Strength and disintegration characteristics of compost pellets produced from urban waste in Sri Lanka

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Introduction

Recovering resources from urban organic waste can serve agricultural production while also closing the nutrient loop. However, resource recovery from both liquid and solid waste streams is only emerging in low-income countries up to now, although the agricultural value of these resources is well recognized. If the value proposition can be adjusted to the local settings then market demand and price could be enhanced.

Two of the major drawbacks in promoting urban solid waste compost are the:

(a) bulky nature and low density of the material, and

(b) low nutrient content of the compost.

To address these issues, the International Water Management Institute (IWMI) implemented a resource recovery treatment project based on the co-composting of nutrient-rich fecal sludge and organic municipal solid waste. By integrating fecal sludge into the co-composting process, a nutrient-rich compost can be produced. The pelletizing process can enhance the density, storage and handling of the compost, but it may also change some of the physical properties of the compost, such as moisture content, disintegration time and nutrient release.

Main objectives

- Increase the nutrient content of compost.
- Optimize production and application features of pellets.
- Assess the strength and disintegration of the co-compost pellets with and without binding agents.

1. Sieve the co-compost with a 5 mm mesh.

2. Check the moisture of the co-compost used as input material.

3. Add water to the mixture to obtain a moisture level of 25%.

4. Add binding agents according to the product and desired mixture.

5. Mix the various inputs thoroughly for pelletizing.

6. Feed the mixture into the pelletizer.

7. Check the quality of the product after pelletizing.

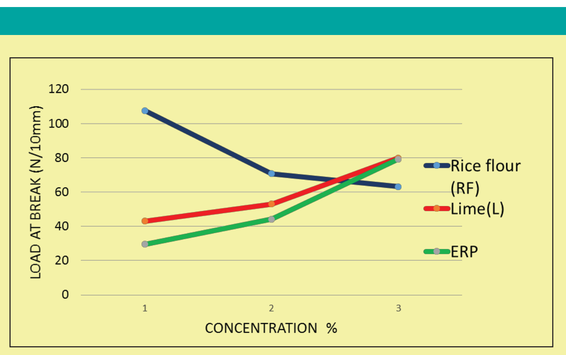
8. Dry the pellets produced to adjust moisture content.

Materials and methods

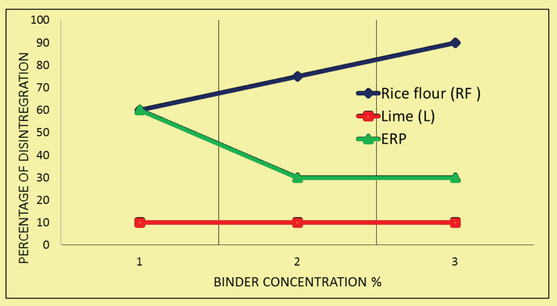
- Drying of fecal sludge in sand-drying beds for 21 days.
- Material input of 1:10 dried fecal sludge:market waste ratio for production of co-compost.
- Screening of final co-compost with the use of 0-5 mm fraction as input material for pellet production.
- Adjustment of moisture content to 25% of co-compost product prior to pelletizing.
- Addition of three binding agents – rice flour (RF), Eppawala Rock Phosphate (ERP), and lime (L) – to the co-compost in concentrations of 1%, 2% and 3%, respectively.
- Follow the die and roller pelletizing method to produce pellets.
- Place 50 g of pellets into 200 ml of distilled water and allow it to disintegrate for 1 month under laboratory conditions without disturbance.

Results

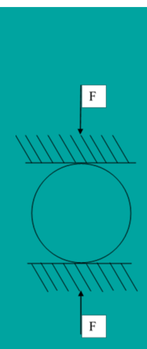
To streamline the production process, compost drying and pulverization must be done prior to pelletization. Within this research study, compost drying and pulverization was replaced by compost sieving and adjusting the water content to 25% as input material for pellet production. This technology adjustment resulted in the reduction of the work involved and energy savings. The graphs below show the trends of the binding agents used on the strength and disintegration properties of pellets during laboratory testing. Both parameters are relevant for the handling, storage and application of pellets.



Strength of the pellets with the three binding agents.



Disintegration of the pellets with the three binding agents.



Disintegration test with 50 g of pellets placed in a 200 ml cup of distilled water.

Appearance of pellets (with low disintegration) applied in the field after several weeks during a low rainfall period.

Note: Pellets with RF used as the binding agent showed the highest disintegration ability under laboratory conditions. Adding RF in concentrations of 1%, 2% and 3% resulted in disintegration of 60%, 75% and 90%, respectively, of the pellet. Using ERP, it was apparent that higher the concentration of the binding agent, lower the disintegration ability, i.e., concentration of 1% resulted in disintegration of 60% of the pellet, but a much lower disintegration of only 30% was achieved with 3% concentration. Addition of lime resulted in the lowest disintegration with less than 10% in all concentrations. Further research will be needed to verify the observed trends and to test additional binding agents, as well as to analyze disintegration properties under field conditions.

Key findings

- Pelletizing could increase the density of the compost material by up to 30%, whereas research is ongoing to further enhance storage properties and reduce packaging volume through adjustment of fertilizer pellets.
- Commonly applied processes prior to pelletizing are compost drying and pulverization. This research study confirmed that both these steps could be eliminated while reducing energy consumption and the work involved in the pellet production process.
- Although compost pellets can be produced without a binding agent for certain pressure and moisture adjustments, application of binding agents proved to be useful to increase pellet strength and to influence disintegration characteristics.
- Some of the binding agents tested can also act as de-binders when water is added later on (e.g., rice flour).

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