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Vermicomposting: Using the soil ecosystem in new places

Research Objectives

Jorge Domínguez analyses the main advances and current trends in vermicomposting after 18 years of continuous progress in scientific, technical, and commercial endeavours.

Detail

Bio

Jorge Domínguez Martín is a professor of Zoology at the University of Vigo, Spain. His research interests are soil ecology, earthworm biology, and vermicomposting of organic wastes. He has supervised eight PhD theses and published many scientific articles and book chapters, making him an international authority on earthworm ecology and vermicomposting.

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Personal Response

Do you think there will be any attempt to genetically engineer a worm that is perfectly optimised for a vermiculture/vermicomposting system?

/// I do not think so, as *Eisenia* spp. are species under strong artificial selection pressure. They are very adapted to sudden changes in an environment, and due to their short life cycle, they are able to adapt to new organic waste and new environmental conditions very quickly. In our laboratory, we have worm cultures that have been living on grape bagasse for more than ten years, and these worms are very different from other populations of the same species living on other organic substrates. //

Universidade de Vigo

Vermicomposting

Using the soil ecosystem in new places

Vermicomposting has gained popularity as a sustainable, environmentally friendly method for waste disposal and fertiliser production. Earthworms and soil microbiota work together to break down and reshape solid organic waste into a fertile humus. From small-scale beginnings, much research has been done to scale up and optimise the physical and biological aspects of the system. Dr Jorge Domínguez, head of the Soil Ecology Laboratory at the University of Vigo in Spain, has been studying a wide range of scientific aspects of this discipline and developed a comprehensive vermicomposting research programme over the past 30 years. He says that further adaptation will allow the implementation of vermicomposting systems towards new applications, such as regenerative and sustainable agriculture and sewage processing.

Vermicomposting is a method of processing organic wastes using earthworms and soil microbes. It has seen a surge in popularity over the last two decades. With the increasing pressure to protect our fragile ecosystems more efficiently and to preserve the integrity of soils, this innovative and natural approach is gaining broad appeal. The pioneers in this field have made progress in both the optimisation of species used in the process and in the adaptation of the technology towards large-scale industrial applications. The scale of a vermicompost operation can range from a small, household container to a complex, automated reactor.

VERMICOMPOST: BREAKING NEW GROUND

Vermicomposting uses a combination of earthworms and soil microbes to transform solid organic waste, such as decaying plant matter or food scraps, into a fully degraded vermicompost which can be applied directly to agricultural soils. As the worms digest the organic litter and convert it into their own waste product, the resulting castings, or worm faeces, drastically change composition of the solid organic waste. The entire microbial community alters as the worms feed on the available fungi and bacteria, thereby encouraging the growth of other microbes whose enzymes further decompose dead organic matter.

This synergistic activity between earthworms and microbes transforms the physical, chemical, and biological characteristics of the starting material. Although the fundamental ideas behind small-scale vermiculture and vermicomposting have existed for many decades, new research is exploring its application towards novel industrial contexts and the decomposition of different types of waste material. To further refine these implementations, many aspects of the vermicompost

system must be understood and optimised. One of the most important of these is the species of worm used.

THE BEST WORM FOR THE JOB

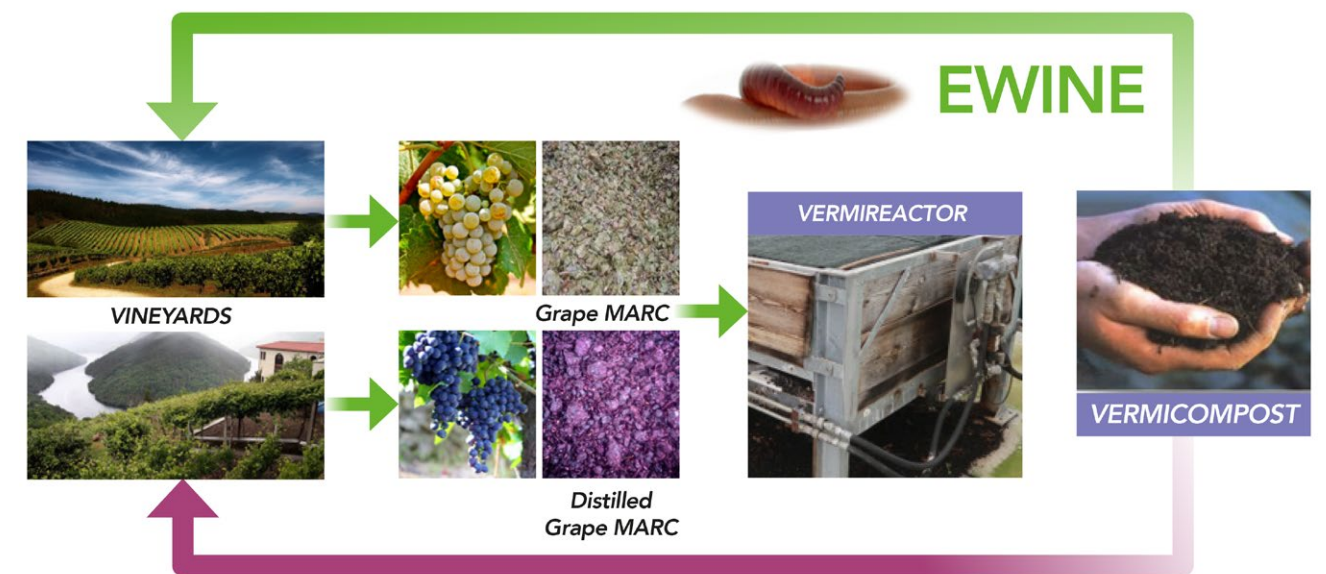
Dr Jorge Domínguez, head of the Soil Ecology Laboratory at the University of Vigo in Spain specialises in earthworm biology. His research focuses on worm species best suited for vermicomposting and their function in soil ecosystems. Of over 7,000 species of earthworms known today, only about six are suitable for vermicomposting. This is because the starting material for the system is unprocessed biological material with a very different structural characteristic compared to soil. The type of worm able to live in this environment would be an epigeic, or surface-dwelling earthworm.

Epigeic worms do not usually burrow into soil, but live within leaf litter instead. Their biological niche is therefore already well adapted to the vermicompost habitat. Most setups have found that members of the genus *Eisenia*, commonly called redworms, are best suited for the role. *Eisenia* is a temperate genus, and its broad temperature tolerance has facilitated its use in vermicomposting systems worldwide.

Although there is some debate as to whether a tropical worm species, such as *Eudrilus eugeniae*, would be better suited to equatorial and tropical zones, few species can compete with the adaptability of *Eisenia*. In addition to temperature and humidity concerns, the physiology of the worm, as well as its life cycle, must be compatible. *E. eugeniae* has a size and life cycle more suitable for vermiculture, the farming of earthworms, than for vermicomposting, to collect their nutrient-rich castings.

DECOMPOSERS AND THEIR DECOMPOSITION

The key to a successful vermicomposting



Summary of the ongoing EWINE project, started in 2012, and undertaken to close a cycle in which grape marc is converted into vermicompost, which is then applied to the vineyards as a biofertiliser and biostimulant treatment.

setup lies in maintaining a dense earthworm population. Like any wild population, numbers will increase when presented with ideal conditions for growth. Within the composting context, this means giving special attention to the moisture content of the system. The metabolism of the earthworms and associated microbes are temperature- and moisture-dependent. However, if either of these are too high, the compost may start to decompose anaerobically (without oxygen).

Careful monitoring of these two critical factors, as well as other chemical conditions, such as pH and salt, will ensure a robust and sustainable system. The worm population will generally increase in proportion to the amount of food available and eventually reach an equilibrium.

Vermicomposting is more than just adding earthworms to organic waste. It involves two phases: the gut-associated process and the cast-associated process. In the first phase, earthworms eat the substrate and convert it into casting. Much of the bacterial and fungal contamination of the unprocessed waste is removed as it passes through the worm's digestive system. During the second phase, the microbial communities adapted to the worm castings further

transform the biomaterial into compost. Understanding the unique requirements of both stages will enable researchers to adapt the system to new industries, such as sewage disposal or agriculture.

THE FUTURE OF FERTILISER

Vermicomposting is a promising alternative for improving the health of agricultural soil in a sustainable manner. The end product, known as earthworm humus or vermicompost, can provide plants with a wide range of nutrients

processing. Vermicomposting of the grape marc created an economical solution for processing an abundantly available industrial by-product. Not only did fertilisation with vermicompost significantly improve grape production, but the resulting wine was found to be of high quality.

Another unique application of the technology is in the treatment of sewage sludge as tertiary treatment in medium and small wastewater

treatment plants. The potential for human pathogens to be removed via earthworm digestion would improve sewage processing and soil health.

Domínguez's research

group is working on a pilot-scale vermicomposting-based process that will remove human pathogens in sewage waste and help convert it into commercial soil amendment.

The combined activity of earthworms and microbiota should produce an environmentally safe and high-quality biofertiliser. While more research is needed to optimise the system and ensure its safety, the potential for an environmentally friendly waste processing method which simultaneously strengthens the earth is a step forward to a waste-free and sustainable future.

Vermicomposting is a promising alternative for improving the health of agricultural soil in a sustainable manner.

and microbial diversity. It has already been shown to improve soil fertility and water retention, thereby reducing the need for commercial synthetic fertilisers.

In one specific context, this technique has been successfully implemented in a circular economy within the grape-producing sector. Commercial vineyards produce an industrial by-product called grape marc, which is the leftover of the skin, pulp, and seeds after the grapes have been processed for wine. Grape marc is already used as an organic soil amendment, but its high acidity and phytotoxic polyphenol content makes it unsuitable as a fertiliser without prior



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