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Original research article

Evaluation of biogenic amines profile in opened wine bottles: Effect of storage conditions

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ABSTRACT

Changes in biogenic amines profile during storage of opened wine bottles have been monitored. Three different wine types were selected (standard and high quality red wines and young white wine), and once opened, wine bottles were kept in different storage conditions (temperature and stopper kind). The total concentration of biogenic amines in just opened bottles ranged between 35.4–39.2 mg/L in standard quality red wine; 18.5–22.8 mg/L in high quality red wine; and 5.08 mg/L in bulk young white wine. Both red wines showed higher amounts of histamine and putrescine, whilst the white wine contained tyramine, putrescine and histamine in a similar concentration. Cadaverine presented a similar concentration for all samples (0.25–0.42 mg/L). Methylamine and spermine were not detected in any sample. The results from 36 samples showed that biogenic amines did not increase significantly in any case. Slight changes in the concentration of certain biogenic amines were detected as a result of the different storage conditions. A principal component analysis using biogenic amines as variables allowed to group the different kinds of wine. Linear Discriminant Analyses grouped the three wine types by storage time. Histamine and cadaverine showed a marked positive correlation in all wine types.

1. Introduction

Biogenic amines are generally considered as a food hazard, even though there is not a threshold for these biomolecules in the European legislation, except for histamine in fishery products (European Commission Regulation (EC) 2073/2005). Recently, a scientific opinion elaborated by the European Food Safety Authority (EFSA) remarked the risk associated with the synthesis of biogenic amines in fermented products, such as cheese, wine, beer, fermented sausages, among others (EFSA, 2011). Thus, histamine is the most widely studied amine due to its ability to produce headaches, hypotension and digestive problems, while tyramine is often associated with migraine and hypertension (Maintz and Novak, 2007). The relation between these biogenic amines in wine and headache remains controversial (Krymchantowski and Da Cunha Jevoux, 2014; Panconesi, 2008), although they may effect a synergistic action (Maintz and Novak, 2007). Furthermore, the effects of these amines may be potentiated by other biogenic amines such as putrescine, cadaverine and agmatine (EFSA, 2011).

Biogenic amines are organic nitrogenous bases of low molecular weight that have been detected and quantified in a great deal of fermented foods and are mainly formed by microbial decarboxylation of some amino acids. On the other hand, volatile amines can be formed by amination and transamination of aldehydes and ketones (Peña-Gallego et al., 2012). Biogenic amines are stable compounds and once they are formed it is difficult to eliminate them (EFSA, 2011).

For all the reasons mentioned above, literature on biogenic amines in different food products, especially in fermented products, is extensive. The concentration of biogenic amines in fermented products depends mainly on three factors: specific bacteria strain(s) present in the fermentation media, carboxylase activity and the amount of precursor amino acids in the substrate (De Las Rivas et al., 2008).

Besides, other factors may play an important role in the final concentration of biogenic amines in wine. Thus, nitrogenous fertilization, climatic conditions during growth, grape variety, geographic location or the level of maturation may cause changes in the amino acids profile in grapes. Moreover, the amino acids concentration may be altered by different prefermentative treatments such as clarification, crushing or duration of maceration process (Herbert et al., 2005). On the other hand, some factors involved in alcoholic and malolactic fermentations, such as pH, temperature, SO_2 concentration, turbidity or volatile acidity may also affect the concentration of biogenic amines (Herbert et al., 2005).

Wine has specifically been studied throughout its different stages of elaboration and storage. Thus, the concentration of biogenic amines has been determined in grapes (Bauza et al., 2007); musts (Del Prete et al., 2009; García-Marino et al., 2010; Rodriguez-Naranjo et al., 2013; Wang

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Table 1
Derivatization reagent, type of detection, LOD and concentrations of biogenic amines in grape musts, wines and wine vinegars from different countries.

Der reagent	Detection	His (mg/L)	Tyr (mg/L)	Put (mg/L)	Cad (mg/L)	Agm (mg/L)	Met (mg/L)	Phe (mg/L)	Spm (mg/L)	Spmd (mg/L)	Total biogenic amines (mg/L)	LOD (mg/L)	Type and country	References
OPA	Fl $\lambda_{ex/em}$: 340/426 nm	1.7–14.9	n.d. – 6.7	0.5–25.0	n.q. – 2.1	n.q.	–	n.q. – 1.35	–	–	7.5–46.6	0.015–0.11	Red wine Spain	García-Marino et al. (2010)
	Fl $\lambda_{ex/em}$: 340/425 nm	n.d. – 18.7	1.1–17.8	7.6–35.7	n.d.	–	n.d.	–	–	–	25.2–96.8	0.05–0.35	Red wine Spain	Arrieta and Prats-Moya (2012)
	Fl $\lambda_{ex/em}$: 340/420 nm	0.3–2.5	0.1 – 0.8	2.3–4.0	0.3 – 0.5	–	–	1.0–2.1	–	–	6.0–12.0	–	Red wine Spain	López et al. (2012)
DNS-CL	UV-vis λ: 220 nm	0.5–27.0	1.1- 10.7	2.93–122	n.d. – 3.27	–	–	n.d. – 1.7	–	0.1–5.0	33.0 ($\bar{X}$)	0.07	Red wine Austria	Konakovsky et al. (2011)
	UV-vis λ:	n.d. – 10.8	n.d. – 18.8	2.4–31.8	0–1.1	–	–	n.d.	n.d.	n.d.	4.3–67.0	0.1–0.5	Red wine Italy	Martuscelli et al. (2013)
	254 nm	n.d. – 3.4	n.d. – 6.8	0.8–12.8	0.3–1.2	–	–	n.d.	n.d.	n.d.	3.6–19.5		White wine Italy	
		n.d. – 4.3	n.d. – 10.8	1.4–9.9	0.7–1.1	–	–	n.d. – 1.5	n.d.	n.d. – 1.4	3.7–24.7		Rose wine Italy	
	Fl $\lambda_{ex/em}$: 254/510 nm	2.2–16.2	8.9–37.3	8.3–17.4	–	–	–	–	–	–	27.7–60.9	–	Red wine Italy	Comuzzo et al. (2013)
	Fl $\lambda_{ex/em}$: 320/523 nm	23.1	–	1.5	0.1	–	0.1	0.2	–	n.q.	26.4 ($\bar{X}$)	0.003–0.22	Red wine Portugal	Ramos et al. (2014)
		2.9–8.9	–	0.2–0.3	n.q. – 0.1	–	0.2–0.4	n.q. – 0.2	–	n.q.	4.4–10.0		White wine Portugal	
		15.1	–	2.2	0.0	–	0.3	n.q.	–	n.q.	19.5 ($\bar{X}$)		Rose wine Portugal	
	Fl $\lambda_{ex/em}$: 293/492 nm	Tr-8.1	5.1–11.5	11.4–32.8	1–2.4	n.d.	0.2–1.7	n.d. – 1.2	n.d.	n.d. – 1.27	49.4 ($\bar{X}$)	0.004–0.06	Red wine Italy	Tuberoso et al. (2015)
		n.d.	n.d.	1.5–10.6	1.1–2.5	n.d.	1.1–2.2	n.d. – 1.8	n.d.	n.d.-Tr	16.2 ($\bar{X}$)		White wine Italy	
DEEMM	UV-vis λ:	0.6–12.0	0.5–2.6	3.9–15.4	0.4–0.8	n.d. – 1.1	–	n.d. – 0.1	1.9–3.8	–	10.4–33.5	0.1–0.6	Red wine Spain	Gómez-Alonso et al. (2007)
	280 nm	n.d. – 0.7	n.d. – 5.5	3.9–18.4	0.2–0.3	0.4–1.1	–	n.d. – 0.1	0.3–2.4	–	5.4–26.7		White wine Spain	
		0.5–14.1	0.1–12.4	3.7–48.7	0.1–1.8	–	0.4–36.6	0.1–2.7	–	–	37.3 ($\bar{X}$)	0.1–0.5	Red wine France	Bach et al. (2012)
		n.d. – 6.2	0.1 – 1.4	2.4–25.1	0.2–1.7	1.3–11.8	–	0.1–0.4	–	0.4–9.7	6.9–42.8	–	Red wine Spain	Martínez-Pinilla et al. (2013)
		n.d.	2.6 – 2.8	4.8–5.2	1.3–1.8	n.d.	–	1.5–1.9	n.d.	4.0–4.5	26.4–26.8	0.03–0.1	Red must China	Wang et al. (2014)
		20.4–23.1	6.2–6.5	11.4–2.6	1.6–3.8	n.d.	–	2.3–4.8	n.d. – 2.2	2.6–9.4	86.3–96.1		Red wine China	
AQC	Fl $\lambda_{ex/em}$: 250/395 nm	n.d.	0.8- 0.9	4.2–15.3	0.5–1.0	–	–	–	–	–	5.6–17.0	0.0004–0.027	Red must Spain	Hernández-Orte et al. (2006)
		2.9–4.7	0.6- 0.7	5.7–16.4	0.7–1.5	–	–	–	–	–	11.5–21.7		Red wine Spain	
		0.1–33.0	0.3–10.8	5.0–135	0.3–2.5	–	–	–	–	–	10.0–180.4	0.015–0.050	Red wine Spain	Peña-Gallego et al. (2009)
		n.d. – 0.3	n.q.	0.1–0.3	n.d. – 0.1	n.q. – 0.1	n.d.	n.d.	n.d. – 0.1	n.d. – 0.1	0.1–0.8	0.007–0.026	Red wine vinegar Spain	Ordóñez et al. (2013)
		n.q.	n.d.	n.q. – 0.1	n.d. – 0.0	n.q.	n.d.	n.d.	0.1	n.q.	0.1–0.2		White wine vinegar Spain	

Der. reagent: Derivatization reagent. His: Histamine. Tyr: Tyramine. Put: Putrescine. Cad: Cadaverine. Agm: Agmatine. Met: Methylamine. Phe: Phenylethylamine. Spm: Spermine. Spmd: Spermidine. UV–vis: UV–vis detection. Fl: Fluorescence detection. λ ex/em: λ excitation/emission. n.d.: non detected. n.q: non quantified. –: non determinated. Tr: Traces. $\bar{X}$: Value. OPA: o-phthalaldehyde. AQC: 6-aminoquinolyl-N-hydroxysuccinimidyl carbamate. DNS-CL: dansyl chloride. DEEMM: diethyl ethoxymethylenemalonate. LOD: Limit of detection.