**Isothermal drying kinetics of sewage sludge using weathered coal fly ash as adjuvant for agronomic application**

Luciano A. Gomes1,2\*, Andreia F. Santos1, Rui J. A. Lopes1, José C. Góis3, Margarida J. Quina1

1. CIEPQPF - Centre of Chemical Processes Engineering and Forest Products, Department of Chemical Engineering, University of Coimbra, Rua Sílvio Lima, 3030-790, Coimbra, Portugal.

2. IFB - Federal Institute of Education, Science, and Technology of Brasília - IFB, Campus Ceilândia Brasília - Federal District, Brazil.

3. Association for the Development of Industrial Aerodynamics, Department of Mechanical Engineering, University of Coimbra, Coimbra, Portugal.

\*Corresponding author: luciano.gomes@ifb.edu.br

**Supplementary information**

* **Drying process procedure**

|  |  |
| --- | --- |
| (a) | (b) |
| Fig. S1. Drying screening phase to determine the (a) cylinder length, and (b) samples: SS, and SS\_CFA. |

|  |
| --- |
|  |
| Fig. S2. Temperature evolution inside the cylinder during the drying process at 70, 100 and 130 ºC [Periods 0, I and II represent the rising rate period, the constant rate period, and falling rate period, respectively]. |
|  |

* **Phytotoxicity tests**

Table S1. pH and EC measured in the extracts used in the phytotoxicity tests.

|  |  |  |
| --- | --- | --- |
| **Samples** | **Parameter** | **L/S (L kg-1)** |
| **5** | **10** | **25** | **50** | **100** | **200** | **500** |
| SS | pH  | 6.44 | 6.71 | 6.81 | 6.81 | 6.73 | 6.44 | 6.13 |
| EC (mS cm-1) | 4.48 | 1.72 | 1.00 | 0.59 | 0.40 | 0.40 | 0.19 |
| SS\_CFA | pH  | 6.25 | 6.73 | 6.86 | 6.99 | 7.07 | 7.18 | 7.31 |
| EC (mS cm-1) | 4.67 | 2.63 | 1.38 | 0.82 | 0.45 | 0.26 | 0.15 |
| CFA | pH  | 8.91 | 8.63 | 8.52 | 8.34 | 7.75 | 7.97 | 7.14 |
| EC (mS cm-1) | 0.83 | 0.49 | 0.24 | 0.15 | 0.09 | 0.08 | 0.06 |

**Germination Index (GI) calculation**

For each sample, the germination index (GI) was calculated by combining Eq. (S1), (S2) and (S3) $RSG (\%)=(\overbar{N}/\overbar{N}\_{b})×100$ (S1)

$RRG (\%)=(\overbar{L}/\overbar{L}\_{b})×100$ (S2)

$GI (\%)=(RSG× RRG)/100$ (S3)

where $\overbar{N}$ and $\overbar{N}\_{b}$ are the mean number of germination seeds in each sample and in control, respectively; $\overbar{L}$ and $\overbar{L}\_{b} $are the mean length of roots in each sample and in control, respectively; $RSG$ is the relative seed germination (%) and $RRG$ (%) is the relative root growth. The GI results were classified as: non-phytotoxic if GI > 80%; mild phytotoxicity 60% < GI < 80%; strong phytotoxicity 40% < GI < 60%; severe phytotoxicity GI < 40% [1,2].

* **Drying kinetics**

|  |
| --- |
|    |
| Fig. S3. Energy consumption during Period I at 70, 100 and 130 ºC to SS and SS\_CFA samples. Results marked with different letters are statistically different through the Tukey HSD test (p < 0.05).  |

* **References**

[1] Gomes LA, Gabriel N, Gando-Ferreira LM, et al. Analysis of potentially toxic metal constraints to apply sewage sludge in Portuguese agricultural soils. Environ. Sci. Pollut. Res. 2019;26:26000–26014. doi:10.1007/s11356-019-05796-6

[2] Pinho IA, Lopes D V., Martins RC, et al. Phytotoxicity assessment of olive mill solid wastes and the influence of phenolic compounds. Chemosphere. 2017;185:258–267. doi:10.1016/j.chemosphere.2017.07.002