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New microbiological stabilization procedures: an alternative to reduce SO_2 levels in wine?

Sourced from the research article "Alternative Methods to SO_2 for Microbiological Stabilization of Wine" (Comprehensive reviews in food science and food safety, 2019)[1].

>>> SO_2 is the most widely used chemical additive in enology because of its antioxidant and antimicrobial properties. However, it can have negative effects on human health. Though this is rare, SO_2 can induce undesirable reactions in sensitive subjects. Regulatory changes concerning sulfite levels in wine have hence encouraged the entire wine sector to study alternative methods. Research has mostly focused on the study of chemical, biological and physical alternatives capable of guaranteeing the microbiological stability of wine. This article deals only with innovative physical techniques. <<<

Currently, the most commonly used physical process for the microbiological stabilization of wine is microfiltration (filtration at 0.1-10 µm pore size). However, the major disadvantage of this technology is related to the phenomenon of clogging of the porous medium by must or wine particles, causing a decrease in process performance and increased implementation costs for maintenance. In this context, a certain number of technologies have emerged and are of interest for application in the food industry because of their microbiological stabilization ability. In this article, all research activities on the application of these technologies to winemaking are briefly presented.

High Hydrostatic Pressure (HHP) treatment

HHP consists in subjecting a product to high pressures of between 100 and 1000 MPa induced by a fluid (often water) at low temperatures[2]. The increase in pressure causes a decrease in the volume of the product, thus affecting its molecular structure and more particularly the structure of the proteins of cell membranes, enzymes and ribosomes of microorganisms. These molecular changes alter the biological role of cell biomolecules leading to death of the microorganism. The first studies on the application of HHP to wine took place in 1994. Treatment in a closed reactor at a pressure of 400 MPa for 2 minutes and at 20 °C demonstrated an effect on the growth of various bacteria: *O. oeni*, *Lactobacillus* spp., *Acetobacter* spp.[1]. HHP treatment (500 MPa, 5 minutes) is also effective against yeasts: *S. cerevisiae* and *B. bruxellensis*, reducing their population by 99 % in wine without affecting its organoleptic properties[1]. In general, increased pressure and treatment time increase the antimicrobial action, but also cause accelerated aging of the wine, with a negative impact on its sensory properties.

Ultrasound (US)

Ultrasound technology uses frequencies between 20 kHz and 100 kHz. When propagated within a liquid, US can generate cavitation phenomena, namely the appearance of small bubbles that implode. This phenomenon results in a localized increase in temperature (5500 °C) and pressure (50 MPa) within the treated product. The destruction of microorganisms present in the medium is thus caused by disruption of their membrane due to this increase in temperature[1]. In winemaking, this technology combined with heat treatment (60 °C, 10 min) finds an application for disinfection of barrels, with a 95 % reduction in viable *Brettanomyces/Dekkera* yeast cells[3]. This treatment thus makes it possible to reduce SO_2 levels during cleaning of winemaking equipment. High-power US has also been applied to wine. Treatment at 24 kHz reduced the population of *Brettanomyces* by 90 % and lactic acid bacteria by 80 %. However, the sensory properties of the wine were considerably affected with the appearance of oxidative and smoky notes[1].

UV © Rémy Junqua

Ultraviolet (UV)

UV technology concerns electromagnetic radiation at a wavelength of between 100 and 400 nm. The most effective wavelength for inducing antimicrobial activity is between 100 and 280 nm (UV-C). The germicidal action of UV-C results from disruption of microorganisms' DNA, preventing their reproduction[4]. In 2011, a team of researchers studied the effectiveness of UV-C at 254 nm, the wavelength with the greatest germicidal power, in a grape juice. The treatment made it possible to inactivate various microorganisms: *Brettanomyces*, *Acetobacter*, *Lactobacillus*, *Pediococcus* and *Oenococcus*[5]. This study showed a decrease in treatment performance

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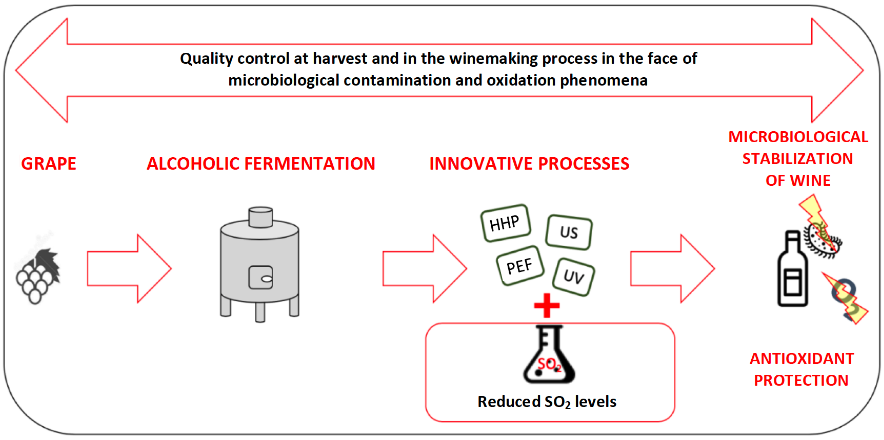

Figure 1. Overall winemaking strategy for the reduction of SO_2 levels using innovative physical processes.

with increased turbidity of the wine. It is best to apply the treatment to clear wines. In addition, a greater antimicrobial effect has been observed in white musts rather than red, probably because of UV absorption by polyphenolic compounds. To get round this problem, a new helical UV reactor has recently been developed[6]. In this system, the wine circulates in a transparent tube wrapped around a UV-C lamp under optimized operating conditions that favor Dean vortices and thus increase contact between the wine and the UV light. This system has been successfully applied on a semi-industrial scale to arrest the fermentation of sweet white wines and before bottling of red wines as an alternative to antimicrobial treatment with SO_2. No impact on treated wines was observed up to 20 months after treatment. The application of this technology to reduce SO_2 levels appears promising. However, its impact on the organoleptic qualities of white wines needs to be studied more precisely: UV at wavelengths around 370 nm, can lead to production of dimethyl disulfide, responsible for "rotten vegetable" odor[7].

■ Pulsed electric fields (PEFs)

PEF treatment is based on the application of short (a few microseconds to a few milliseconds) electrical pulses (5-50 kV/cm) at high voltage on a product placed between two electrodes. This causes electroporation of the microorganisms' cells with an increase in their permeability that leads to cell death. PEFs have been shown to be of interest in winemaking for a variety of applications, such as extraction and microbiological stabilization. The factors affecting the efficiency of the process are related to the operating conditions (intensity and treatment time), the microbial species and physicochemical characteristics of the medium. Treatment of red wines before bottling (20 kV/cm for 4 ms) can inactivate *B. bruxellensis*, *O. oeni* and *P. parvulus* without affecting the phenolic component of the wine[8]. The interest of using PEFs to arrest alcoholic fermentation during the production of sweet wines has also been demonstrated[8]. In conclusion, this technology has a variety of applications with a very short processing time and low energy consumption. In addition, the cost of the process is relatively low compared to other physical processes. For example, the cost for HHP is estimated at between 200 and euros700/ton while PEF costs around 20-80 euros/ton[8]. However, the effect of the treatment on the organoleptic characteristics of the wine is not well known.

■ Conclusions

The application of the innovative processes described in this article (Figure 1) is encouraging with a view to reducing SO_2 levels. However, their implementation on an industrial scale and on different wine matrices remains to be validated. In addition, all of these methods, depending on the operating conditions, have an effect on the organoleptic characteristics of the wine. Given this point, the major challenge remains the optimization of these processes in order to achieve the desired effect without affecting wine quality.

As with chemical alternatives, therefore, no technology is capable of totally replacing SO_2, especially with respect to its antioxidant activity. These technologies must therefore be considered as complementary strategies in an integrated approach to master all stages of winemaking from the vineyard to the cellar. ■

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1 Lisanti, MT., Baiotta, G., Nioi, C., Moio L., (2019). Alternative methods to SO_2 for microbiological stabilization of wine. *Comprehensive Reviews in Food Science and Food Safety*, 18, 455-479

2 Cao, X., Zhang, Y., Zhang, F., Wang, Y., Yi, J., & Liao, X. (2011). Effects of high hydrostatic pressure on enzymes, phenolic compounds, anthocyanins, polymeric color and color of strawberry pulps. Journal of the Science of Food and Agriculture, 91, 877–885.

3 Yap, A., Schmid, F., Jiranek, V., Grbin, P., & Bates, D. (2008). Inactivation of *Brettanomyces/Dekkera* in wine barrels by high power ultrasound. *Australian and New Zealand Wine Industry Journal*, 23, 32–40.

4 Bintsis, T., Litopoulou-Tzanetaki, E., & Robinson, R. K. (2000). Existing and potential applications of ultraviolet light in the food industry: A critical review. *Journal of the Science of Food and Agriculture*, 80, 637–645.

5 Fredericks, I. N., du Toit, M., & Krügel, M. (2011). Efficacy of ultraviolet radiation as an alternative technology to inactivate microorganisms in grape juices and wines. *Food Microbiology*, 28, 510–517.

6 Junqua, R. (2017). Procédés innovants de stabilisation microbiologique des moûts et des vins. Thèse de Doctorat, Université de Bordeaux.

7 Ribereau-Gayon, P., Glories, Y., Maujean, A., & Dubourdieu, D. (2006b). Handbook of Enology. The chemistry of wine and stabilisation and treatments, (Vol. 2). *Chichester, England: John Wiley & Sons Ltd.*

8 Delsart, C., Grimi, N., Boussetta, N., Sertier, C. M., Ghidossi, R., Peuchot, M. M., & Vorobiev, E. (2015). Comparison of the effect of pulsed electric field or high voltage electrical discharge for the control of sweet white must fermentation process with the conventional addition of sulfur dioxide. *Food Research International*, *77*, 718–724.