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ANALYSIS OF THE FILTRATION EFFICIENCY OF WHITE WINES USING DIFFERENT FILTER AIDS

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1. Introduction

The global wine market, having recently entered into full crisis, is suffering some changes in its production and marketing. The reasons for these changes are mainly due to new trends in consumer demand for wine safety and quality standards at low cost. It is a new model of consumption defined as "daily wine" that large retail chains are producing with a "private label", buying quality wine at low costs and selling it in packages with their own brand. This is because the consumer, for everyday consumption, chooses a wine with a safe brand that meets his needs from an economic and qualitative point of view.

Against this trend, wine industries of a certain size, such as social cellars, in order to be included in this "network" that would enable them to overcome the current severe crisis in the sector, should focus on the rationalization of production techniques to reduce costs and improve the wine's quality. It is well known that the final price of wine depends nearly exclusively on production, transformation, and packaging costs. Reducing the costs for transformation and packaging would certainly give the product competitiveness on the market and this could be realized through the production of wine packaged in cask bladders ("bag-in-box"). Additionally, a recent study on the quality of wine carried out in Canada showed that wine packaged in bag-in-boxes preserves its qualitative characteristics [Blake 2009].

In the case of winemaking for the production of a wine stored in bag-in-boxes, filtration is a very important technique because it gives the finished product clearness and stability. Clearness is one of the qualities that the consumer demands from a good wine, especially in white wines; in fact, he sees no clear sign of an alteration even if the sensory qualities remain intact [Ribereau-Gayon 2004].

Filtration is one of the main operations in the production of wines. It has been variously studied concerning both the different filtration techniques and the impact they can have on wines especially in terms of colour, flavour profile, and the level of polyphenolic compounds.

Some authors have studied the membrane filtration of wines from Cabernet Sauvignon grapes, finding a significant influence of this operation on the flavour profile and polyphenols, as well as a decrease in the intensity of colour [Arriagada-Carrazana 2005]. Other authors [Peri 1988] compared the ultrafiltration, microfiltration and intermediate filtration techniques both on white and red wines obtaining differences in the taste and colour of wines. Still other authors [Urkiaga 2002] tested different polymeric microfiltration membranes in order to characterize the most suitable that guarantees an adequate hygienisation and clearness without altering the organoleptic properties of the product.

Moreover, it has been verified that with or without applying filtration before storing the wines in oak barrels, has a remarkable influence on the accumulation of the oak volatile compounds during aging for the Merlot variety [Jimenez Moreno 2007]. From a microbiological point of view, the influence of the filtration on the removal of yeasts and bacteria in different Spanish wines has been studied [Ubeda 1999]. A comparative study of crossflow microfiltration with the conventional filtration of sherry wines showed that microfiltration has a higher effectiveness than conventional filtration because it confers higher physic-chemical stability [Palacios 2002].

Among the classic filtration techniques, precoat filtration is one of most effective in the clarification of wine. The filter aids, the particles that form the precoat layer, due to their complex shape and surface properties, are able to capture very fine particles as well as macromolecules; diatomites (silica particles) is the most largely used to perform precoat filtration.

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To properly maintain the filter aid precoat layer and to maintain porosity, body-feed of filter aids are often applied [Boittelle 2008].

On the basis of what is set out above, a remarkable interest from researchers on wine filtration techniques and a multidisciplinary approach emerges.

The experimentation was based on the application of a low cost filtration technique on white wines in order to test the retention efficiency as a function of various filter aids used in the production of daily wines with an IGT (Typical Geographic Indication) brand.

2. Materials and methods

The study was conducted in May 2009 at the Social Winery "Alto Belice" located in Sancipirello, in the province of Palermo, using a white wine of the variety *Catarratto comune* with the Typical Geographic Indication (IGT) Sicily, produced in the 2008 vintage.

A bell filter with vertical disks by Padovan Company was used for the tests. It is a filter used in winemaking both for rough and polish filtrations of white wines.

The rough filtration has a sieving action on the surface, as it eliminates most of the impurities in suspension in the wine through filtration layers with high porosity. Then, the polish filtration is performed clarifying the wine, where the filtration layers predominantly operate for adsorption and depth [Peri 1983; Sciancalepore 2006].

The filter machine used during the tests consists of a stainless steel frame provided with wheels. The components of the machine are mounted on (Fig. 1). In particular, there is a stainless steel filtration chamber horizontally disposed with one end closed by a dome provided with a sluice to discharge the wash water. Inside there are 29 stainless steel disks with a diameter of 0.50 m each, vertically arranged and pressed on a hollow tree placed in communication, through special lightings, with the disks themselves and running by the collector of the filtrated wine that flows from these elements during the process. In addition, there is a device to unload the precoat at the end of the filtration cycle, a repassing of the wine tank made of a stainless steel bowl disposed between the chamber pressure and the base of the filter, a centrifugal feed pump, and a preparation tank of the suspension of the filter aid. The machine is also equipped with an electrical panel, a manometer, and valves of entry and discharge of the product. The machine was first used for the rough filtration and then for the polish filtration performed on the wine under study.

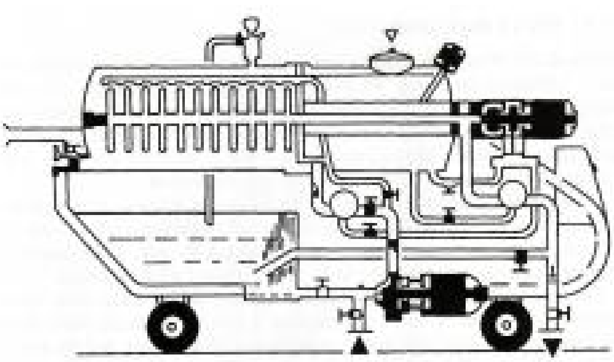

Fig. 1 - Scheme of the filter used during the tests.

In particular, the experimentation was conducted considering three filtration tests named A, B and C both for rough and polish filtrations. Tests A and B consisted in applying the filtration with the formation of a precoat using different filter aids, and test C was based on a precoat filtration and continuous body-feed. The operating cycle of tests A and B included the following stages: formation of the precoat, filtration and discharge of the spent filter cake, and washing of the filter. The operating cycle of test C included the formation of a precoat, filtration of the wine with the continuous addition of the filter aid, unloading of the spent filter cake, and washing of the filter.

The white wine subject to filtration, equal to 1.500 hl, was placed into three stainless steel tanks with a capacity of 500 hl each, respectively used for the A, B, and C tests. Before the experiments, physical-chemical analyses were performed to determine the following parameters: pH, alcohol content, temperature, viscosity, SO_2 as provided by the official methods of analysis according to EC Regulation 2676/90 (Table 1).

pH	3.3
Alcohol (%)	13.19
Temperature (°C)	23
Viscosity (Pa × s)	2×10^{-3}
Total acidity (g/l) in tartaric acid	4.65
Volatile acidity (g/l) in acetic acid	0.31
Free SO_2 (mg/l)	20
Total SO_2 (mg/l)	92

TABLE 1 - Results of the physical-chemical analyses on the wine.

The filtration process was set to perform first the rough and then the polish filtration applying the A, B, and C tests. In particular, the rough filtration, from which tests *Ar*, *Br* and *Cr* were obtained, was performed adopting two operating pressures: an initial quantity of wine equal to 250 hl was filtered to the operating pressure of 2 bar (*Ar1*, *Br1* and *Cr1*) and the remainder of 250 hl was filtered to the operating pressure of 1.5 bar (*Ar2*, *Br2* and *Cr2*). This was done to assess the influence of pressure in the different rough filtration tests. Then, the polish filtration was applied to all the tests coming from the rough filtration performed at the operating pressure of 2.0 bar, from which the tests *Ap1*, *Bp1* and *Cp1* (for wine subject to rough filtration at the pressure of 2.0 bar) and *Ap2*, *Bp2* and *Cp2* (for wine subject to rough filtration

Trade name	Nature	Colour	Permeability [Darcy]
Enolite K1	diatomites (silica particles)	pink	0.03 ÷ 0.05
Enolite K5	diatomites (silica particles)	white	5 ÷ 8
Europerl 800	Perlite	white	2.70
Filtrobril HS	based on pure cellulose with a high concentration of fiber	white	0.10
Filtrobril HM	based on pure cellulose with a mean concentration of fiber	white	0.25
Randacel 30	pure cellulose	white	0.10 ÷ 0.18
Randacel 50	pure cellulose	white	0.18 ÷ 0.25

TABLE 2 - Filter aids characteristics.

at the pressure of 1.5 bar) were obtained.

Table 2 shows the main features of the filter aids used in the filtration.

In test A the precoat was created using Europerl 800 (kg 2.5), Randacel 150 (kg 2.5), Enolite K5 (2.5 kg) for the rough filtration and Europerl 800 (kg 2.5), Randacel 50 (kg 2.5), Enolite K5 (2.5 kg), Enolite K1 (2.5 kg) for the polish filtration. The mixtures used are like “traditional” ones, that is, the most commonly used in social cellars.

In test B the precoat was created using Europerl 800 (kg 2.5), Filtrobril HM (2.5 kg), Enolite K5 (2.5 kg) for the rough filtration and Europerl 800 (kg 2.5), Filtrobril HS (2.5 kg), Enolite K5 (2.5 kg), Enolite K1 (2.5 kg) for the polish filtration. These mixtures contain Filtrobril, having better technical characteristics than Randacel in terms of adsorption and homogeneity of the precoat.

In test C the precoat was created using Europerl 800 (kg 2.5), Filtrobril HM (2.5 kg) for the rough filtration and Europerl 800 (kg 2.5) and Filtrobril HS (2.5 kg) for the polish filtration, while the continuous body-feed was made using Filtrobril HM (50 g / hl) in the rough filtration and Filtrobril HS (50 g / hl) in the polish filtration. It differs from the previous tests because of the type of filtration, with precoat and continuous body-feed, where mixtures of filter aids without diatomites are used.

In all the tests the time for the precoat formation was 15 minutes, while the flow of the filter was 125 hl/h.

From the experiments conducted in the cellar, 39 samples of wine were taken (12 for each test plus 3 samples of the initial wine), placed in bottles of 0.75 l and quickly transferred to a controlled temperature in the laboratory of the ITAF Department in order to perform the physical analyses for colour and turbidity.

The colour analysis was performed using the Beckman spectrophotometer DU-640 model, by assessing the absorbance at 420 nm. All the samples were previously centrifuged to allow the sedimentation of suspended particles. The tests were performed in three replicates obtaining 117 spectrograms.

To determine the turbidity of the wine, a portable torbidimeter was used (model Hi 93703, Hanna Instruments Company), with a scale from 0 to 1000 FTU calibrated at two points, 0.0 and 10 FTU.

The values obtained were compared through statistical analysis performed by the software: Statgrafics Centurion, XV version, Statpoint inc., USA.

Finally, the wines obtained from the different tests after running the polish filtration were submitted to a panel of 20 tasters using the Duo-Trio test [Roessler 1978] in order to determine any differences between them.

3. Results and discussion

The data obtained from laboratory analyses were always statistically processed and the average of the samples obtained with different operating pressures (2.0 and 1.5 bar) compared using the t-test at a 95% level significance, while the averages of the samples of the three tests of filtration (A, B and C) were compared using Duncan’s multiple comparison procedure at a 95% confidence level. Table 3 shows the results of the spectrophotometric analyses performed on the wine samples after rough filtration.

Sample	Absorbance 420 nm		Sample	Absorbance 420 nm	
	mean	st.dev.		mean	st.dev.
Control	0.00111 a	0.00010	Control	0.00111 a	0.00010
Ar1	0.00107 a	0.00005	Ar2	0.00103 a	0.00016
Br1	0.00107 a	0.00005	Br2	0.00093 a	0.00022
Cr1	0.00110 a	0.00018	Cr2	0.00107 a	0.00005

TABLE 3 - Results of the colour analysis of the wine samples after rough filtration.
Note: Different letters in the column denote a statistically significant difference at the 95.0% confidence level.

Comparing the means of the samples of the three types of rough filtration performed at the same pressure, there are no statistically significant differences with reference to the control test. Moreover, the comparison between the means of samples *Ar1* and *Ar2* referred to two different operating pressures, shows that there are no statistically significant differences, similar results are obtained by comparing the *Br1* samples with *Br2* and the *Cr1* samples with *Cr2*.

Table 4 shows the results of the spectrophotometric

Sample	Absorbance 420 nm		Sample	Absorbance 420 nm	
	mean	st.dev.		mean	st.dev.
Control	0.00111 a	0.00010	Control	0.00111a	0.00010
Ap1	0.00120 a	0.00017	Ap2	0.00107 a	0.00005
Bp1	0.00111 a	0.00009	Bp2	0.00118 a	0.00010
Cp1	0.00108 a	0.00011	Cp2	0.00107 a	0.00005

TABLE 4 - Results of the colour analysis of the wine samples after polish filtration.
Note: Different letters in the column denote a statistically significant difference at the 95.0% confidence level.

analyses performed on the wine samples after polish filtration.

Comparing the means of the samples of the three types of polish filtration performed at the same pressure, no statistically significant differences emerge also with reference to the control test. Moreover, the comparison between the means of samples *Ap1* and *Ap2* pertinent to two different operating pressures, used to perform the previous rough filtration, shows that there are no statistically significant differences, similar results are obtained by comparing the *Bp1* samples with *Bp2* and *Cp1* with *Cp2*.

The results show that the filter aids used in the two types of filtration, rough and polish, did not cause any change in the wine colour.

Finally, a comparison between the samples subject to rough filtration and polish filtration in the three tests A, B and C was made, from which there were no statistically significant differences in any case.

Table 5 shows the results of the turbidity analyses performed on the wine samples after rough filtration. The comparison among the means of the three types of filtration and the control, shows that there are always statistically significant differences at the operating pressure of 2.0 bar and 1.5 bar, except for the *Br2* and *Cr2* samples.

Sample	Turbidity [FTU]		Sample	Turbidity [FTU]	
	mean	st.dev.		mean	st.dev.
Control	144.00 a	3.605	Control	144.00 a	3.605
Ar1	125.00 b	12.165	Ar2	108.67 b	15.503
Br1	51.04 c	0.816	Br2	38.63 c	0.308
Cr1	33.87 d	1.838	Cr2	25.11 c	1.752

TABLE 5 - Results of the turbidity analysis of the wine samples after rough filtration.
Note: Different letters in the column denote a statistically significant difference at the 95.0% confidence level.

Comparing the means of the samples of the same type of filtration performed with different operating pressures, statistically significant differences were obtained in test B, namely the *Br1* and *Br2* samples and test C with respect to the *Cr1* and *Cr2* samples, while there are no differences between the test A samples.

The results of the analysis show that turbidity values after rough filtration have a decrease of 60% going from test A to test B and 73% going from test A to C at the operating pressure of 2 bar. A pressure of 1.5 bar results in a decrease in turbidity of 65% moving from test A to B and 77% from test A to C. Tests B and C respectively show a decrease in turbidity of 24% and 26%, going from a 2.0 to 1.5 bar.

Table 6 shows the results of the turbidity analysis performed on the samples of wine after polish filtration.

Sample	Turbidity [FTU]		Sample	Turbidity [FTU]	
	mean	st.dev.		mean	st.dev.
Control	144.00 a	3.605	Control	144.00 a	3.605
Ap1	19.64 b	0.426	Ap2	18.85 b	0.173
Bp1	17.17 c	0.175	Bp2	15.48 c	0.313
Cp1	10.38 d	1.009	Cp2	5.13 d	0.599

TABLE 6 - Results of the turbidity analysis of the wine samples after polish filtration.
Note: Different letters in the column denote a statistically significant difference at the 95.0% confidence level.

The comparison among the means of the samples of the three tests after polish filtration shows that there are always statistically significant differences between the various tests; even within the same test between samples *Ap1* and *Ap2*, *Bp1* and *Bp2*, *Cp1* and *Cp2* there were statistically significant differences. Also note that the best result in terms of turbidity is achieved in test *Cp2* with a value of 5.13 FTU; the turbidity value of wine in *Cp2* test is lower than Ap2 and *Bp2*, respectively 73% and 67%. Finally, the turbidity value in test *Cp2* is lower by 51% compared to test *Cp1*.

The data above show that the filter aids used to perform the various types of rough and polish filtration have led to changes in wine turbidity.

Finally, a comparison of the turbidity of the samples subject to rough and polish filtration in tests A, B and C was made, always showing statistically significant differences at the 95% confidence level.

The data above show that rough and polish filtered wine had a good reduction in the level of turbidity.

The results of the sensory test are shown in table 7.

Number of tasters*: 38
Positive recognition: 22
Minimum number of positive responses (p=0,05): 25

TABLE 7 - Results of the Duo-Trio Test. *To be intended as the number of recognitions.

Analyzing the answers given by the members of the sensory evaluation panel, although the most positive awards (22 vs. 16), no differences were found in terms of aroma between the different tests.

4. Conclusions

Very interesting results emerged from the experiments on the application of three filtration tests through the use of different filter aids for the production of an IGT Sicily wine for "daily" consumption.

The wines obtained from the different tests showed no changes in terms of colour and aromas, while remarkable differences were obtained with regards to turbidity.

The test that gave the lowest value of turbidity of the final wine was the precoat and continuous body-feed filtration through the use of Filtrobril HM and HS filter aids both for the formation of a precoat and for body-feed, giving the filter a high value of permeability and stiffness. It allowed to reduce by one step the wine turbidity of 82% in the rough filtration and 96% in the polish filtration. With regards to the process parameters, with particular reference to the different operating pressures, the results confirmed that lower values of pressure allow to further improve the retention efficiency of the filter media with lower values of turbidity of 51% compared with the similar test.

Therefore, the study allows to affirm that for the marketing of wide consumption wine at low prices, it is critical to apply the correct filtration technique in order to obtain a competitive product on the world market. The wine obtained from the C test, in fact, has excellent qualitative characteristics to be packaged in bag-in-box immediately after stabilization. The other tests, however, produced wines with turbidity values that can not be directly marketed in any form. These, in order to achieve the characteristics of the wine obtained from test C, require further treatment, thus inevitably increasing management costs and reducing competitiveness.

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Summary

The global wine market, having recently entered into full crisis, is suffering some changes in its production and marketing. The reasons for these changes are mainly due to new trends in consumer demand for wine safety and quality standards at low cost. Social cellars, in order to be included in this new trend, should focus on the rationalization of the production techniques to reduce the costs and improve the quality of wine. In the case of winemaking for the production of a wine stored in a bag-in-box, filtration is a very important technique because it gives the finished product clearness and stability. The experimentation was based on the application of a low cost filtration technique on white wines in order to test the retention efficiency as a function of various filter aids used in the production of daily wines with an IGT (Typical Geographic Indication) brand.

The results show that wines obtained from the different tests had no changes in terms of colour and aromas, while remarkable differences were obtained with regards to turbidity.

Keywords: filtration, white wine, wide consumption.

Report on the 38th International Symposium
Actual Tasks on Agricultural Engineering
22-26 February 2010, Opatija, Croatia

The 38th International Symposium **Actual Tasks on Agricultural Engineering** was held on 22-26 February 2010 in the Grand Hotel "Adriatic" Opatija, Republic of Croatia. The principle Organiser, the Agricultural Engineering Department, Faculty of Agriculture, University of Zagreb was supported by the following frameworks: the Department of Agricultural Engineering, Faculty of Agriculture, University J.J.Strossmayer, Osijek, the Department of Bio-systems Engineering, Faculty of Agriculture, University of Maribor (Slovenia), the Agricultural Institute of Slovenia, the Hungarian Institute of Agricultural Engineering Gödöllö and the Croatian Agricultural Engineering Society. Co-sponsors of the Symposium were CIGR, EurAgEng, AAAE and the Association of Agricultural Engineers of South Eastern Europe (AAESEE).

This year 80 participants from 13 countries attended the Symposium. It consisted of an Opening Session and six Topic Sessions covering all the broad subjectareas that fall under the scope of Agricultural Engineering. At the Opening Session Prof. Milan Mesic, Vice-Dean of the Faculty of Agriculture, University of Zagreb, delivered his speech emphasising the importance of the Event and its long tradition. The Convenor, Prof. Silvio Kosutic ended the Opening Session bringing the greetings of the Croatian Society of Agricultural Engineering to the audience. A number of lectures followed, among which are worth mentioning: "**A multi-ring model to simulate particle-based systems in biomaterials transport"** presented by MSc Jalal Kafashan from Belgium, **"Wine growing and producing farm buildings: Meta – design analysis for definition of spatial layouts** given by Dr.sc. Stefano Benni from Italy, "**New possibilities for technology of potato fertilization"** featured by Dr. J. Cepl from Czech Republic, "**Using Jathropa (*Jathropa curcas* L.) vegetable oil in biodiesel production"** delivered by Prof. Dr. Miran Lakota from Slovenia, "**Monitoring of site specific Fe and Zn variability on the apple area using the GIS based spatial pattern maps"** proposed by Dr. M. Rustu Karaman from Turkey , "**The effects of the relationship between machine and plant on the losses and profitability- (example of dry pea harvesting)**" introduced by Prof. Istvan Husti from Hungary and "**Utilisation possibilities of biomass from agriculture as an energy supply in Slovenia**" highlighted by Dr. Viktor Jejcic from Slovenia. In the Topic Sessions, each starting with a review report, 40 papers were discussed, in oral presentation. At the Closing Session the Convenor emphasised the role of EurAgEng and CIGR in the ecologically sustainable development of agriculture and in the preservation of the rural cultural heritage within the East-European countries. Participants were given printed copies of the Proceedings consisting in Volumes of 471 pages,containing 45 papers. Papers from the Proceedings have been indexed in database ISI Proceedings since 1997. Maziva Zagreb d.d.-INA group (national petrol company) presented its new palette of bio-degradable oils emphasising the progress made in keeping pace with well-known worldwide competitors. Other companies like Same-Deutz Fahr, Agco, highlighted their current programmes by means of video and oral presentations during afternoon Sessions.

Information regarding the 39th Symposium in the year 2011 will soon be available at the web site: http://atae.agr.gr

Prof. Silvio Kosutic, Convenor of the Symposium
Prof. Daniele De Wrachien, Past President of EurAgEng