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A new technique for exploitation of wine lees

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Abstract

The possibility of obtaining high quality wine from lees could increase value added for farm productions. A new technique introduced on an industrial scale to provide wine from lees of different origin is presented. After racking, the lees are collected in an innovative steel system and processed in controlled conditions of temperature, micro-oxigenation and cycles of remixing. During the treatment, an increase of color intensity, total polyphenols and total polysaccharides of wine from the lees was detected while the hue was stable. The obtained results indicate that the proposed method could be an effective tool for exploitation of the lees on winery scale. The new technology strongly reduced the time necessary to reach positive oenological objectives.

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*Keywords:*lees; winemaking; polysaccharides; polyphenols; astringency; wine color.

1. Introduction

Wine lees are the residue that forms at the bottom of vessel containing wine during the storage or after treatments. After racking, lees are collected at the winery and then disposed. Some particular types of wine are left in contact with their lees during aging and only a small part of lees are used in traditional aging. Sparkling wine, obtained with champagne method, are aged on lees after foaming. In general, the major effect of aging on lees is the reduction of color and aroma oxidative phenomena in white wine (Lavigne et al., 2007). More recently, the practice

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of aging on lees has spread in making red wine. In this case, colloids of lees prevent the precipitation of tannins and anthocyanin complexes and the practice can lead to a better stability of wine color (Escot et al., 2001). Therefore, lees are characterized by an interesting oenological potential due to their complex composition and properties (Pérez-Serradilla and Luque de Castro, 2008). Microorganisms are the main part of this matrix, while tartaric acid and inorganic matter are minor. During aging, yeast autolysis modifies the composition of lees in terms of wine active compounds (Rosi et al., 1999; Del Barrio-Galán et al., 2011). Mannoproteins, lipids, volatile compounds and enzymes of lees are involved in the improvement of wine quality. The aromatic composition of wine is deeply modified during the aging on lees. In general, the contact with lees produces less astringent wine, with a slightly less intensity of color. Lees play a role in the removal of undesirable compounds of wine such as volatile phenols and residues of treatments (Pérez-Serradilla and Luque de Castro, 2008). However, off-flavors of wine can arise during aging on lees. Lees can be responsible for the presence of precursors and enzymes that under favorable conditions can lead to the synthesis of biogenic amines (González-Marco andAncín-Azpilicueta, 2006). These compounds are responsible for disagreeable odors commonly reported and are also a risk for consumers due to their physiological effects (Bauza et al., 1995). Long times, frequent “bâtonnages”, and close monitoring of the evolution of the product are required to achieve positive results. A strategy of sustainability for farms must provide processes for the efficient exploitation of by-products. Recently, a new technique was tested on industrial scale for the management of total wine lees from Sangiovese grapes (Fia and Gori, 2014). The present study arises from the need to develop an efficient alternative method for the exploitation of lees with the main objective of obtaining high quality wine and increasing the added value for farm productions.

2. Materials and methods

2.1 Processing system

An innovative system has been introduced on an industrial scale for lees processing. It is a stainless steel tank, 25 hL capacity, insulated for 75% of its surface and equipped with several accessories for the optimization of loading, mixing, draining, separation of seeds and discharge of semi-solid residue. The core of the system is composed of four whorls to stir up the lees. The device automatically controls the operations of remix, pump-over, temperature and micro-oxygenation of the product. A semi-automatic prototype, capacity 12.5 hL, was used for the tests conducted in 2012.

2.2 Processing techniques

At the winery, a new technique was applied to provide wine from the lees of different origin. For the tests A and B lees from Sangiovese grapes (80%) and other red variety of red grapes (20%), vintage 2012, were used. Lees from Sangiovese grapes (100%) were used for the tests C, D and E, vintage 2013. Finally, tests F, G and H were conducted with lees from mixed variety of grapes (Cabernet Franc, Syrah, Merlot, Montepulciano, Cabernet Sauvignon, Viognier) originated from the farm processing, vintage 2013. The grapes were harvested in excellent health and vinified depending on the winery protocol. After completion of alcoholic and malolactic fermentations, the wines were kept in a tank for sedimentation and then racked. The lees were collected in a steel tank and added with SO_2 (60 mg/L). The lees, with density varying from 1.1 to 1.4 g/L, were pump-overed for 30 min, used to fill the new system and then processed at 22 °C. Tests A and B were conducted with the prototype and the lees were stirred every two days for 30 min. At the end of the treatment, lees were kept still inside the system at 20 °C. Samples were taken at the beginning and at the end of treatment (30 and 60 days for test A and B, respectively). Test B was set up 30 days after test A, using older lees. For tests C, D, E, F, G and H (vintage 2013), the lees were stirred every 8 h for 10 min for seven days and 3 mg/mL/month of O_2 were provided. Then the lees were kept still inside the system at 20 °C, with micro-oxygenation (3 mg/mL/month). Immediately after a remixing, samples were taken directly from the system at the beginning (0), after 3, 7 days of treatment and one month later (30). About seven days passed between each processing. Indeed, samples E and H match with the oldest lees. A β-glucanase commercial preparation (10 g/hL) was added to the lees at the beginning for tests C, D, F and H. Control samples

(CA, CB, CC, CD, CE, CF, CG and CH) were obtained from the tanks where lees were maintained still at 20°C, without providing O_2 and with SO_2 added (60 mg/L).

2.3 Analytical measurements

Samples of lees were centrifuged for 10 min, at 12000 rpm, 4 °C. The clear supernatant was used to determine the following parameters. Color intensity (I) and hue (H), total polyphenol (TPI_{280}), total flavonoids (TF), total anthocyans (TA) and total flavonoids non-anthocyanic (TFn) following the methods described by Di Stefano et al., (1989). Monomeric (Mon %), polymeric (Pol %) and copigmented (Copig %) anthocyanins, cofactors (C) were determined following the method proposed by Boulton (1996). Astringency mucin index (AMI) was determined as described by Fia et al., (2009) and gelatine index (G) as described by Glories (1976). Total polysaccharides (TP) was obtained following the method described by Usseglio-Tommaset (1976). Proteins isolated by precipitation with ethanol and the protein content were evaluated on the ethanol extract (Bradford, 1976; Moreno-Arribaset al., 2002). A 30 mL volume of absolute ethanol was added to 10 mL of must and wine. After 1 h at 0 °C, samples were centrifuged at 12000 rpm, at 4 °C, for 10 min. The obtained pellet was washed twice with ethanol and the excess ethanol gently removed. The pellets were dried at 40 °C for 1 h and then solubilized in 1.0 mL of distilled water. The total protein (TPr) were quantified by Protein Assay kit (Bio-RadHercules, CA, USA). A standard curve of bovine serum albumin (Sigma-Aldrich, Milan, Italy) was prepared in a range of concentration from 0.2 to 1.4 mg mL^{-1}. All measurements were carried out in triplicate and averaged.

3. Results and discussion

Wine samples A, C and F are grouped according to the vintage, variety of grapes and type of the lees treatment by the Principal Component Analysis (PCA) of the chemical parameters (Fig. 1). A large part of the variance (72%) is explained by the first two principal components. Samples A, C and F correspond to the wines obtained from the processing of fresher lees.

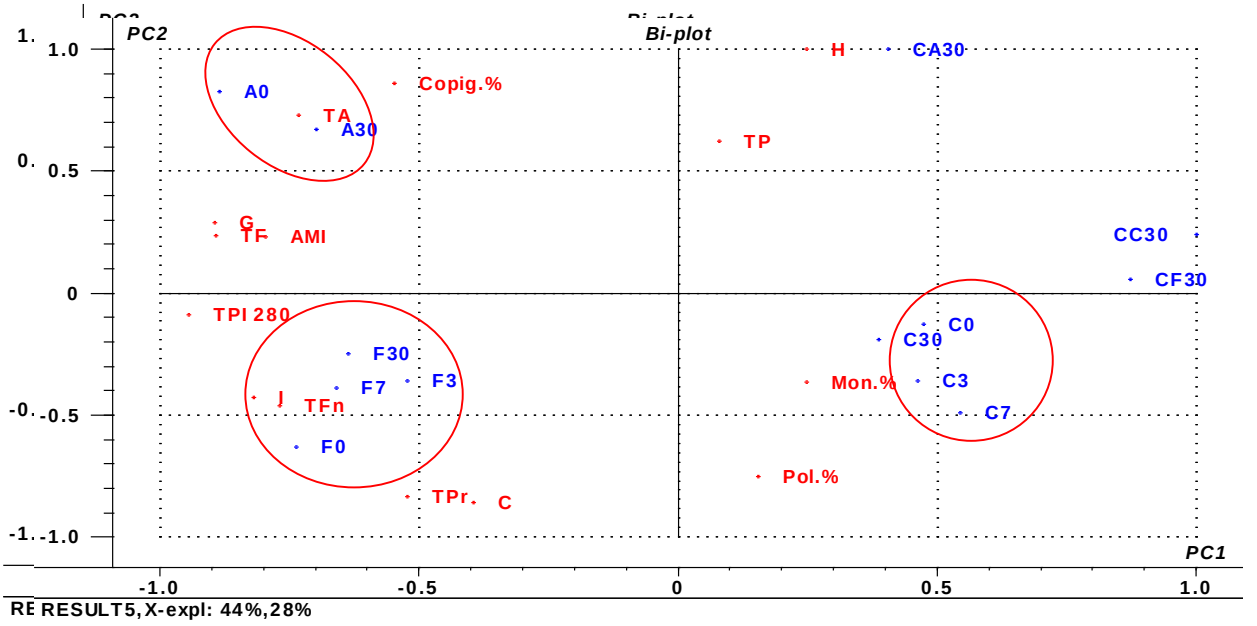

Fig. 1. PCA of the chemical parameters of samples A, C and F at the beginning (0), after 3, 7 days of treatment and one month later (30). CA30, CC30 and CF30 are the control samples after 30 days. Color intensity (I) and hue (H), total polyphenol (TPI280), total flavonoids (TF), total

anthocyans (TA), total flavonoids non-anthocyanic (TFn), Monomeric anthocyanins (Mon %), polymeric anthocyanins (Pol %), copigmented anthocyanins (Copig %), cofactors (C)), astringency mucin index (AMI), gelatine index (G), total polysaccharides (TP), total protein (TPr).

In these tests, the control samples resulted on the opposite side of the graph with respect to the samples of wine from treated lees A30 and F30, analyzed one month after beginning the processing. The treated samples were different from the control for the most part of the chemical parameters measured that were significantly higher, except for hue. After 30 days, the processed samples A30 and C30 were different from the sample taken at the start (A0 and C0) for total polysaccharide content, which was higher in the wine from treated lees (Table 1).The release of mannoproteins, parietal polysaccharides of yeast, during aging on lees was previously reported by other authors (Pérez-Serradilla and Luque de Castro, 2008). Several months were required to obtain a significant increase of these compounds (Loira et al., 2013). The proposed technique strongly reduced the time necessary to reach this objective. Some parameters of phenolic matter and color of the treated samples contribute to distinguish the processed samples from the control. In 2013, with the introduction of the new system, only seven days of processing led to a significant increase of color intensity. Generally, a decrease of anthocyanins in wines after contact with lees is reported by other authors (Pérez-Serradilla and Luque de Castro, 2008). It can be assumed that the observed increase in color intensity of wine is due to the release of pigments adsorbed on the matrix obtained by the stirring technique and with the aid of the β-glucanase preparation added. The reactivity of polyphenols against proteins, measured in terms of AMI, slightly decreased during processing indicated that the final wine can be perceived as less astringent. However, AMI of processed samples was higher with respect to that of the control which was at a very low level. An excessive reduction of AMI could reveal a loss of body of the wine (Vincenzi et al., 2013).

Table 1. Chemical parameters of the samples A, C and F at the beginning (0), after 3, 7 days of treatment and one month later (30). CA30, CC30 and CF30 are the control samples after 30 days. Color intensity (I) and hue (H), total polyphenol (TPI280), astringency mucin index (AMI), total polysaccharides (TP), total protein (TPr).

Sample	*I*	*H*	TPI_{280}	*AMI*	*TP (g/L)*	*TPr (mg/L)*
A0	6.2 ± 0.1b	0.8 ± 0.02b	48.1 ± 0.2c	18.2 ± 0.0c	1.4 ± 0.0a	23.2 ± 1.0c
A30	6.4 ± 0.1c	0.7 ± 0.02a	47.5 ±0.2b	12.4 ± 0.0b	1.7 ± 0.0b	11.9 ± 2.6b
CA30	3.2 ± 0.2a	0.9 ±0.02c	39.0 ±0.2a	8.3 ± 0.4a	1.4 ± 0.0a	4.3 ± 1.7a
C0	3.4 ± 0.2b	0.7 ±0.02b	37.0 ±0.2b	7.8 ± 0.5c	1.5 ± 0.0b	15.4 ± 2.1b
C30	5.3 ±0.1c	0.6 ±0.02a	41.0 ±0.2c	6.2 ± 0.4b	1.7 ± 0.0c	1.6 ± 1.7a
CC30	2.8 ±0.2a	0.9 ±0.02c	34.0 ±0.2a	4.3 ± 0.0a	1.4 ± 0.1a	0.8 ± 1.8a
F0	9.4 ± 0.1c	0.6 ±0.02a	49.3 ±0.2c	26.9 ± 1.4c	1.1 ± 0.0b	22.2 ±2.0b
F30	8.1 ± 0.1b	0.7 ±0.02b	48.4 ±0.2b	7.8 ± 0.1b	0.8 ± 0.0a	21.8 ± 2.4b
CF30	4.8 ± 0.2a	0.7 ±0.02b	32.3 ±0.2a	0.0 ± 0.0a	0.8 ± 0.0a	6.0 ± 0.2a

Data expressed as mean ± SD. Mean values labelled with different letters indicate statistically significant difference among the samples within the same processing ($P< 0.05$).

In 2012, chemical parameters of wine obtained from older lees, used to perform test B, showed a quite different trend during processing compared to test A. Also in 2013, the tests conducted with the older lees showed a different performance probably due to the aging of the matrix. Indeed, modelling obtained by PCA explained only the 56% of the variance between the samples (Fig. 2). Total polysaccharide content and AMI were lower in treated samples B30 and B60 (data not shown) with respect to the control sample (CB30 and CB60). The observed decrease of total polysaccharides could be due to the formation of unstable complexes between them and other phenolic compounds (Del Barrio-Galán et al., 2011).

The samples F, G and H were grouped according to the age of lees by the PCA analysis (Fig. 3). In 2013, parameters of phenolic matter and polysaccharides content of samples from lees, of mixed variety, were significantly higher compared to those of the control samples. Monomeric anthocyanins were at different levels depending on the type of lees. As in 2012, better performance was obtained with the fresher lees (sample F).

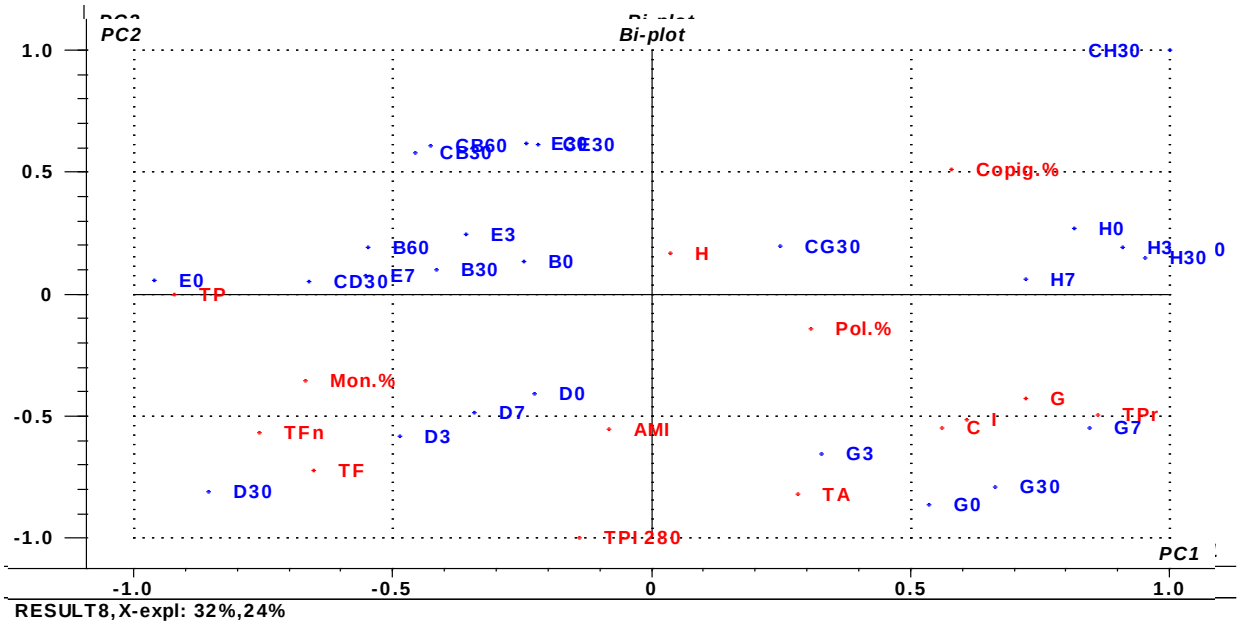

Fig. 2. PCA of the chemical parameters of samples B, D, E, G and H at the beginning (0), after 3, 7 days of treatment and one month later (30). CB30, CD30, CE30, CG30 and CH30 are the control samples after 30 days. Color intensity (I), hue (H), total polyphenol (TPI280), total flavonoids (TF), total anthocyans (TA), total flavonoids non-anthocyanic (TFn), Monomeric anthocyanins (Mon %), polymeric anthocyanins (Pol %), copigmented anthocyanins (Copig %), cofactors (C)), astringency mucin index (AMI), gelatine index (G), total polysaccharides (TP), total protein (TPr).

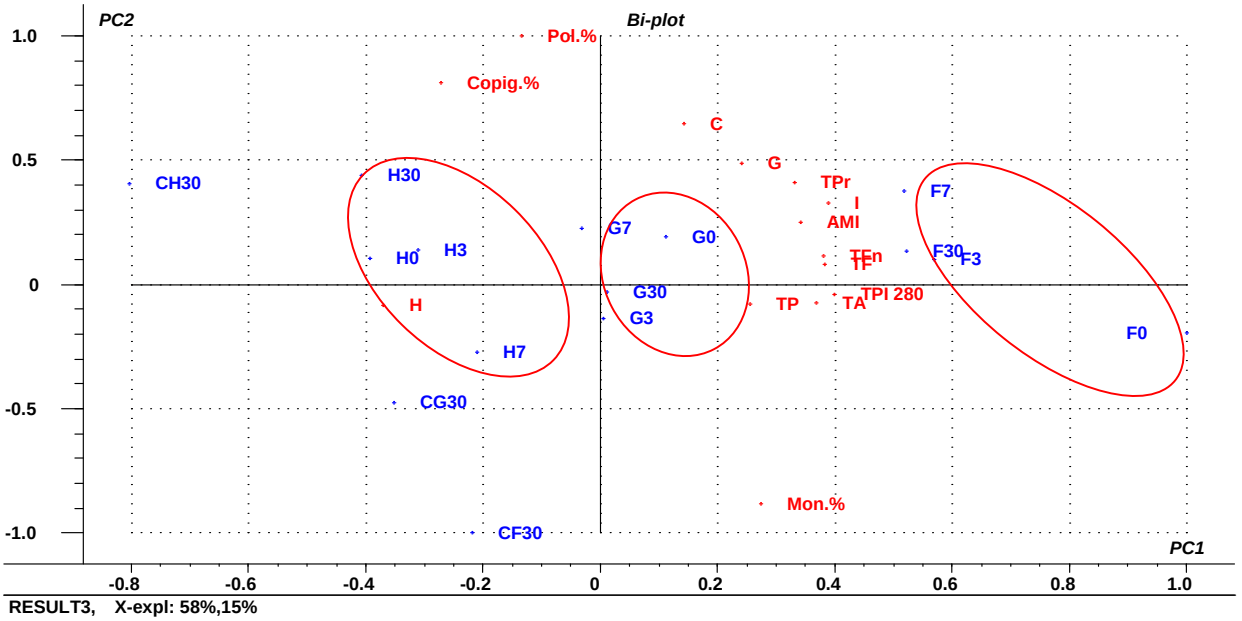

Fig. 3. PCA of the chemical parameters of samples F, G and H at the beginning (0), after 3, 7 days of treatment and one month later (30). CF30, CG30 and CH30 are the control samples after 30 days. Color intensity (I) and hue (H), total polyphenol (TPI280), total flavonoids (TF), total anthocyans (TA), total flavonoids non-anthocyanic (TFn), Monomeric anthocyanins (Mon %), polymeric anthocyanins (Pol %), copigmented anthocyanins (Copig %), cofactors (C)), astringency mucin index (AMI), gelatine index (G), total polysaccharides (TP), total protein (TPr).

During processing, an increase of colour intensity, and polysaccharides was detected in wine from the lees, with and without enzyme added. Total polyphenols and hue of colour was stable. The Astringency Mucin Index (AMI) decreased indicating that polyphenols became progressively less reactive towards proteins. During the treatment, no off-flavours arose in wine without further addition of SO_2.

3. Conclusions

The new technique could contribute to the astringency and texture of wine from total lees as well as to color characteristics, in terms of intensity and stability. The present research led to an optimization of the industrial process and the introduction of a new system made it possible to achieve a high degree of efficiency. In conclusion, the overall results indicate that the method proposed can be an effective tool for exploitation of the lees on winery scale.

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