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Research Article

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5IF 4VJUBCJMJUZ PG 6TJOH 7FSNJDPNQPTUJO 5BOL 8BTUF

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Abstract

An investigation into the viability of vermicomposting septic tank waste was carried out. Progression of the

Class A Australia and USA) product for small isolated communities that have an interest in recycling/reusing their own waste.

Materials and Methods

Microorganisms	USA		New Zealand *	New South Wales *
	Class A	Class B	Grade A	Class A
E. coli	N/A	N/A	<100 MPN/g	N/A
Faecal coliforms	<1000 MPN/g	<2000000 MPN/g	N/A	<1000 MPN/g
Salmonella spp.	<3 MPN/4 g		<1/25 g	Not detected/50 g
Camplylobacter spp.			<1/25 g	
Enteric viruses	<1 PFU/4 g		<1 PFU/4 g	<1 PFU/4 g
Helminth ova	<1/4 g		<1/4 g	<1/4 g

N/A=No limits; PFU: Plaque-Forming Unit; MPN: Most Probable Number; *New Zealand and New South Wales Grade/Class B sludges have no limits for microorganisms

Table 2: Pathogen density limits adapted from United States Environment Protection Agency (US EPA); New South Wales Environmental Protection Agency (NSW EPA) and New Zealand Waste Water Association (NZ WWA).

waste and well acclimatised. Rodríguez-Canché et al. [10] reported complete removal of Helminth ova a er 60 days of vermicomposting from sewage sludge with an initial native concentration of 12.5 ova/g dry wt., which were almost 2 orders of magnitude lower than ours.

Campylobacter spp. concentrations in the nished product (Table 4) were several orders of magnitude greater than the NZ guideline limits (Table 2) [14]. Campylobacteriosis is the most frequently noti ed foodborne disease in New Zealand, with yearly noti cations in the order of 160 per 100,000 of population (New Zealand Public Health Surveillance Report, 2012) and for this reason it is monitored in biosolids in New Zealand [14]. Several studies have found a poor correlation between faecal indicators and Campylobacter spp. concentrations and this was evident in this experiment as E. coli was undetectable in 3 of the 4 treatments. Inglis et al. [33] found Campylobacter spp. surviving in compost for up to 7 months with no signi cant decrease in numbers, and stated that the ability of Campylobacter spp. to persist in an ecosystem that is so inhospitable challenges the common belief that Campylobacter spp. do not survive well outside of their hosts.

Chemical property change over the time of vermicomposting

e baseline chemical compositions of all treatments at time of setup are listed Table 1. Over the course of the experiment the NH_4-N

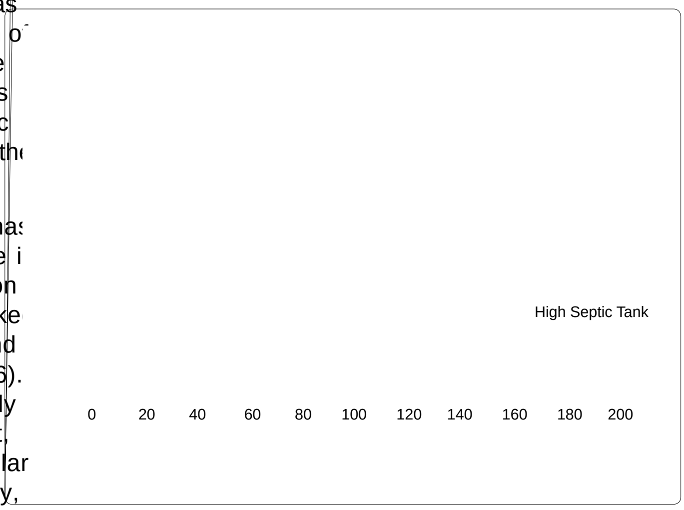
good indicator of biological activity and is closely related to microbial biomass [37]. Our results show a signi cant negative correlation of anaerobically mineralisable N with extract-N (Spearman's -1.000) and soil NO_3^--N (Spearman's -1.000), and the highest values, as expected, were found in the NC, reinforcing the view that earthworms help facilitate the mineralisation of N.

In general all treatments showed increases in Olsen-P until day 89 a er which a steady state was achieved (Figure 5). As Olsen-P represents a signi cant portion of the total mineralisable P, it was used in this study as a surrogate when looking at the mineralisation of organic-P during composting. e negative control had a slower rate of mineralisation, though this was not found to be signi cant. Worms are e cient at mineralising organic-P from a wide range of organic materials [9] as observed by the increase in rate of Olsen-P in the treatments that included worms.

Dehydrogenase activity in soils and other biological systems has been used as a measure of overall microbial activity [38], since it is an intracellular enzyme related to the oxidative phosphorylation process [25]. For the PC treatment, dehydrogenase activity peaked at 33 days then tracked downwards consistently until around 89 days where it stabilized at a relatively low activity (Figure 6). Low Dissolved Organic Carbon (DOC) may account for generally lower activity in this treatment (Table 1). In the LS treatment, dehydrogenase activity peaked at day 47 then followed a similar trend to the PC treatment, but stabilised at a much higher activity, which matches well with DOC. In both the NC and HS treatments, dehydrogenase peaked at 61 days and then continued to track downwards at a similar the rate of decline. These results suggest that dehydrogenase might not be affected by earthworms and that the type and quantity of waste could determine the activity of this enzyme in compost. This is supported by the findings of Aira and Dominguez [33] who found that dehydrogenase activity did not change in pig and cow manure after transit through the gut of *Eisenia fetida*

Conclusion

Vermicomposting has the potential to transform septic tank waste into high value compost as it is e ective in stabilizing nutrients and reducing pathogens. However, some pathogens, such as Helminth ova and *Camplylobacter spp.* can still be present at potentially unsafe levels that would not allow the compost to be safely handled. Traditional "end-point" detection parameters such as mineralisation of organic N do not relate well to pathogen reduction. Our study showed that the use of *E. coli* spp. as a surrogate for pathogen concentration was unsuitable. Pre-pasteurisation or further composting may be required to produce a pathogen free product.



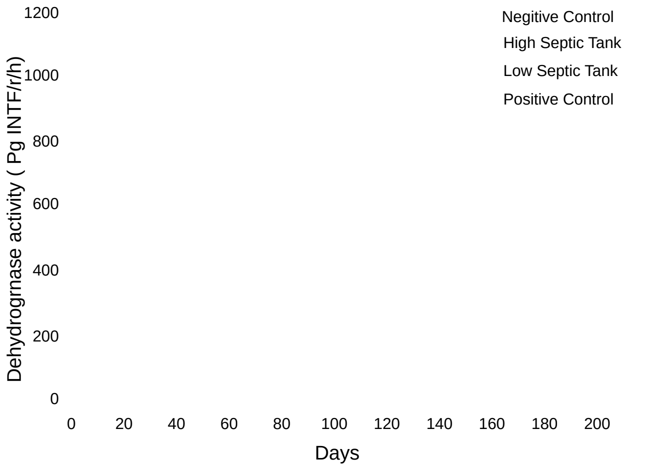


Figure 6: Dehydrogenase activity during vermicomposting.

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