has minor impact on fatty acids losses. Results of research demonstrate that at the temperature of 20°C losses make up 6,6%, at the temperature of 30°C – 8,0%. As in the case of others volatile compounds temperature of 40°C influences significantly on fatty acids content, the percent of losses is equal to 30,7%.

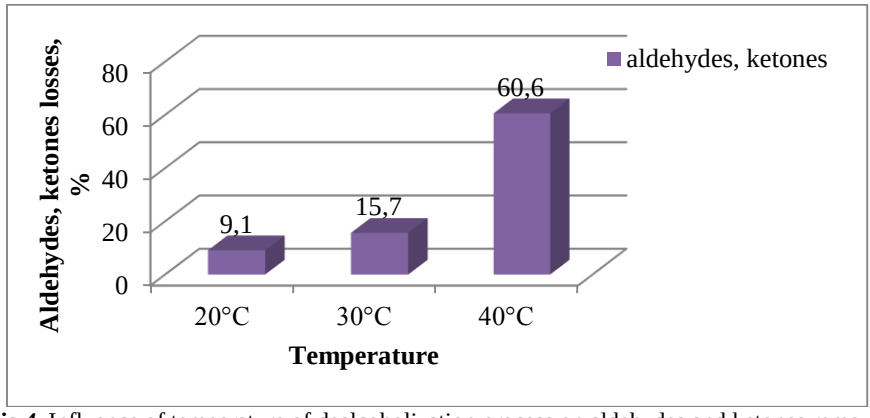

Fig.4. Influence of temperature of dealcoholization process on aldehydes and ketones removal from wine

In the fig. 4 the influence of temperature on aromatic aldehydes and ketones removal in the dealcoholization process was studied. The presented data demonstrate that losses of aldehydes and ketones depend on temperature. The highest loss is registered at the temperature of 40°C and is equal to 60,6%, followed by the temperature of 30°C with loss equal to 15,7%. The temperature of 20°C has the minor impact on aldehydes and ketones losses in the process of ethanol removal and consists 9,1%. Minimal losses can be explained by low efficiency of the process of ethanol removal at this temperature.

Conclusions

Thus, the experimental data regarding the influence of temperature on ethanol removal in the dealcoholization process of white wines, as well as on physical-chemical composition of obtained wines demonstrated the major influence of temperature 40°C on the wine quality especially a significant depletion of wine aroma (major losses of esters and higher alcohols). Temperature of 20°C has the minimal impact on composition of wine as a result of low efficiency of dealcoholization process. Temperature of 30°C can be recommended for removal of alcohol from wine using method of vacuum distillation because of efficiency improving of the process and insignificant influence on wine composition.

References

1. **Ruf J.C.** OIV rules and implications concerning reduction of alcohol levels. In: 1st International Symposium Alcohol level reduction in wine- Oenoviti International Network, France, Bordeaux, 2013, p.49-52.
2. **Bely M. et al.** Non-conventional yeasts and alcohol levels reduction. In: 1st International Symposium Alcohol level reduction in wine-Oenoviti International Network, France, 2013, p.33-37.
3. **Gonçalves F. et al.** Alcohol reduction in wine by nanofiltration. Some comparisons with reverse osmosis technique. In: 1st International Symposium, Alcohol level reduction in wine – Oenoviti International Network, France, 2013, p.64-67.
4. **Saha B. et al.** Review of processing technology to reduce alcohol levels in wines. In: 1st International Symposium Alcohol level reduction in wine-Oenoviti International Network. France, 2013, p.78-86
5. **Bălănuţă A., Scutaru A.** Production of natural low alcohol white Chardonnay by using immobilized yeast. In: Modern Technologies in the Food Industry, 2014, p. 148-153.
6. **Pickering G. J.** Low- and Reduced Alcoholic wine: A Review. In: Journal of Wine Research, 2000, vol. 11 (2), p. 129–144.
7. Vacuum distillation process. http://en.wikipedia.org/wiki/Vacuum_distillation (visited 07.06. 2015)
8. **Belisario-Sánchez Y. Y. et al.** Dealcoholized wines by spinning cone column distillation: Phenolic compounds and antioxidant activity measured by the 1,1-diphenyl-2-picrylhydrazyl method. In: J. Agric. Food. Chem., 2009, vol. 57(15), p. 6770-6778.