INTEGRATION OF VERMICOMPOSTING OF WINE BY-PRODUCTS IN VINEYARDS FOR REGENERATIVE VITICULTURE

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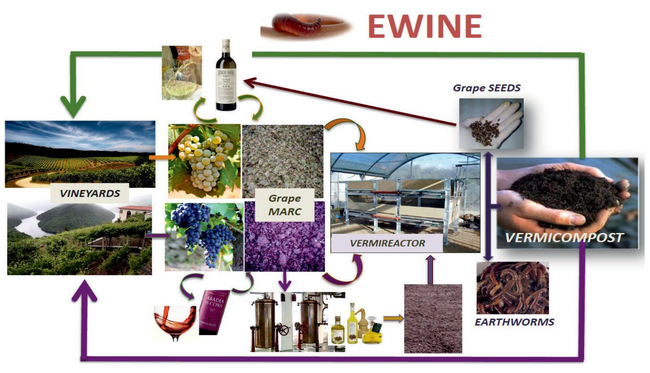
ABSTRACT

Vineyards are typically managed intensively to maximize wine production, which leads to a decline in biodiversity and soil fertility, as well as environmental problems such as changes in primary production and the nutrient cycle, a decrease in surface biodiversity, high soil erosion, eutrophication and groundwater contamination, and the generation of large amounts of byproducts. This study provides an overview of how earthworms and vermicomposting can support the circular economy and sustainable agriculture by creating an integrated cycle that converts byproducts from the local wine industry into vermicompost usable as a biofertilizer and soil conditioner in vineyards. The results of this research have important implications for steering the wine industry toward a circular, sustainable, and regenerative economy.

OBJETIVE

The aim of this study is divided into two main objectives, which form part of the EWINE project. EWINE is an ongoing project, launched seven years ago, designed to complete a full cycle that enables: (1) the transformation of grape marc into vermicompost, and (2) the study of the effects of this vermicompost on vineyard soils, as well as on the grapes and wine quality.



MATERIALS AND METHODS

We process three types of grape marc using vermicomposting:

1. Grape marc from white wine (Albariño variety)
2. Grape marc from red wine (Mencía variety)
3. Used grape marc (after distillation to produce alcoholic beverages)

The grape marc was processed in pilot-scale bioreactors, where it was layered over time to be broken down by earthworms. The entire process was monitored periodically and studied in detail.

We monitored changes in the physicochemical properties of grape marc during vermicomposting and characterized the final vermicompost derived from the three types of grape marc.

We studied the effects of vermicompost derived from grape marc on the soil and vines over five growing seasons in different vineyards belonging to two designations of origin and located in two distinct biogeoclimatic zones: the white Albariño variety in Atlantic Galicia (northwestern Spain) and the red Mencia variety in rugged river valleys, with a more continental climate.

BIOFERTILIZATION USING VERMICOMPOST DERIVED FROM GRAPE MARC

The vermicompost was applied to the vines in solid form (once a year) and in liquid form as vermicompost tea (three times during the budding, flowering, and fruit-setting stages). These vines (leaves, grapes, and their corresponding soils) were compared with the same number of vines treated under standard commercial winery conditions (CONTROL).

GRAPE HARVEST

For five consecutive harvests, grape yields were recorded for each of the control and experimental vines in the vineyards. Grape samples were collected from each vine and stored at -20 °C until analysis.

RESULTS

It takes time to achieve high earthworm population densities. After five years, we have “artificially selected” earthworm populations that are well-adapted to each type of grape marc. Finally, throughout the year we maintain population densities of over 16,000 earthworms per square meter, and these adapted populations process the grape marc very quickly.

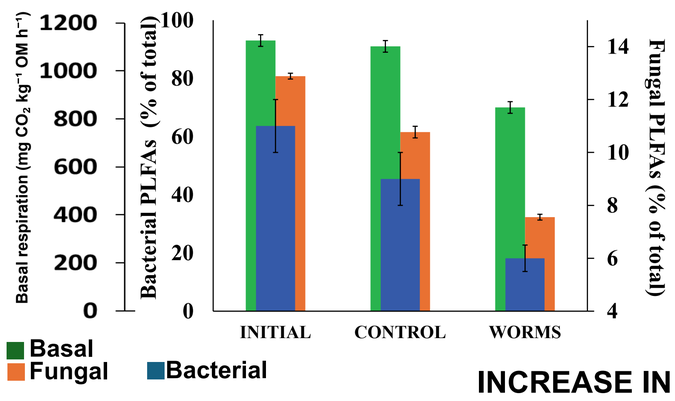
Range of properties of vermicompost derived from grape marc

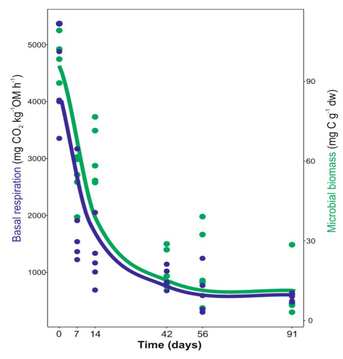
Vermicompost	Concentration (g·kg^{-1} dry weight)	Vermicompost	Concentration (g·kg^{-1} dry weight)
Total Carbon	350 – 500	Total Iron	1 – 10
Total Nitrogen	12 – 42	Total Manganese	0.05 – 2.5
C/N Ratio	10 – 40	Total Boron	0,004 – 0,04
Total Phosphorus	1 – 10	Total Molybdenum	0,001 – 0,03
Total Potassium	5 – 18	Lignin	300 – 800
Total Calcium	5 – 25	Celulose	35 – 200
Total Magnessium	1 – 5	Hemicelulose	10 – 150
Total Sulfur	1 – 8	Total Polyphenols	5 – 25

Vermicompost	Value
pH	7.1 – 7.8
Conductivity e. (mS·cm^{-2})	0.1 – 0.2
Organic Matter (%)	72 – 90
Resting respiration (mg·O_2·kg^{-1}·M·Oh^{-1})	30 – 200

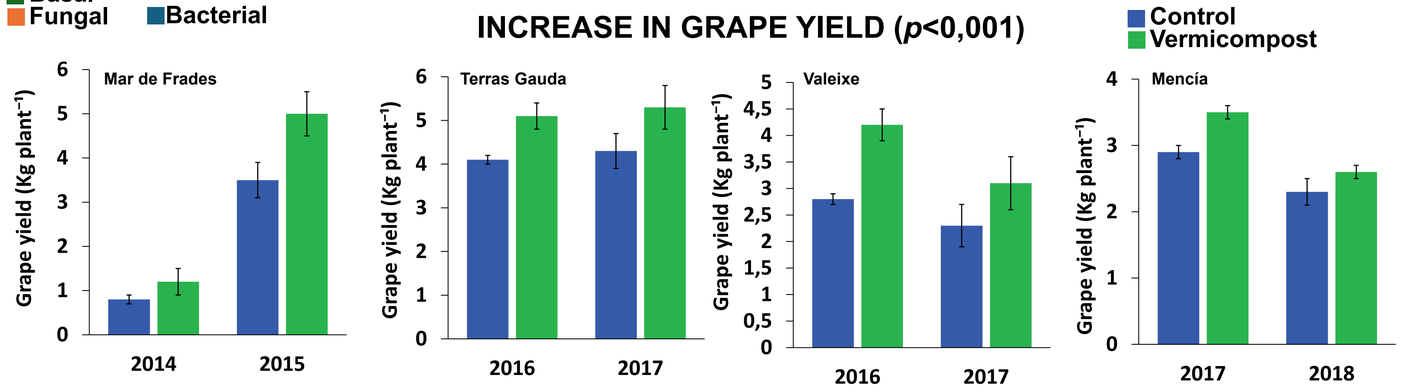
The material undergoes a dramatic transformation, and its appearance and texture are fantastic, with a reduction in mass of between 50% and 80%.

We studied the effects of earthworms on the abundance and structure of microbial communities (microbial biomass, bacterial biomass, and fungal biomass) and their activity (basal and induced respiration and enzymatic activities).



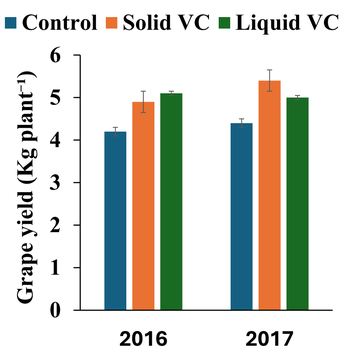


INCREASE IN GRAPE YIELD (p<0,001)



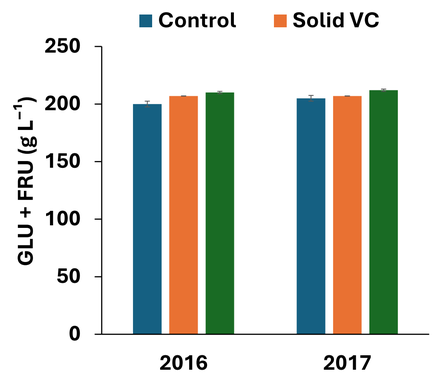
Vines fertilized with vermicompost produced significantly more grapes in all cases, for both grape varieties and in both biogeoclimatic regions, between 2014 and 2018.

SIMILAR INCREASES WITH SOLID OR LIQUID VERMICOMPOST



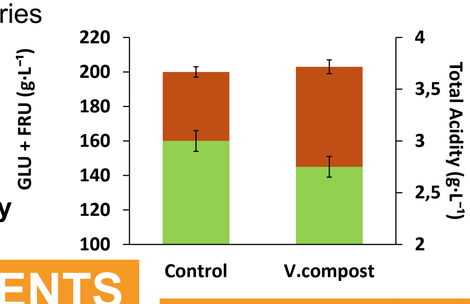
In all cases, the effect of biofertilization with VC on grape production was similar whether VC was applied in solid or liquid form (VC tea). Therefore, depending on vineyard management practices, wineries can choose the most appropriate application method.

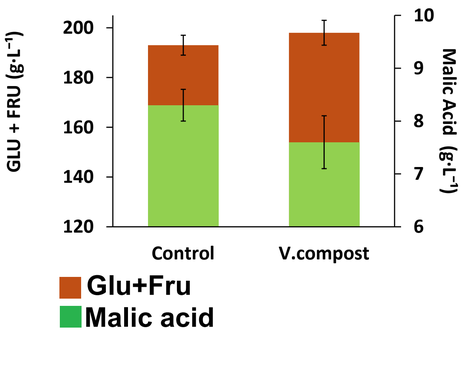
The effect of biofertilization with VC on the “standard” quality of the grapes was similar whether VC was applied in solid or liquid form (VC tea).



NO EFFECT ON THE “STANDARD” QUALITY OF THE GRAPES

The quality of the grapes was similar in terms of standard oenological properties, such as sugar content, and this is very important because, when it comes to distinctive wines, wineries always prioritize quality over quantity... and it is often argued that an increase in quantity is offset by a decline in quality.





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CONCLUSIONS

The end product of vermicomposting, known as vermicompost or worm castings, provides a wide variety of microorganisms and nutrients that are more easily absorbed by plants. Nutrient-rich vermicompost increased production capacity in the vineyards where it was applied, thereby minimizing the need for commercial synthetic fertilizers. Fertilization with vermicompost not only significantly improved grape production, but the harvested grapes and the resulting wine were of very high quality.