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Application of cross-flow filtration to wine production

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Summary

Technological evolution can be considered today similar to others production factors as work and money because it is a very important tool for industrial activity helping to the production rationalization and the product quality improvement. In the last years the technological innovation has concerned also the winemaking with techniques as the cross-flow microfiltration and the micro-oxigenation. These techniques have replaced or integrated the usual techniques with a reduction of productive costs and ecological impact and a improvement of product quality. Very important between these techniques is the cross-flow microfiltration used for the clarification of musts and wines. This technique is about to replace the traditional filtration with diatomaceous hearth determining a reduction of pollution and health hazard. In this work the results concerning the cross-flow microfiltration use in Piedmont wines production are reported. In particular the effects for product composition, work management and wine-making costs are examined.

Key word: wine, microfiltration, cross-flow filtration, diatomaceous earth

Introduction

Filtration is a essential technique for modern enology, as clearness is a important parameter for wine acceptability by consumers and opalescence and sediment sign of poor quality (Morando et al., 1986). Filtration is a separation technique used to eliminate a solid in suspension from a liquid by passing it through a filter medium consisting of a porous layer that traps the solid particles.

In wine the particles can be classified into three groups according their size: ions, colloids and suspended solids. Particle dimensions and deformability influence the filtration speed. Particularly the particles with a little deformability have a less clogging in comparison with the deformable ones also with a greater dimension. In wine industry the microfiltration is a technique used for separation of suspended solids, yeasts, bacteria and colloids. The most used membranes have a porosity between 0.2 and 1 µm. The availability of membranes with high permeability and a less porosity (cut-off 500.000-1.000.000 Dalton) and the use of cross-flow technique have determined an extension of the application of the membrane filtration systems (Dziezak, 1990; Zironi et al., 1992; Gostoli et al., 1993; Delfini et al., 1994; Morassut e Serra, 1996; Bernard, 1998, 1999; Gautier, 1998; Drioli e Todisco, 1999; Asola, 2000; Todisco et al., 2000).

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The cross-flow prevent the clogging because the particles are not press to filter as in perpendicular filtration but are carried out in parallel to the filter. The aim of this work was to compare a cross-flow filtration and a filtration through a diatomaceous earth precoat for some red and white Italian wines (Berger et al., 1997).

Material and methods

Housing with anisotropic polisulfon membranes (Wine Filter Koch-Romicon) was used. The fibers have a internal diameter of 1.1 mm and a surface of 10.5 m^2. The filtration is obtained for sieving but is possible also a repulsion between the sulfonic groups with a negative charge. The membrane has also an anisotropic structure with a conical profile and this limit the internal occlusion. The product is moved by a pump and a rate of retentate is send to a stoking tank. Filter capability is kept higher by means of flow direction inversion on the surface with an automatic system without the production breakdown. Technical characteristic of filtration plant were: Filtering surface 126 m^2; power 25 kW; flow 36 hL/h for red wine and 54 hL/h for white wine.

For each test the product was subdivided into two parts; the first was filtered by a membrane filter and the second with a diatomaceous earth precoat filter.

Wine analysis were performed according to Italian Standard Methods. Aroma was determined by extraction with C18 cartridge and GC-MS analysis. For the sensory analysis was applied the duo-trio test with 20 assessors. Trials were carry out on red wines Barbera and Dolcetto (120 hL), on white wines Cortese and Chardonnay (800 hL) and sweet wine Moscato (1000 hL).

Results

The final retentate volume (3-5 hL) and the flow rate (50 hL/h for red wines and 35 hL/h for white ones) are usual for this plant. Some additives with proteins could have some negative effects on filtrability of the wine, as depicted in a trial with the Dolcetto wine, where the flow rate was just 20 hL/h.

Permeate torbidity is always lower than 0.2 NTU and the filtrability index is higher than 5. During the filtration of Cortese wine the wine temperature is increased of a minimum of 3°C from the start to a maximum of 7 °C at the end of the process.

For white wines there are not chemical differences between test and treated wines exception for a small decrease (-5%) of tartaric acid and potassium in treated wines due to the higher effects of tartaric stabilisation after the cross-flow filtration.

For Moscato wine there are not differences in aroma compounds determined (exanol, Ox A, Ox B, Ox C, Ox D, linalol, HO-trienol, neral, α-terpineol, citronellol, nerol, geraniol, 2-phenil ethanol) due to different filtration techniques. Also for red wines there are non chemical differences between test and treated wines also for colour, anthocyans and flavonoids (Table 1)

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Table 1. Cross-flow filtration effects for colour of red wines.

	Barbera		Dolcetto	
	Diatomaceous earth	Cross-flow	Diatomaceous earth	Cross-flow
Colour intensity	0.406	0.407	0.684	0.650
Hue	0.763	0.790	0.578	0.577
Anthocyans (mg/L)	118	115	213	211
Flavonoids (mg/L)	845	845	1535	1561

Finally also the duo-trio test showed no differences between test and treated wines.

The only differences between the two techniques are present for economical aspects. With 35.000 hL/year of filtered wine, a depreciation of 15 years, a life of 7 years for the filter and a cleaning every 400 hL the final costs of wine obtained by cross-flow filtration is 0.155 € /hL lower than wine obtained by diatomaceous earth filtration.

Other differences between these techniques are present for work organisation. For the use of the cross-flow filter a worker is necessary only for start, ending and plant sanification because the process is totally automatic and there is nothing to add to the wine. On the opposite in a diatomaceous earth filtration a worker is necessary during all the treatment and for the handling of a both new and exaust diatomaceous earth both specific devices and operator protections are needed.

Also the cross-flow filtration need to have an inert gas inside the tank to prevent the oxidation in both starting and ending recipients. Also the correct cleaning of the membrane is needed to keep their life longer.

Discussion

The results obtained are many:

- there are not differences between the wines obtained by cross-flow and diatomaceous earth filtration;
- there are not significant temperature increments during the cross-flow filtration;
- the tartaric stabilisation is faster for wine after the cross-flow filtration compared to the wine filtered with conventional systems;
- the membranes cleaning and the choice of fining are essential for good performances of cross-flow filtration system;
- with the cross-flow filtration a reduction of costs for filtration media is possible;
- with the cross-flow filtration the environmental impact is reduced and less manpower is necessary.

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