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Investigation on the influence of spray-drying technology on the quality of Sicilian Nero d'Avola wines

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ABSTRACT

The purpose of the present work was to find a correlation between microencapsulation technology applied to wines and the resulting quality of the wine itself in terms of volatile composition and phenolic profile. To this aim, samples of Nero d'Avola wines produced in Sicily (Italy) were investigated in order to: i) elucidate the aromatic composition by means of HS–SPME coupled with GC–MS; ii) assess the polyphenolic content by UHPLC mass spectrometry; iii) compare the results obtained from both the screenings with those relative to the same wines that had previously been subjected to spray-drying. The results showed a marked reductionThe results here obtained evidenced a marked reduction of odour active compounds in microencapsulated wines, after resolubilization in water/ethanol; when considering the total amount of volatiles, a twofold reduction was observed. Conversely, the qualitative analysis of phenolic compounds and anthocyanin-derived pigments showed no influence of the spray-drying process on these functional constituents.

1. Introduction

Spray-drying falls within the group of microencapsulation technologies, including spray-chilling, fluidized-bed coating, extruding, lyophilisation, coacervation, among others (Desai & Park, 2005; Nedovic, Kalusevic, Manojlovic, Levic, & Bugarski, 2011). Spray-drying has been applied in the food industry for many decades, basically due to its cheapness, flexibility, robustness, efficiency. Based on a simple definition, "encapsulation" is a technique which entraps particles (usually bioactive compounds) within a wall material, working as a "shell" or "matrix". The products of such a technological process are microcapsules with diameters comprised in the range of μm–mm, generally containing active ingredients. More specifically, spray-drying is a technological process where a liquid is atomized through a hot gas (air or nitrogen) current, becoming consequently a powder (Gharsallaoui, Roudaut, Chambin, Voilley, & Saurel, 2007). Mainly because of the water removal from food commodities, the advantages derived from spray-drying are numerous: i) reduction of microbiological decay events; ii) instantaneous solubilisation of spray-dried products (improved product's handling); iii) decrease of transport costs due to consistent volume reduction of powdered products ("green" feature of the technology); iv) protection of the core material against environmental factors (i.e. moisture, light, oxygen); v) improvement of organoleptic properties of a food (e.g. masking bitterness of an ingredient by coating it with a wall material having a pleasant taste); vi) elimination of cross reactions between more ingredients. A key role in a successful spray-drying procedure is played by the wall material chosen as encapsulating agent; the latter must be able to protect the capsule content, to be stable over time and to avoid interaction with the outer environment. Encapsulation technologies are utilized not only in food industry, but also in other fields (e.g. dried detergents reconstituted upon use). A variety of synthetic polymers is available as wall material; however, this list is definitely restricted when the spray-dried product is destined for food consumption. Commonly, carbohydrates (starches, syrup solids, maltodextrins, pectins), gums (gum Arabic, mesquite gum) or milk proteins are employed as wall material (Gharsallaoui et al., 2007).

Red wines are suitable matrices for spray-drying, since they are mainly constituted of water, ethanol and bioactive molecules, such as polyphenols. The beneficial effects exerted by moderate consumption of

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Table 1
HS–SPME–GC–MS composition of wine samples. Compounds in bold are "odour active" (see text). Values are means of triplicate analyses. n.f. = not found. N/A = not available.

Nr.	Compound	Odour threshold* (μg/L)	DVB/Car/PDMS		CW/DVB		Car/PDMS		PDMS	
			Neat wine (μg/L)	Spray-dried wine (μg/L)	Neat wine (μg/L)	Spray-dried wine (μg/L)	Neat wine (μg/L)	Spray-dried wine (μg/L)	Neat wine (μg/L)	Spray-dried wine (μg/L)
1	Acetaldehyde	120	0.08	0.03	0.11	0.40	0.21	0.16	0.05	0.07
2	Dimethyl sulfide	1	0.02	n.f.	n.f.	n.f.	0.01	n.f.	n.f.	n.f.
3	Ethyl formate	N/A	0.02	0.02	n.f.	n.f.	0.01	0.07	0.15	0.08
4	Ethyl acetate	7500	12.2	0.50	4.23	0.23	19.8	1.29	37.7	1.65
5	Ethanol	100,000	59.6	47.6	336.0	219.0	59.3	66.7	210.0	316.0
6	Ethyl propanoate	10	0.32	n.f.	n.f.	n.f.	0.21	n.f.	0.68	n.f.
7	**Ethyl isobutyrate**	0.1	1.01	n.f.	0.38	n.f.	0.45	n.f.	2.45	n.f.
8	2,3-Butanedione	0.86	0.04	0.04	0.29	0.25	0.12	0.11	0.08	0.17
9	Ethyl butyrate	1600	0.88	n.f.	0.31	n.f.	0.49	n.f.	2.13	n.f.
10	1-Propanol	50,000	0.25	0.17	0.17	0.13	0.35	0.13	0.31	0.16
11	Succinic acid, butyl propyl ester	N/A	0.04	n.f.	n.f.	n.f.	0.04	n.f.	n.f.	n.f.
12	Ethyl 2-methylbutyrate	18	0.39	n.f.	0.13	n.f.	0.23	n.f.	0.88	n.f.
13	**Ethyl isovalerate**	3	0.60	0.02	0.15	n.f.	0.28	< 0.01	1.36	n.f.
14	2-Methylbutyl acetate	5	n.f.	0.02	n.f.	n.f.	n.f.	0.02	n.f.	n.f.
15	Isobutanol	40,000	1.31	0.04	1.88	0.07	0.79	0.06	4.42	0.22
16	2,2,6-Trimethyl-6-vinyltetrahydropyran	N/A	0.09	n.f.	n.f.	n.f.	0.041	n.f.	n.f.	n.f.
17	Isoamyl acetate	30	3.03	0.08	0.73	0.06	1.60	0.06	5.54	0.34
18	Ethyl valerate	5	0.02	0.11	n.f.	0.17	n.f.	0.02	0.04	0.15
19	1-Butanol	150,000	0.06	n.f.	n.f.	n.f.	0.07	n.f.	0.17	n.f.
20	Sulfur dioxide	N/A	n.f.	n.f.	0.61	2.23	n.f.	n.f.	n.f.	n.f.
21	Limonene	200	n.f.	0.07	n.d.	0.09	n.f.	n.f.	0.13	0.16
22	Isoamyl alcohol	30,000	37.3	2.44	63.5	3.64	26.9	2.24	93.9	5.50
23	**Ethyl hexanoate**	14	7.36	0.13	2.57	0.15	3.51	0.03	12.2	0.39
24	2,4-Hexadienoic acid, ethyl ester (2*E*,4*E*)-	N/A	n.f.	0.01	n.f.	0.06	n.f.	n.f.	n.f.	n.f.
25	(1*E*,2*E*)-Dipropenylcyclobutane	N/A	n.f.	n.f.	n.f.	n.f.	0.20	n.f.	n.f.	n.f.
26	Isoamyl butyrate	N/A	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0.06	n.f.
27	Hexyl acetate	1500	0.05	n.f.	0.01	n.f.	n.f.	n.f.	0.07	n.f.
28	**Octanal**	0.7	n.f.	0.06	0.13	0.05	n.f.	0.07	0.49	0.12
29	Acetoin	800	0.51	n.f.	0.39	0.26	0.48	n.f.	n.f.	n.f.
30	3-Hexenoic acid, ethyl ester	N/A	0.03	n.f.	0.01	n.f.	n.f.	n.f.	0.05	n.f.
31	4-Methyl-1-pentanol	5000	0.01	n.f.	0.05	n.f.	0.02	n.f.	0.03	n.f.
32	2-Heptanol	300	n.f.	n.f.	0.01	n.f.	0.02	n.f.	n.f.	n.f.
33	3-Methyl-1-pentanol	2.2	0.06	n.f.	0.07	n.f.	0.04	n.f.	0.09	n.f.
34	Ethyl heptanoate	2.2	0.05	n.f.	0.02	n.f.	0.01	n.f.	0.15	n.f.
35	Ethyl lactate	14,000	1.85	0.59	6.17	2.44	1.96	0.91	2.84	0.71
36	1-Hexanol	8000	1.35	0.15	1.16	0.09	1.52	0.20	1.42	0.11
37	(3*E*)-Hexen-1-ol	400	n.f.	n.f.	0.04	n.f.	n.f.	0.06	0.02	n.f.
38	(3*Z*)-Hexen-1-ol	400	n.f.	n.f.	0.15	n.f.	n.f.	n.f.	0.01	n.f.
39	Methyl octanoate	200	0.11	0.02	0.07	n.f.	0.03	n.f.	0.13	n.f.
40	Nonanal	1	0.08	0.20	0.05	0.35	0.02	n.f.	0.35	0.95
41	Carbon disulfide	N/A	0.02	n.f.	n.f.	n.f.	0.02	n.f.	n.f.	n.f.
42	**Ethyl octanoate**	5	11.06	0.52	10.5	1.29	1.99	0.17	23.4	2.57
43	1-Octen-3-ol	1	n.f.	n.f.	0.02	n.f.	n.f.	n.f.	n.f.	n.f.
44	1-Heptanol	300	0.22	0.03	0.15	0.04	0.12	n.f.	0.20	0.06
45	Isoamyl hexanoate	N/A	n.f.	n.f.	0.02	n.f.	n.f.	n.f.	n.f.	n.f.
46	Furfural	14,100	0.35	0.18	0.10	0.14	0.24	0.15	0.08	n.f.
47	Acetic acid	N/A	n.f.	n.f.	8.31	9.62	1.04	0.31	n.f.	n.f.
48	2-Propyl-1-pentanol	N/A	0.93	0.85	1.51	4.29	0.46	0.71	1.12	0.99
49	3-Ethyl-4-methylpentanol	N/A	0.11	n.f.	0.12	n.f.	0.08	n.f.	0.18	n.f.
50	Ethyl nonanoate	N/A	n.f.	0.09	n.f.	n.f.	n.f.	n.f.	0.26	n.f.
51	2,3-Butanediol	120,000	0.09	n.f.	0.89	1.86	0.07	0.04	0.20	n.f.
52	Linalool	25	0.26	0.07	0.24	0.21	0.15	0.05	0.29	n.f.
53	*n*-Octyl formate	N/A	0.21	0.02	0.23	0.09	0.08	n.f.	0.29	n.f.
54	Isoamyl lactate	200	0.28	0.02	0.44	n.f.	0.18	0.02	0.42	n.f.
55	**β-Ionone**	0.09	n.f.	n.f.	0.24	0.60	0.02	0.02	0.03	n.f.
56	Hexadecane	N/A	n.f.	0.03	n.f.	n.f.	0.06	0.02	n.f.	0.47
57	Propylene Glycol	N/A	0.06	n.f.	0.46	0.32	n.f.	n.f.	n.f.	n.f.
58	*n*-Nonylcyclohexane	N/A	n.f.	0.03	n.f.	0.10	n.f.	n.f.	n.f.	0.29
59	Terpinen-4-ol	110	n.f.	n.f.	n.f.	n.f.	n.f.	0.01	n.f.	n.f.
60	Diethylene Glycol ethyl ether	N/A	n.f.	n.f.	0.13	0.19	n.f.	n.f.	n.f.	n.f.
61	2-Furancarboxylic acid, ethyl ester	N/A	0.10	< 0.01	0.11	0.01	0.02	n.f.	0.09	n.f.
62	Ethyl decanoate	200	1.01	0.03	1.52	1.49	0.22	0.04	2.61	2.09
63	Dihydro-2(3*H*)-furanone	50,000	0.05	0.02	0.29	0.42	0.04	0.05	0.04	0.06
64	Butanoic acid	240	0.29	0.05	0.48	0.25	0.10	0.04	0.42	0.17
65	Furfuryl alcohol	2000	n.f.	n.f.	n.f.	n.f.	0.05	0.065	n.f.	n.f.
66	Diethyl succinate	200,000	11.2	2.08	17.7	11.2	2.35	0.59	20.2	6.45
67	Ethyl dec-(9*E*)-enoate	100	n.f.	n.f.	n.f.	n.f.	n.f.	n.f.	0.05	n.f.
68	2-Methylhexanoic acid	N/A	n.f.	0.03	0.69	0.41	0.09	0.04	0.14	n.f.
69	α-Terpineol	330	0.36	0.10	0.33	n.f.	0.09	0.03	0.34	0.07

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