



ASSESSMENT OF THE PESTICIDE PROFILE DURING VERMICOMPOSTING OF GRAPE MARC

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INTRODUCTION

Grape cultivation for wine production involves the use of pesticides to ensure the quality and yield of the crop. Globally, 11 million tons of grapes are produced each year, primarily for wine production¹, and the final product is subject to strict regulations regarding maximum pesticide residue limits.

However, this process generates approximately 25% by-product in the form of grape marc (consisting of skins, seeds, and pulp), for which there are currently no specific regulations regarding the concentration of these compounds².

ALTERNATIVE

OBJETIVE

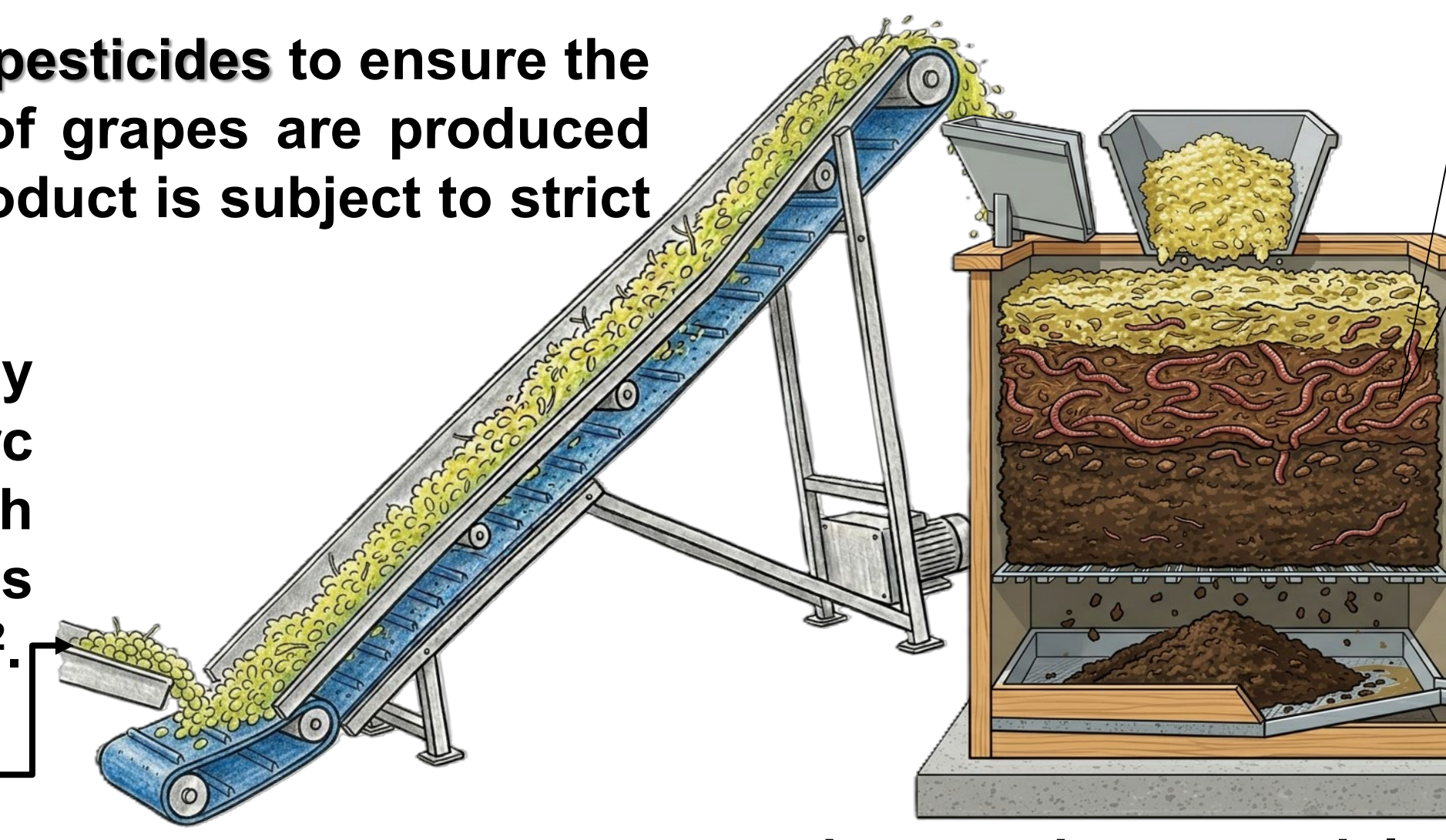
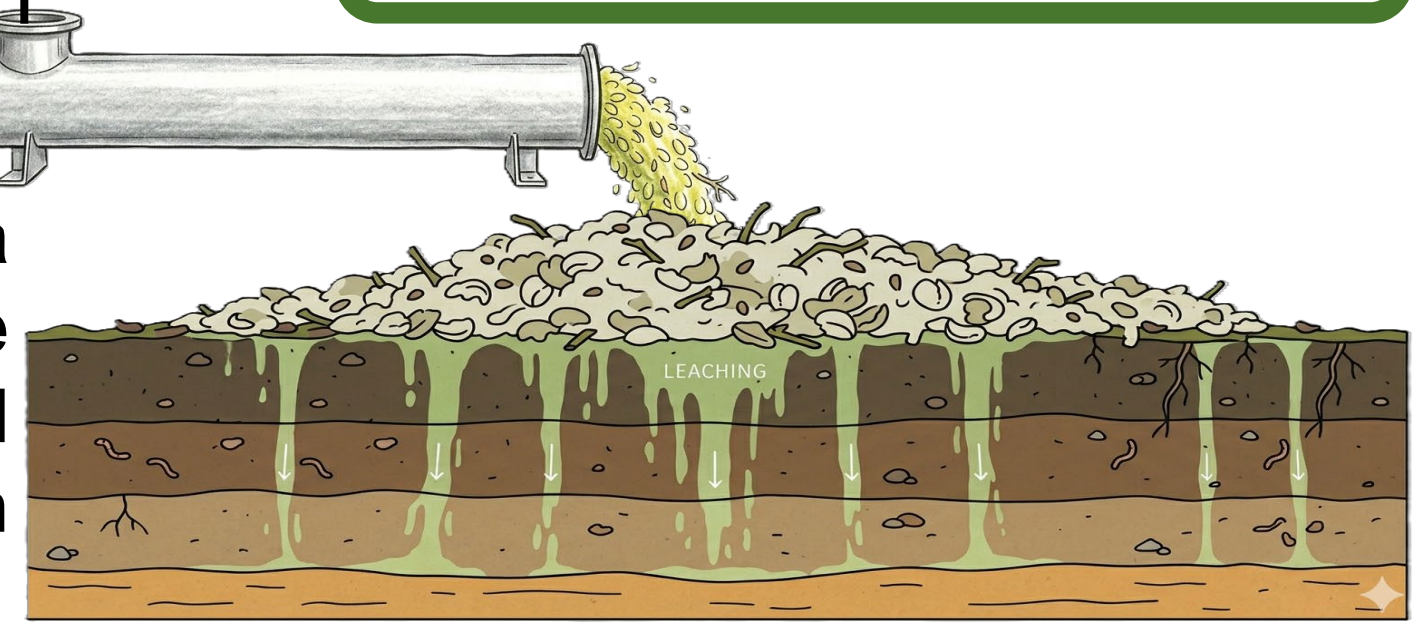
To detect and quantify pesticide residues in the marc of Albariño white grapes and to evaluate their transformation during vermicomposting using the red worm *Eisenia andrei*. The study evaluates whether vermicomposting is a safer and more effective alternative to the direct application of marc, allowing for the reduction and homogenization of the pesticide load, as well as the production of a final product suitable for use in agricultural soils.



A sustainable alternative for its recovery is biotransformation by earthworms, resulting in vermicompost³. Although vermiremediation is known to provide a substrate that can be directly applied as a soil amendment, the effect of the starting material on the potential pesticide pool remains uncertain, raising questions about its safety.



As a result, their indiscriminate accumulation in soil can pose a potential environmental risk due to the presence of pesticides and phytochemicals in high concentrations

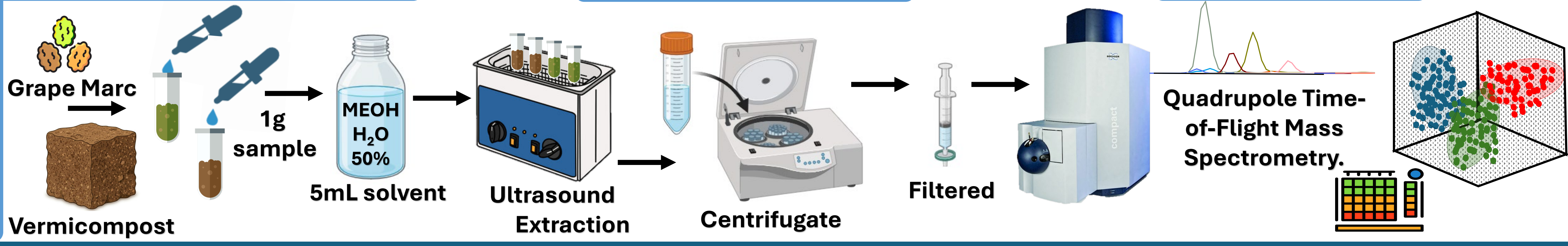


COMPARATIVE ANALYSIS

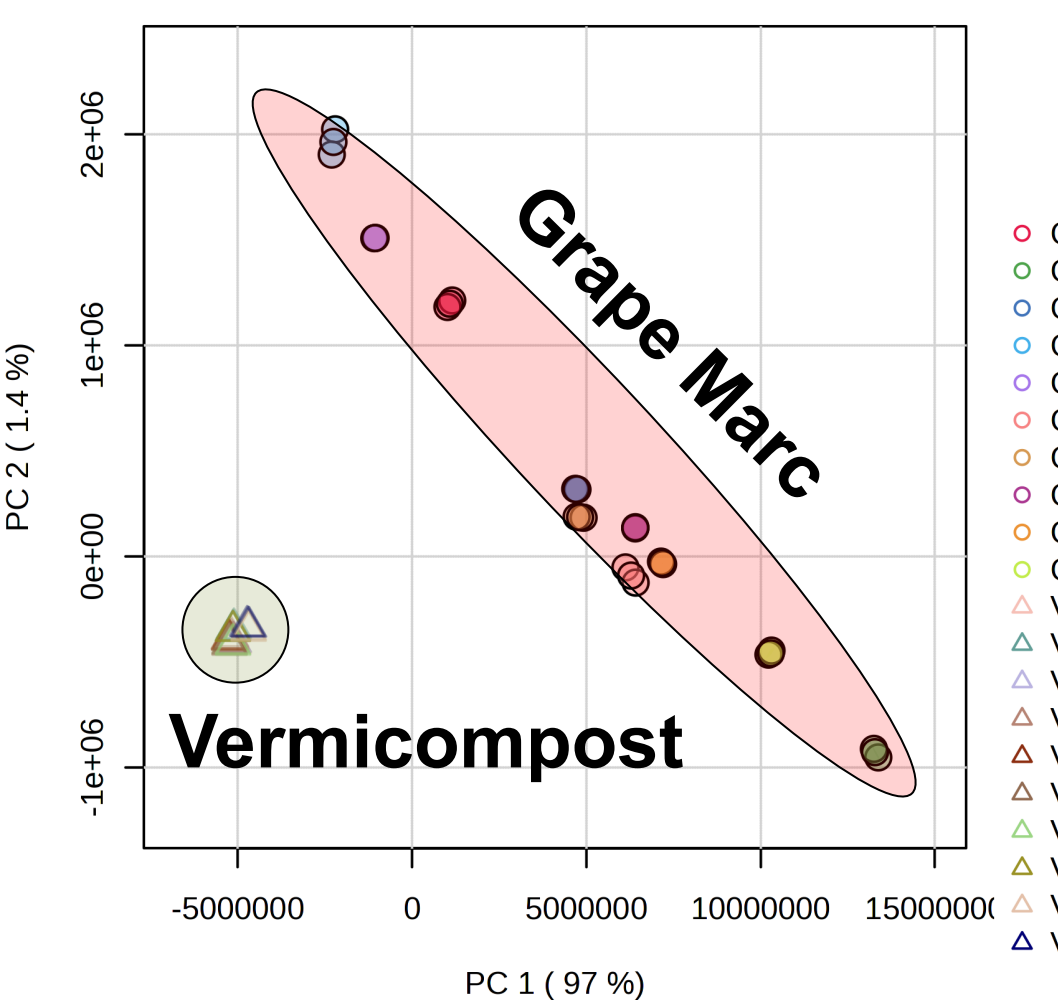
GREEN EXTRACTION

DEEP ANALYSIS

METHODOLOGY

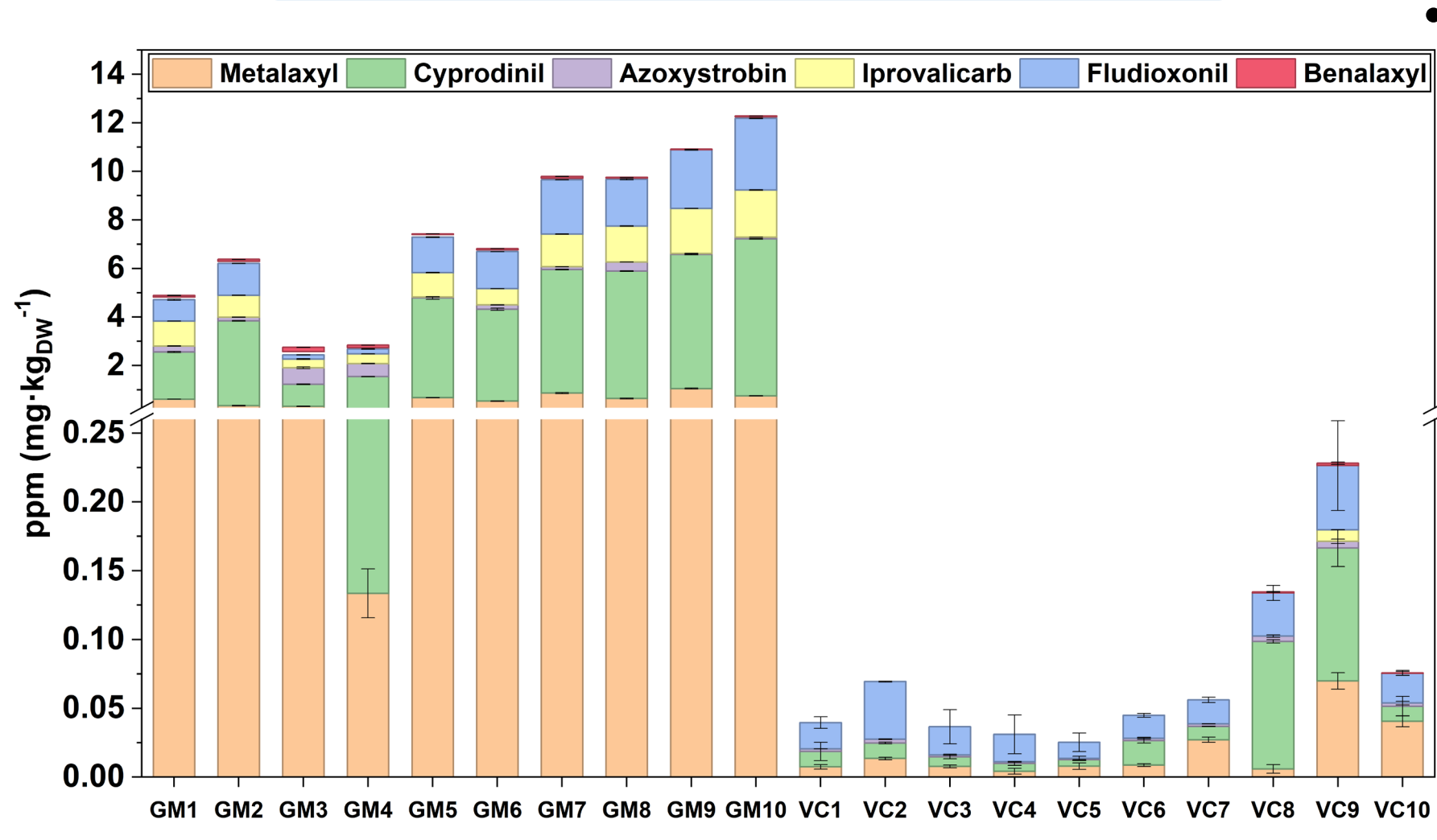


PCA ANALYSIS



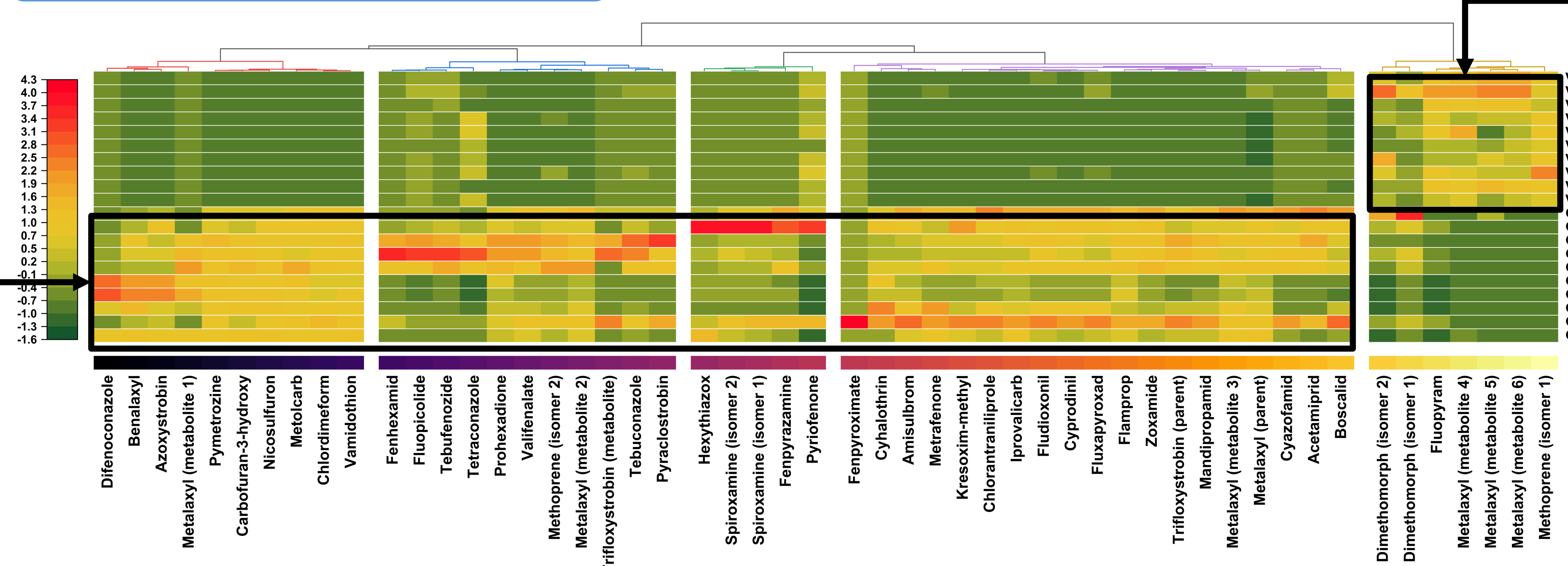
- Grape marc (GM) shows greater dispersion across sampling points, indicating higher compositional variability.
- Vermicompost (VC) exhibits a much more homogeneous distribution, reflecting a more stable and uniform matrix.
- A clear group separation is observed, with well-defined discrimination between VC and GM samples.

TARGET ANALYSIS



- 6 target compounds were selected for analysis.
- GM shows a total combined concentration of ~8 ppm
- VC does not exceed 0.25 ppm in total concentration, indicating a strong overall reduction.
- Within the GM samples, cyprodinil exhibits the highest concentration ($3.798 \pm 0.0023 \text{ mg} \cdot \text{kgDW}^{-1}$)

HEAT MAP

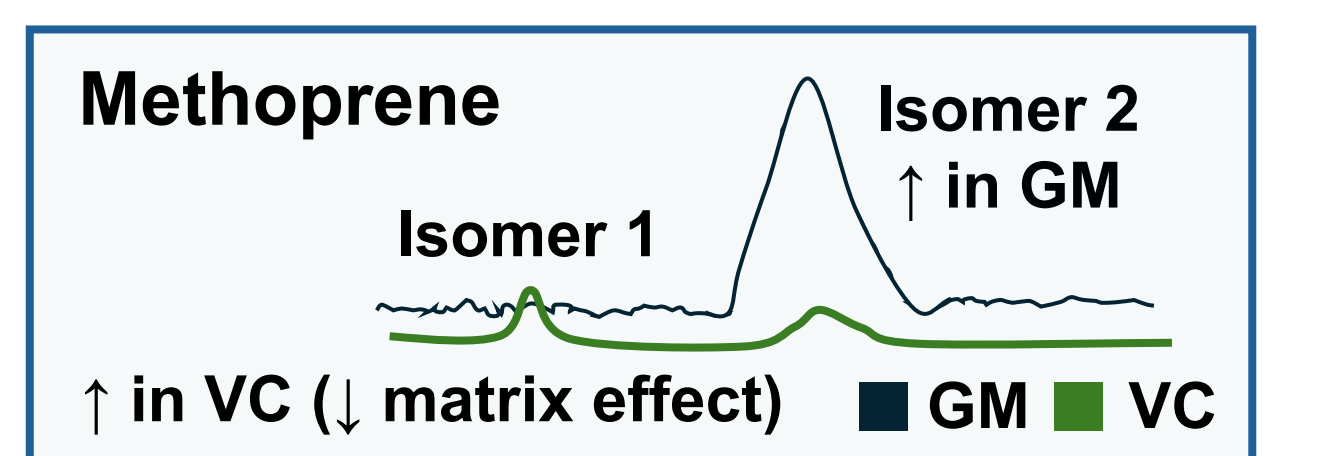


GROUP 5 Shows a higher relative presence in VC in relation to GM.

- Greater persistence of conformationally more stable isomers
- Reconcentration effect associated with the VC process
- Biotransformation processes during VC, leading to the formation of derived metabolites.

Dimethomorph (2 isomers)
DT50 >30 days
Moderate to high persistence

Fluopyram
DT50 >300 days
High adsorption capacity.



Minor responses of metalaxyl-derived metabolites

- GROUP 1** LogP ↓
 - GROUP 2** Presence of triazole compounds.
 - GROUP 3** Moderate volatility.
 - GROUP 4** Widely used pesticide. High stability.
- GM shows 4 well-defined pesticide groups.**

A higher response is observed for 45 pesticides in GM compared to 52 compounds detected in the untargeted screening.

CONCLUSIONS

REFERENCES

ACKNOWLEDGMENTS

- Pseudotarget UHPLC-Q-TOF approach enabled comprehensive pesticide profiling.
- Vermiremediation reduced >45 pesticides in the initial material.
- VC achieved ~98% reduction in key quantified compounds (metalaxyl, cyprodinil, azoxystrobin, iprovalicarb, fludioxonil, benalaxyl).
- A limited subset of compounds (fluopyram, dimethomorph, tetraconazole, metalaxyl derivatives) persisted or showed relatively higher responses in vermicompost.
- Results support vermicomposting as an effective biotransformation process for mitigating pesticide loads in grape marc and improving its suitability as an organic amendment.
- Findings provide a baseline for future monitoring and regulatory consideration of pesticide residues in wine industry by-products.

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