Production of biosolid pellets from sewage treatment plants for multiple uses

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Highlights:

- Study and characterization of sewage sludge for multiple uses.
- Viability of sewage sludge as a biomass for energy use.

Keywords: Sewage sludge; Sustainable waste management; Granulation.

INTRODUCTION

The management of solid waste, especially sludge from sewage treatment plants, represents a complex environmental and logistical problem (Zomer et al., 2018). Among the main solutions adopted are available in landfills and conversion into energy through the use of biomass (Borges, 2008).

However, the use of this material as an agricultural fertilizer requires attention and caution due to the presence of pathogenic microorganisms and heavy metals in its composition, CONAMA Resolution n° 375/2006 (Brasil, 2006) and CONAMA Resolution n° 498/2020 (Brasil, 2020).

Sewage sludge is composed of several functional groups, such as acids, alcohols, amines, nitriles, ketones and hydrocarbons, but mainly contains organic groups, such as proteins, carbohydrates and lipids, which, even after digestion during treatment, will be present in the final sludge.

The main objective of this research was to carry out studies on the characterization and evaluation of sewage treatment plant sludge pellets for multiple uses, focusing on granulated fertilizer and biomass.

METHODOLOGY

Previous tests to define a trace formulation were carried out through maceration of the WWTP biosolids, a particle size test in accordance with the NBR 7181 standard (ABNT, 2016).

Molding was carried out by heating the binding material and water in a Becker with the aid of a microwave and a Bunsen burner, after which the macerated sludge was added. The resulting mixture was manually molded with extruder equipment to achieve the granule shape.

The granules were allowed to dry for approximately 24 hours at room temperature to carry out tests to determine the resistance and other desired physical parameters.

The test to determine the calorific value was carried out in accordance with the ABNT NBR 8112/1986 (ABNT, 1986) standard (Charcoal – Immediate analysis). With the values of moisture content, ash content, and volatile matter content, the fixed carbon content and calorific value were obtained using Equation 1, which is correlated with the immediate analysis developed by Parikh et al. (2005), in which 450 types of biomass were considered and presented an absolute error of 3.74%. Each test was carried out in triplicate to determine the highest calorific value (PCS).

$$PCS = (0{,}3536 * F) + (0{,}1559 * V) - (0{,}0078 * A) \qquad Equação\ 1$$

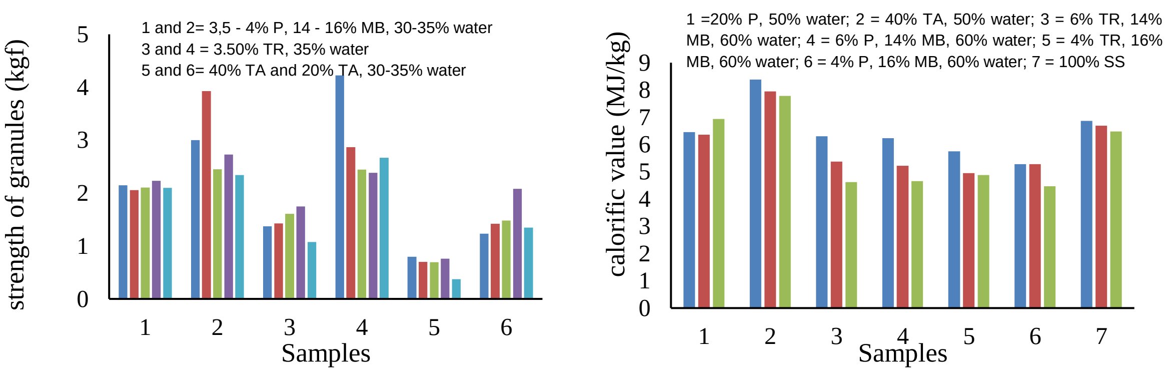
where F is the fixed carbon content, A is the ash content (%), and V is the volatile content.

The compressive strength was carried out using test equipment universal mechanics, model Shimadzu Load Cell SPL – 10 KN. The mean and standard deviation for 5 bodies samples were analyzed to verify the treatments and their characteristics.

RESULTS AND CONCLUSIONS

The selected treatments were compositions with biosolids, variations in biodegradable organic binders (AOs), and a binding mineral produced from heating gypsum (MB - mineral binder) based on $CaSO_4$ and water. The materials used as binders cannot be clearly identified because the research is in the patent generation consultation phase.

Figure 1. Compressive strength (left) and Calorific value (right) of samples with different compositions. Binder 1 – starchy organic binder called P, Binder 2 – powder product that provides elasticity called TR, Binder 3 – vegetable binder that provides coagulation called TA, mineral binder – MB, SS -sewage sludge



Source: The author (2024)

The moisture content test showed values ranging from 10 to 25%, the highest values for treatments with the powder binder that provides elasticity called TR and MB. In terms of compressive strength, with a greater proportion of the TR binder, the starchy organic binders P and MB presented resistances between 2.0 and 2.6 kgf (samples 1, 2, 4), while lower amounts of P, TR and MB (samples 3, 5, 6) reached 0.7 to 1.5 kgf (Figure 1), with commercial indications above 1.5 kgf for transport and storage of the product (Rodella et al., 2000).

The calorific value of the granules varied between 8 and 12 MJ/kg (Figure 1), highlighting that the treatments with only the TA binder, the TR binder and the P binder had higher calorific values than the compositions combined with MB. This value can be compared to that of other materials used for biomass, such as cellulose, which has a value of 17 MJ/kg (Santos et al., 2011)(Santos, 2011).

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