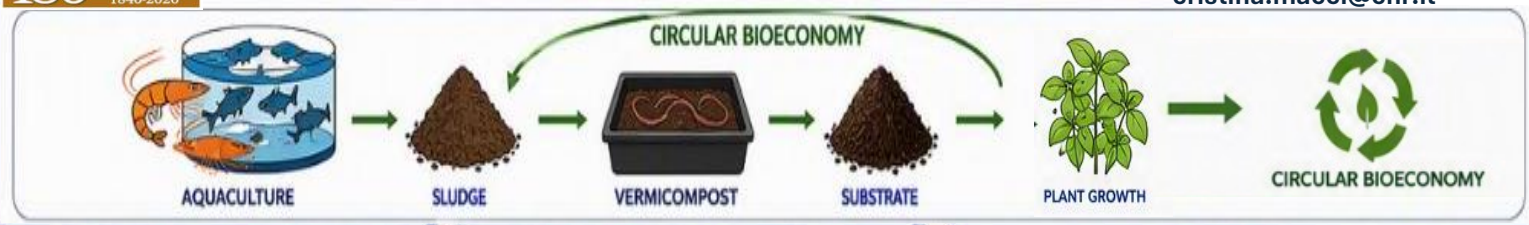
Valorization of Saline Aquaculture Sludge through Vermicomposting: Challenges and Opportunities for Circular Bioeconomy Systems

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1. BACKGROUND & OBJECTIVE

Why this study?

Aquaculture systems generate nutrient-rich sludge. High salinity and a low C/N ratio make it unsuitable for direct vermicomposting, limiting earthworm survival and process efficiency

Objective

To evaluate the conversion of high-salinity aquaculture sludge into high-quality vermicompost using appropriate pre-treatment and vermicomposting strategies

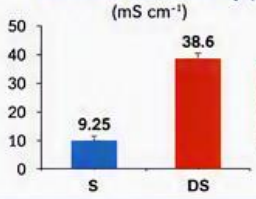
Sludge sources



Sludge characteristics
(before pre-treatment)

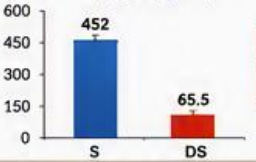
Parameter	S (Sedimented)	DS (Air-dried)
Moisture (%)	84.8 ± 0.3	53.4 ± 2.0
pH	7.94 ± 0.05	7.65 ± 0.11
EC (mS cm⁻¹)	9.25 ± 0.04	38.6 ± 1.1
TOC (%)	22.4 ± 0.3	21.0 ± 0.9
TN (%)	2.34 ± 0.07	2.49 ± 0.28
C/N ratio	9.59	8.43
N-NO_3^- (mg kg⁻¹)	36.4 ± 4.6	61.2 ± 18.7

Electrical Conductivity (EC)
(mS cm⁻¹)



Drying increased salinity more than fourfold

Respiration Activity (CO_2 evolution)
(mg CO_2 g^{-1} ss)



Drying strongly reduced microbial activity

The challenge

High salinity (up to 38.6 mS cm⁻¹) and very low C/N ratio make these sludges unsuitable for direct vermicomposting.

2. EXPERIMENTAL WORKFLOW



1 Sludge collection
from two local aquaculture facilities

2 Water removal



3 Characterization
Physical-chemical properties, nutrients, respiration, enzyme activities

4 Pre-treatment
Water dilution + amendment to reduce salinity, adjust C/N and improve aeration





5 Ecotoxicity tests
(earthworm survival)



6 Palatability tests
(feeding preference)

7 Vermicomposting trials
Four selected mixtures



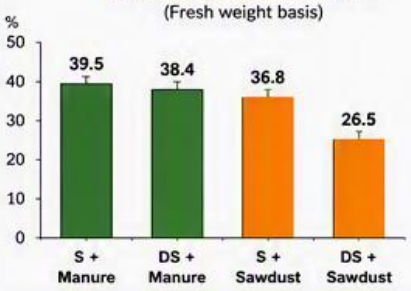
8 Agronomic validation
Basil (*Ocimum basilicum*)
Three fertigation regimes





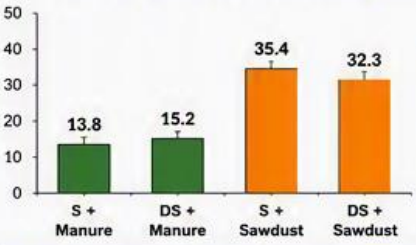
3. RESULTS

3.1 Conversion efficiency (%)
(Fresh weight basis)



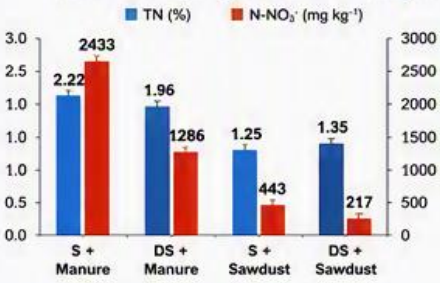
Manure-based mixtures achieved conversion efficiencies comparable with commercial vermicomposting systems.

3.2 Final C/N ratio of vermicomposts



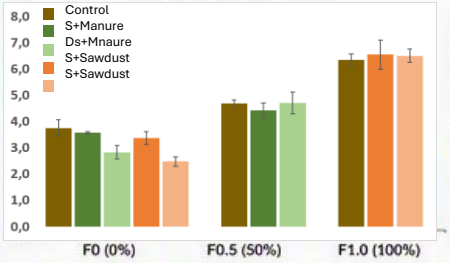
Manure promoted the production of a more mature and stable vermicompost.

3.3 Nutrient quality of final vermicomposts



Manure-based mixtures are richer in nutrients, especially available N.

3.4 Agronomic test – Basil (*Ocimum basilicum*)
Plant dry biomass (g plant⁻¹)







- No phytotoxic effects were observed under any fertigation regime.
- Plant growth increased with fertigation intensity.
- Winter conditions limited overall biomass production.

KEY MESSAGES

1. SALINITY IS THE MAJOR LIMITATION
High EC (up to 38.6 mS cm⁻¹) and low C/N ratio make sludge unsuitable for direct vermicomposting.

2. PRE-TREATMENT IS ESSENTIAL
Water dilution and organic amendments (manure or sawdust) improve conditions and ensure earthworm survival.

3. MANURE PERFORMS BETTER THAN SAWDUST
Higher conversion efficiency, better maturity, and greater nutrient availability.

4. SAFE FOR PLANT GROWTH
All vermicomposts were non-toxic and compatible with basil growth.
Biomass increased with fertigation intensity.

5. CIRCULAR BIOECONOMY OPPORTUNITY
Vermicomposting transforms aquaculture waste into valuable biofertilizers, closing the nutrient loop.