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Evidence of changes in the micro-element composition of wine due to the yeast strain.

Evidenza di variazioni nella composizione in micro-elementi dei vini dovute al ceppo di lievito.

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Summary

Twenty mineral elements (Al, As, B, Ba, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Rb, Sn, Sr, V, and Zn) were quantified by Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES) in wines produced under real winery conditions from 11 different white juices, each fermented with 4 different commercial yeast strains. The yeast strains proved to affect the final contents of Co, Cu, Mg, Na, Pb, Sr and Zn in the wine.

Riassunto

Venti elementi minerali (Al, As, B, Ba, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Rb, Sn, Sr, V e Zn) sono stati analizzati, per Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES), in vini prodotti in reali condizioni di cantina a partire da 11 mosti bianchi, ciascuno fermentato con 4 diversi ceppi di lievito commerciale. Il ceppo di lievito ha dimostrato di condizionare il contenuto finale di Co, Cu, Mg, Na, Pb, Sr e Zn dei vini.

Introduction

Some of the products used as adjuvants and fining agents in winemaking, e.g. bentonite, tannins and yeast hulls, proved to affect the mineral element composition of wine even if they are not specifically intended for this purpose (Postel et al., 1986; Enkelmann, 1988; McKinnon et al., 1992; Leske et al., 1995; Bauer et al., 2001; Molina et al., 2001; Nicolini et al., 2004a, 2004b). Also yeasts, both under living and non-living form, can contribute to modify the amounts of micro-elements in wine, lowering significantly the final content of some heavy metals (Volesky et al., 1993; Volesky and May-Phillips, 1995; Blakwell et al., 1995). The aim of this paper is to ascertain whether the yeast strain, fermenting under real winery conditions, can affect significantly the elemental composition of wine.

Key words: micro-elements, wine, fermentation, yeast strains, ICP-OES.
Parole Chiave: micro-elementi, fermentazione, ceppi di lievito, ICP-OES.

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Material and methods

In the experimental winery of the Istituto Agrario di S. Michele all'Adige, 11 mono-variety white grape juices, previously added with 70 mg/L of SO_2 and racked after settling to clearness at temperature ranging between 5°C and 10°C, were inoculated (200 mg/L) with 4 different dry selected yeast strains available on the Italian market (yeast code: A, B, C, D). Just before the inoculum, the content of wild yeasts was less than 1 x 10^5 CFU in all the juices. Forty-four fermentations were carried out on semi-industrial scale with the same fermentation and storage equipments, in stainless steel and in glass, respectively. The same winemaking procedures were applied. Except SO_2, added at the same doses in each wine, no other adjuvant or additive was used either in juices or in wines. Analyses were run on the cold-stabilised and sterile filtered wines (0.45 µm). Twenty elements (Al, As, B, Ba, Ca, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Na, Ni, Rb, Sn, Sr, V, and Zn) were analysed by Inductively Coupled Plasma – Optical Emission Spectrometry (ICP-OES), according to Larcher and Nicolini (2001).

Data were statistically analysed with STATISTICA™ for Windows v. 5.1, 1997 (StatSoft Italia S.r.l., Padova, Italy).

Results and discussion

Submitted to Anova, with "yeast strain" and "juice" as source of variance, the wines produced by the different *Saccharomyces cerevisiae* yeast strains had statistically different contents for 7 of the 20 elements measured. *Table 1* displays only the statistically significant elements. In particular, differences were quantitatively important for Cu, Zn and Pb. For Cu, they can be related to the different genetic capability of the strains to produce H_2S precipitating Cu during fermentation, and also Pb depletion can be ascribed to the same mechanism (Ribéreau-Gayon et al., 2000). As for the content of this latter element, also interferences due to exocellular polysaccharides produced by yeasts and different equipments of pectic enzymes of the strains can be hypothesized. In fact, they could modify the type and overall content of colloids in wine, particularly of lead-complexing rhamnogalacturonan dimers (Pellerin et al., 1997), - resistant to pectolytic enzymes and forming coordination complexes with di- and trivalent cations -, thus affecting the content of lead able to react with sulfide. At the same time, also not energy-mediated Pb biosorption by cell walls (Volesky and May-Phillips, 1995) can contribute to the Pb depletion. To justify the different contents in wines, different metabolic needs of the yeast strains can also be taken into account for Zn - with biphasic accumulation (metabolism-independent and - dependent) by live-yeasts - and Co (Norris and Kelly, 1977; White and Gadd, 1987; Jackson, 1993).

Differences can be due also to the eventual presence of excipients and residues in the product marketed as selected dry yeasts. This hypothesis could not be verified, and could modify the observed results in the case in which yeasts are added after phases of propagation in tanks.

Tab. 1: Mineral composition of wines (mean values; n = 11) in relation to the commercial yeast strain inoculated (200 mg/L) in the juices for fermentations on semi-industrial scale. (Significance at Tukey's test: *, ** = $p<0.05$, $p<0.01$, respectively).

Tab. 1: Composizione minerale dei vini (valori medi; n = 11) in relazione al ceppo di lievito commerciale inoculato (200 mg/L) nei mosti per fermentazioni in scala semi-industriale (Significatività al test di Tukey: *, ** = *p<0.05, p<0.01, rispettivamente*).

element *elemento* (µg/L)	sign.	yeast strain / *ceppo di lievito*			
		A	B	C	D
Co	**	3,2 a	2,0 b	1,8 b	1,5 b
Cu	*	175 ab	121 b	179 ab	204 a
Mg (mg/L)	*	71,8 a	70,5 ab	68,6 b	72,0 a
Na (mg/L)	*	7,53 ab	7,39 b	7,79 ab	7,88 a
Pb	*	21,5 b	28,2 a	27,1 ab	30,5 a
Sr	**	115 ab	120 a	113 b	120 a
Zn	*	638 a	533 ab	500 b	629 a

As expected, the differences due to the source of variance "juice" were statistically significant for several elements, but such data are not reported being of no interest.

Conclusions

The work, carried out under real conditions of winery, put in evidence that the simple choice of the winemaker on yeast strain to be used for fermentation can affect the final element composition of wine, and could modify the wine stability, e.g. in relation to peculiar S-containing aroma compounds. Besides, the work showed that the "levurage" - definitely not applied, as a rule, to modify the mineral composition - can be taken into account also to reduce the need of specific treatments of metal depletion in wine.

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