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Research Note

Potential impact of processed *Harmonia axyridis* on the taste of 'Chasselas' and 'Pinot noir' wines

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K e y w o r d s : Asian ladybeetle, *Vitis vinifera*, organoleptic tests.

Introduction: The multicoloured Asian ladybeetle *Harmonia axyridis* Pallas (Coleoptera, Coccinellidae) has been released as a biological control agent in Europe since 1995 (Brown *et al.* 2008). Due to its rapid dispersal, *H. axyridis* is now established in Central Europe and is likely to spread soon over the whole continent (Brown *et al.* 2008). Despite the benefits it offers as a biological control agent, this invasive species is very well known for the suppression of non-target arthropods, the invasion of households in autumn, and the feeding and contamination of fruits (Koch and Galvan 2008). In the United States, *H. axyridis* moves to vineyards shortly before harvest, when natural prey gets scarce. There they aggregate in grape clusters and start to feed on previously injured berries (Galvan *et al.* 2006). However, damage due to grape feeding is negligible; the primary problem with *H. axyridis* is the contamination of the harvest. When ladybeetles are disturbed or crushed during vinification, they release a yellow fluid that contains alkylmethoxypyrazines, which creates an unpleasant odour and tastes nasty (Pickering *et al.*, 2005). Wine tastings have shown that densities as low as 1.5 and 1.9 insects per kilogram grapes can affect the quality of white 'Riesling' and red 'Frontenac' wines, respectively (Pickering *et al.* 2007; Galvan *et al.*, 2007a). In Europe, wine growers are beginning to worry about the impact of *H. axyridis* on the quality of their processed wines. In this study we artificially contaminated the vinification of 'Chasselas' and 'Pinot noir', the two main varieties of Switzerland, with three different densities of *H. axyridis* and determined the impact of crushed ladybeetles on the taste of processed wines.

Material and Methods: In August 2007, individuals of *H. axyridis* (HA) were collected in sunflower fields around Nyon (Switzerland). Collected ladybeetles were kept in aerated plastic boxes and were stored in a climate chamber at 10°C until vinification. From the mid of September, grapes of the variety 'Chasselas' and 'Pinot noir' were harvested. Harvested grapes were randomly contaminated with three different densities of living adults of *H. axyridis* (1 HA/kg grapes, 5 HA/kg grapes and an uncontaminated control with 0 HA/kg grapes). In the white grape variety 'Chasselas', ladybeetles were crushed together with 50 kg grapes in a horizontal pneumatic bladder press (maximal pressure of 6 bars). In the red grape variety 'Pinot noir', vats were filled with insects and 50 kg of destemmed and crushed grapes. After sulphitation and nine days of maceration and skin fermentation, vats were emptied and the 'Pinot noir' pomace was pressed. After pressing, must of Chasselas was sulphited and cleared. After the alcoholic fermentation, all wines were centrifuged and subject to malolactic fermentation. Thereafter, they were chemically and physically stabilised and in March 2008, wines were filtered and bottled. At filling, the basic chemical properties of wines were analysed by a mid-infrared spectrophotometer (FOSS Winescan). Two months later, a panel of 12 trained tasters estimated the organoleptic quality of bottled wines in a series of altogether 33 wines. Wine tasters rated various organoleptic criteria (see Table) on a scale from 1 (bad/weak) to 7 (excellent/high). Data obtained were analysed using the FIZZ software from Biosystèmes (F-21560 Couternon).

Results and Discussion: The addition of *H. axyridis* did neither affect the start nor the duration of the fermentation. The basic chemical properties, such as pH, total acidity, tartaric acid, malic acid, volatile acidity and ethanol, did not differ between the three wine groups contaminated by different densities of ladybeetle (Table). At the organoleptic level, contamination of grapes with *H. axyridis* had a significant effect on the rating of processed 'Chasselas' wines as well as 'Pinot noir' wines (Table). In 'Chasselas', the noncontaminated control could be clearly distinguished from the two ladybeetle-contaminated wines. Contaminated wines were of lower fruitiness, fineness, structure, acidity and equilibrium (Table). The colour of the noncontaminated 'Chasselas' was more intense than in the two *Harmonia* variants. This was surprising, because in a similarly designed study Pickering *et al.* (2005) were not able to detect any effect of *H. axyridis* on the colour intensity of white wines. In general, the 12 tasters did not appreciate the overall note of the contaminated 'Chasselas' and were astounded by their "rancid oil" odour. In 'Pinot noir', the noncontaminated wine was judged superior to the two ladybeetle-contaminated wines for most organoleptic criteria (Table). However, statistically significant differences could mainly be established between the control and the heavily contaminated wine. The quality of the heavily contaminated 'Pinot noir' was rated very low by the panel, in particular, its fruitiness, spiciness, fineness, structure, intensity and quality of tannins, softness and robustness. Altogether, this led to a very poor appreciation of the overall note. However, colour intensity, shade, acidity, dryness and bitterness were not noticeably affected by the addition of ladybeetles. Colour intensity and acidity are opposed to the results obtained for 'Chasselas'. Our results on 'Chasselas' and 'Pinot noir' confirm the findings on the varieties 'Riesling' and 'Frontenac' in the United States (Pickering *et al.* 2007, Galvan *et al.* 2007 a). Taking into account the average weight of a grape cluster of 300 g for 'Chasselas' and of 180 g for 'Pinot noir', one can estimate

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Table

Average value of chemical and organoleptic properties for control and *H. axyridis*-contaminated 'Chasselas' and 'Pinot noir' wines on a scale from 1 to 7 (1 = bad/weak, 4 = satisfactory, 7 = excellent/high)

Properties	Chasselas				Pinot noir			
	0 HA/kg[a]	1 HA/kg[a]	5 HA/kg[a]	P[1]	0 HA/kg[b]	1 HA/kg[b]	5 HA/kg[b]	P[1]
Chemical								
pH	3.37	3.27	3.35		3.69	3.57	3.53	
Total acidity	5.03	5.73	5.21		4.29	4.66	4.63	
Tartaric acid	1.5	1.7	1.7		0.9	1	1	
Malic acid	<0.1	0.31	0.26		<0.1	<0.1	<0.1	
Volatile acidity	0.77	0.75	0.59		0.60	0.53	0.54	
Ethanol	10.65	10.16	10.14		12.78	12.57	12.43	
Organoleptic								
Colour intensity	3.99 a	3.58 b	3.46 b	***	3.89	3.93	3.85	
Shade					4.10	4.18	4.13	
Fruitiness	3.05 a	2.63 b	2.44 b	**	3.50 a	3.35 a	2.47 b	**
Spiciness					2.80 a	2.71 a	2.10 b	*
Quality / Fineness	3.13 a	2.36 b	2.16 b	**	3.75 a	3.32 a	2.52 b	**
Structure	3.58 a	3.32 b	3.27 b	*	3.65 a	3.60 a	3.21 b	**
Acidity	3.94 b	4.33 a	4.01 b	*	3.73	3.72	3.85	
Equilibrium	3.38 a	3.02 b	3.13 b	***				
Intensity of tannins					4.04 a	3.78 ab	3.71 b	*
Quality of tannins					3.78 a	3.46 a	2.64 b	*
Dryness/roughness					3.15	3.35	3.77	
Softness					3.25 a	2.79 ab	2.61 b	*
Robustness					2.98 a	2.60 b	2.34 b	**
Bitterness	3.20	3.50	3.65		2.52	2.56	2.84	
Overall note	3.24 a	2.28 b	2.31 b	***	3.99 a	3.32 a	2.03 b	***

[1] Chemical properties were not statistically analysed, *P*-value of the overall ANOVA for the organoleptic criteria: * $P \leq 0.05$; ** $P \leq 0.01$; *** $P \leq 0.001$.

[a,b] Treatments with different letters are significantly different (Fisher's LSD post-hoc test: $P \leq 0.05$).

that the "ladybug taint" can be noticed at densities as low as 0.3 HA and 0.2 HA per cluster, respectively. According to Galvan *et al*. (2007 b), these values correspond to 18 % and 12 % of grape clusters colonized by at least one *H. axyridis*. Surveys conducted shortly before vintage indicated that the numbers of *H. axyridis* are currently far below this threshold in Western Switzerland, even in vineyards were the presence of ladybeetles was confirmed in summer (data not shown). Nevertheless, our results emphasise that there is a real risk of wine contamination. Thus, the evolution of the multicoloured Asian ladybeetle in vineyards should be carefully monitored in order to anticipate future problems.

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