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Review

Does *Oenococcus oeni* produce histamine?

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ABSTRACT

The presence of histamine in wine and other fermented foods may pose a toxicological risk for consumers. Production of histamine by *Oenococcus oeni*, which is the main agent of malolactic fermentation in wine and thus very important for the wine industry, has been extensively analyzed with contradictory results. If histamine production by *O. oeni* strains is a widespread trait, enological practices will be affected and the use of non-producing commercial *O. oeni* starters should be strongly recommended to avoid histamine production during winemaking. However, a review of published data showed that most evidence strongly supports the view that *O. oeni* is not responsible for histamine production in wine. We therefore propose the adoption of common analytical methods and the introduction of publicly-available validated histamine-producing *O. oeni* reference strains as a common positive control in assays to resolve this important issue.

Contents

1. Introduction

Biogenic amines (BA) occur in different kinds of foods, such as cheese, fish products, beer, and wine (Smit et al., 2008). They are of concern in relation to food spoilage and food safety, and their content in foods should be as low as possible. At high concentrations, biogenic amines are risk factors for food intoxication, while moderate levels may lead to food intolerance. They can induce headaches, respiratory distress, hyper/hypotension and several allergic disorders in consumers (Silla, 1996; Ladero et al., 2010).

Of the biogenic amines, histamine is the most dangerous. The symptoms of histamine poisoning relate to effects on blood vessels and smooth muscles, and include headache, nasal secretion, bronchospasm, tachycardia, extrasystoles, hypotension, flushing and asthma (Maintz and Novak, 2007). Sensitive persons suffer from numerous undesirable reactions after intake of histamine-containing foods or beverages (Bodmer et al., 1999; Maintz and Novak, 2007). To minimize its toxological effects, it is suggested that histamine concentration should not exceed 2 mg/l in alcoholic beverages such as wine (ten Brink et al., 1990). The only country with a limit for histamine in wine (10 mg/l) was Switzerland until 2008, but currently there is no legal or regulatory limit for histamine content in wine in any country of the world.

Histamine is produced by enzymatic decarboxylation of the amino acid histidine (Landete et al., 2008). Reported concentrations of histidine in wine range from 1.0 mg/l to 26.0 mg/l, with an average value of 9.9 mg/l (Bouloumpasi et al., 2002). It is assumed that most

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Table 1
Studies reporting histamine production by *O. oeni*.

Year	Description	Detection method	No.[a]	Histamine production	Reference
1994	*Isolation of histamine-producer *O. oeni* IOEB 9204 strain	HPLC	1 (IOEB 9204)	250 mg/l in Carr media containing 6 g/l histidine	Lonvaud-Funel and Joyeux (1994)
1998	*Identification of the gene encoding the *O. oeni* IOEB 9204 histidine decarboxylase, and purification and characterization of the protein	CO_2 release	1 (IOEB 9204)	ND	Coton et al. (1998b)
	*Wines from Southwest France contained histamine-producing *O. oeni* strains.	Indirect deduction from data of histamine in wine	58/118 wines contain histamine	*O. oeni* have been isolated in these wines but not tested for histamine production	Coton et al. (1998a)
2000	*Isolation of decarboxylase positive strains from Portuguese wines which were unable to produce significant levels of histamine	DM, HPLC	6/220 strains	Strains were positive in DM, but no significant histamine levels were detected by HPLC	Leitao et al. (2000)
	**O. oeni* strains isolated from Spanish ciders were low histamine producers.	HPLC	5/12 strains	2 mg/l in medium containing 10 g/l histidine	Del Campo et al. (2000)
2002	**O. oeni* strains isolated from Italian wines were histamine producers.	HPLC	27/44 strains	1 to 30 mg/l in MRS broth	Guerrini et al. (2002)
2005	*Wines from three Spanish regions contained low histamine-producer *O. oeni* strains.	DM, HPLC	7/12 wines	11–34 mg/l in medium containing 20 g/l histidine, or 0.5–11 mg/l in wine	Landete et al. (2005b)
	**O. oeni* strains were low histamine producer.	DM, enzymatic, HPLC, PCR	1/32 strains by DM 24/32 strains by enzymatic, HPLC and PCR	1/32 strains produced 100 mg/l and 23/32 strains produced <48 mg/l in media containing 20 g/l histidine	Landete et al. (2005a)
2006	*Study of the *hdc* expression in *O. oeni* 4024	Molecular methods	1 (*O. oeni* 4024)	ND	Landete et al. (2006)
2007	**O. oeni* strains were histamine producers.	DM, HPLC, PCR	33/39 strains	22.3 ± 17.7 mg/l in DM containing 2 g/l histidine; and 4.2 ± 3.2 mg/l in wine containing 500 mg/l histidine	Landete et al. (2007a)
2008	*High frequency of HDC^+ *O. oeni* in wine samples from the Bordeaux area	QPCR and colony hybridization	256/264 wines contain histamine; 8 strains isolated in these wines	*O. oeni* have been isolated in these wines but not tested for histamine production.	Lucas et al. (2008a)
	**O. oeni* strains were low histamine producers.	DM, HPLC	0/26 strains by DM 8/26 strains by HPLC	2.6–5.6 mg/l in a media containing 20 g/l histidine	Rosi et al. (2008)
	*3800 nucleotides of the HDC region from *O. oeni* IOEB 9204 were deposited in a nucleotide database.	Molecular methods	1 (IOEB 9204)	ND	Accession DQ132887
2009	*One histamine-producer strain isolated from Tempranillo wines	DM, HPLC, PCR	1/90 strains	9.24 mg/l in wine	Izquierdo Cañas et al. (2009)
	*Isolation of *O. oeni* strains from wines having high histamine content	Indirect deduction from data of histamine in wine	ND	Wines contain histamine; *O. oeni* strains have been isolated in these wines, but not tested for histamine production.	López et al. (2009)

[a] Number of positive strains or wines vs. total analyzed; ND: no determined; DM: Differential medium.