LADYBUG TAINT: PART 1

Dr. Carien Coetzee

Basic Wine

23 November 2020

Ladybugs, also known as ladybirds or lady beetles, are generally considered beneficial insects. They are a significant source of **biological control for aphids**, tiny plant-sucking insects that damage several major crops. However, for the wine producer, the presence of the seemingly beneficial insect in the vineyard can have **potentially hazardous effects** and result in a wine with a distinct taint commonly called **'ladybug taint'**.

WHAT IS LADYBUG TAINT?

A wine with ladybug taint will have prominent unpleasant flavours often described as **green pepper, asparagus, rancid peanut butter, rotting spinach, blue cheese, sawdust and earth**[1–4]. These aromas originate from the presence of **methoxypyrazines** that are secreted/extracted by/from the ladybug.

Even though the taint poses no known health threat to humans, the presence of these compounds can have a profound effect on the wine quality by modifying both ortho- and retro-nasal aromas as well as taste modalities, while at the same time masking varietal and other desirable sensory attributes in wine[1].

SOURCES OF METHOXYPYRAZINES IN WINE

It is important to remember that ladybugs are **not the only source of methoxypyrazines in wines and the compounds can originate naturally from the grape** as well. See previous blog posts on methoxypyrazines:

- Managing green aromas in the vineyard: Methoxypyrazines
- Managing green aromas in the cellar: Methoxypyrazines

Certain grape varieties, such as Sauvignon blanc, Cabernet Sauvignon, Merlot, Cabernet franc and Carménère are **more likely to contain grape-derived methoxypyrazines** at the time of harvest. Even though ladybug-derived methoxypyrazines and grape-derived methoxypyrazines increase the same aromatic compounds, the **composition and/or concentration of the methoxypyrazines extracted differ**, with ladybug taint resulting in much more unpleasant flavours when compared to grape-derived methoxypyrazines which can contribute to award-winning wines (see 2020 Sauvignon Blanc SA Top 10 chemical analysis).

LADYBUGS IN THE VINEYARD

The effect of the ladybugs on wine was first widely observed and reported in 2001. The beetle was introduced in several countries as a biocontrol agent[5–10] but has since expanded its range and become an invasive species in many parts of North America, South America, Europe and South Africa[5,11–15].

In regions with established beetle populations, adult beetles migrate en masse into vineyards before and during grape harvest, aggregating on the ripe grape clusters and **may become incorporated with the fruit during processing**. The insect will feed opportunistically on (damaged) fruit when prey is scarce[15]. Just one ladybug per vine is enough to taint the wine and with global warming, the presence of ladybugs in the vineyard has increased (warmer winters allow the beetles to survive in greater numbers).

LADYBUG SPECIES CONTRIBUTING TO LADYBUG TAINT

There are **two species mainly responsible** for the ladybug taint:

- *Harmonia axyridis* (multicoloured Asian ladybird beetle or harlequin ladybird beetle)
- *Coccinella septempunctata* (seven-spot ladybird beetle)

In South Africa, the harlequin Ladybird was **first noticed** in the early 2000's on an experimental farm in Riviersonderend, Western Cape where fairly large numbers of **aphids** were present on wheat[15]. At the time adults and larvae of the unfamiliar ladybird beetle species were collected for research purposes. The species were **not detected** during 2005 **when aphid infestations were very low**.

It is unknown how long the invasive species has been in South Africa, how it gained entry to the country, and whence it originated. The presence of the beetle in South Africa is of considerable concern, given its potentially aggressive and invasive nature, as is presently being evaluated and documented in North America and Europe.

COMPOUNDS SECRETED / EXTRACTED BY THE LADYBUGS

The methoxypyrazines in the ladybug hemolymph are secreted by the insects[16] during grape processing and the compounds linked to the taint are:

- **2-Isopropyl-3-methoxypyrazine (IPMP)**
- 2-Isobutyl-3-methoxypyrazine (IBMP)
- 2-*sec*-butyl-3-methoxypyrazine (SBMP)
- 2,5-dimethyl-3-methoxypyrazine (DMMP)

Lower intensities of fruit and floral descriptors have also been noted as well as changes in the perception of sweet, acid and bitter tastes[17], however, studies have not been able to identify compounds other than the methoxypyrazines to be significant contributors to ladybug taint.

A study[17] tested the **concentration of methoxypyrazines in wines made from grapes either in the presence or absence of ladybugs**. Live ladybugs were added to the grapes during processing at 10 beetles per kilogram of grapes. Results showed **significant increases in methoxypyrazine** content. Results also showed a higher increase in methoxypyrazine content when the beetles were added during **red wine processing**. This increase is likely due to the **much longer period in which the beetles are in contact with the must** during red winemaking, allowing **more time for extraction** of the methoxypyrazines. Other than that, the **increased ethanol** concentration due to alcoholic fermentation may also allow for **greater extraction and/or retention** of these compounds as the methoxypyrazines are highly soluble in ethanol[18].

Another study reported **no difference between the two beetle species in their methoxypyrazine contribution** to Riesling wine[18]. Practically, this suggests that wine **producers do not need to differentiate between the species when making preventative/remedial decisions in the vineyard or winery.**

WHEN ARE THE METHOXYPYRAZINES INSECT-DERIVED AND WHEN IS IT GRAPE-DERIVED?

Firstly, assess whether the **grape variety used is prone to elevated methoxypyrazine concentrations**. A **vineyard's history** of methoxypyrazine content should also provide a decent indication whether it is grape-derived or not and provoke further investigation. If a variety/vineyard is not known to produce high methoxypyrazine content, then the source might be non-grape-derived.

As mentioned previously, the taint differs sensorially from natural grape-derived methoxypyrazines, mostly due to the **difference in concentration and composition**. All four of the listed methoxypyrazines can occur naturally in certain grapes, however, the **concentration ratio between the methoxypyrazines might implicate the source**. IBMP is by far the more prevalent methoxypyrazine in South African Sauvignon banc wines[19]. Therefore, **untainted wines** containing methoxypyrazines will **usually have much higher levels of IBMP compared to IPMP** (if present at all). See the 2020 Sauvignon Blanc SA Top10 analysis for typical natural grape-derived methoxypyrazine concentrations. To the contrary, studies have shown that **IPMP is the most important contributor to wines with ladybug taint**[17]. Therefore, **elevated concentrations of IPMP and a lower than usual IBMP:IPMP ratio are good reasons to suspect that the methoxypyrazines are insect-derived (however not definite).**

CONCLUSION

Part 1 of this two-part blog series on the ladybug taint addressed the **main effects of ladybug taint** on wine composition, the **species involved** and **how to distinguish between grape-derived methoxypyrazines and insect-derived methoxypyrazines**. **Part 2** of this blog series will briefly look at **preventative and remedial actions** to avoid the taint from spoiling your wine.

REFERENCES

(1) Pickering, G.; Lin, J.; Riesen, R.; Reynolds, A.; Brindle, I.; Soleas, G. Influence of Harmonia Axyridis on the Sensory Properties of White and Red Wine. *American Journal of Enology and Viticulture* **2004**, *55* (2), 153–159.

(2) Pickering, G. J.; Lin, Y.; Reynolds, A.; Soleas, G.; Riesen, R.; Brindle, I. The Influence of Harmonia Axyridis on Wine Composition and Aging. *Journal of Food Science* **2005**, *70* (2). https://doi.org/10.1111/j.1365-2621.2005.tb07117.x.

(3) Ross, C. F.; Weller, K. Sensory Evaluation of Suspected Harmonia Axyridis-Tainted Red Wine Using

Untrained Panelists. *Journal of Wine Research* **2007**, *18* (3), 187–193. https://doi.org/10.1080/09571260801899881.
(4) Ejbich, K. Producers in Northeastern U.S., Ontario Bugged by Bad Odors in Wines. *Wine Spectator* **2003**.
(5) Chapin, J. B.; Brou, V. . Harmonia Axyridis (Pallas), the Third Species of the Genus to Be Found in the United States (Coleoptera: Coccinellidae). *Proceedings of the Entomological Society of Washington 93* (3), 630–635.
(6) Ongagna, P.; Giuge, L.; Iperti, G.; Ferran, A. Cycle de Développement d'Harmonia Axyridis (Col. Coccinellidae) Dans Son Aire d'introduction: Le Sud-Est de La France. *Entomophaga* **1993**, *38* (1), 125–128. https://doi.org/10.1007/BF02373146.
(7) Coderre, D.; Lucas, É.; Gagné, I. THE OCCURRENCE OF HARMONIA AXYRIDIS (PALLAS) (COLEOPTERA: COCCINELLIDAE) IN CANADA. *The Canadian Entomologist* **1995**, *127* (4), 609–611. https://doi.org/10.4039/Ent127609-4.
(8) FERRAN, A.; NIKNAM, H.; KABIRI, F.; PICART, J. L.; DE HERCE, C.; BRUN, J.; IPERTI, G.; LAPCHIN, L. The Use of Harmonia Axyridis Larvae (Coleoptera: Coccinellidae) against Macrosiphum Rosae (Hemiptera: Sternorrhyncha: Aphididae) on Rose Bushes. *EJE* **1996**, *93* (1), 59–67.
(9) LaMana, M. L.; Miller, J. C. Field Observations on Harmonia Axyridis Pallas (Coleoptera: Coccinellidae) in Oregon. *Biological Control* **1996**, *6* (2), 232–237. https://doi.org/10.1006/bcon.1996.0029.
(10) Brown, M.; Miller, S. Coccinellidae (Coleoptera) In Apple Orchards Of Eastern West Virginia And The Impact Of Invasion By Harmonia Axyridis. *Entomological News* **1998**, *109*, 143–151.
(11) Tedders, W. L.; Schaefer, P. Release and Establishment of Harmonia Axyridis (Coleoptera: Coccinellidae) in the Southeastern United States. *Entomological News* **1994**, *105*, 228–243.
(12) Almeida, L. M. de; Silva, V. B. da. Primeiro Registro de Harmonia Axyridis (Pallas) (Coleoptera, Coccinellidae): Um Coccinelídeo Originário Da Região Paleártica. *Revista Brasileira de Zoologia* **2002**, *19* (3), 941–944. https://doi.org/10.1590/S0101-81752002000300031.
(13) Adriaens, T.; San Martin y Gomez, G.; Maes, D. Invasion History, Habitat Preferences and Phenology of the Invasive Ladybird Harmonia Axyridis in Belgium. In *From Biological Control to Invasion: the Ladybird Harmonia axyridis as a Model Species*; Springer Netherlands: Dordrecht; pp 69–88. https://doi.org/10.1007/978-1-4020-6939-0_6.
(14) Koch, R. L. The Multicolored Asian Lady Beetle, Harmonia Axyridis: A Review of Its Biology, Uses in Biological Control, and Non-Target Impacts. *Journal of Insect Science* **2003**, *3* (1). https://doi.org/10.1093/jis/3.1.32.
(15) Stals, R.; Prinsloo, G. Discovery of an Alien Invasive, Predatory Insect in South Africa: The Multicoloured Asian Ladybird Beetle, Harmonia Axyridis (Pallas) (Coleoptera: Coccinellidae). *South African Journal of Science* **2007**, *103*, 123–126.
(16) Cai, L.; Koziel, J. A.; O'Neal, M. E. Determination of Characteristic Odorants from Harmonia Axyridis Beetles Using in Vivo Solid-Phase Microextraction and Multidimensional Gas Chromatography–Mass Spectrometry–Olfactometry. *Journal of Chromatography A* **2007**, *1147* (1), 66–78. https://doi.org/10.1016/j.chroma.2007.02.044.
(17) Botezatu, A. I.; Kotseridis, Y.; Inglis, D.; Pickering, G. J. Occurrence and Contribution of Alkyl Methoxypyrazines in Wine Tainted by Harmonia Axyridis and Coccinella Septempunctata. *Journal of the Science of Food and Agriculture* **2013**, *93* (4), 803–810. https://doi.org/10.1002/jsfa.5800.
(18) Kögel, S.; Botezatu, A.; Hoffmann, C.; Pickering, G. Methoxypyrazine Composition of Coccinellidae-Tainted Riesling and Pinot Noir Wine from Germany. *Journal of the Science of Food and Agriculture* **2014**, *95* (3), 509–514. https://doi.org/10.1002/jsfa.6760.
(19) van Wyngaard, E. Volatiles Playing an Important Role in South African Sauvignon Blanc Wines, University of Stellenbosch: Stellenbosch, 2013, Vol. Master in.

Photo by Kandis Glasgow on Unsplash