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WASTES

solutions treatments opportunities

5<sup>th</sup> International Conference WASTES: solutions treatments opportunities

5<sup>th</sup> International Conference  
2019

Costa da Caparica  
4 > 6  
september



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# WASTES

solutions treatments opportunities

5<sup>th</sup> Costa da Caparica  
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2019 International  
Conference

CVR - Centro para a Valorização de Resíduos  
Campus de Azurém da Universidade do Minho  
4800-058 Guimarães  
PORTUGAL

Telef.: +351 253 510 020  
Fax: +351 253 510 029  
<http://www.cvresiduos.pt>  
e-mail: [geral@cvresiduos.pt](mailto:geral@cvresiduos.pt)



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## POTENTIAL USE OF LEACHATES FROM A MECHANICAL BIOLOGICAL MUNICIPAL SOLID WASTE TREATMENT PLANT AS FERTILIZERS

J. Cardoso<sup>1</sup>, M.T. Vertonha<sup>2</sup>, J.B. Mees<sup>3</sup>, P. Brito<sup>4</sup> and H.T. Gomes<sup>5</sup>

<sup>1</sup> Centro de Investigação da Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253, Bragança, Portugal, jonathancardoso@ipb.pt

<sup>2</sup> Centro de Investigação da Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253, Bragança, Portugal, mvertonha@gmail.com

<sup>3</sup> Programa de Pós-Graduação em Tecnologias Ambientais, Universidade Tecnológica Federal do Paraná, Campus Medianeira, 85884-000, Paraná, Brasil, juliana@utfpr.edu.br

<sup>4</sup> Centro de Investigação da Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolónia, 5300-253, Bragança, Portugal, paulo@ipb.pt

<sup>5</sup> Centro de Investigação da Montanha (CIMO), Instituto Politécnico de Bragança, 5300-253 Bragança, Portugal, and Laboratory of Separation and Reaction Engineering – Laboratory of Catalysis and Materials (LSRE-LCM), Faculdade de Engenharia, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal, htgomes@ipb.pt

### ABSTRACT

Leachates produced from treatment plants contains carbon, nitrogen, phosphorus, potassium and trace elements. This work aims to assess if a leachate, generated from a mechanical and biological treatment of compost, can be used as a potential source for fertilizers, and thus develop and design a sequence of processes which could effectively convert the leachates to commercial fertilizers according to the requirements of the proposal of regulation of the European Parliament of 2016. The analysis shows that the leachate could result in an organo-mineral fertilizer with high organic carbon content. However, some heavy metals, nitrogen and phosphorous contents do not fulfill the legislation requirements and potassium content remains to be characterized.

**Keywords:** Treatment plant, leachate, waste processes, fertilizers.

### INTRODUCTION

Each year a increasing quantity of wastes is disposed in the Nature, which not only causes economic and environmental problems for the society, but also represents a waste of resources. The generation of wastes in Europe has raised in 21 of the 31 Member States, the amount of municipal waste generated per capita increased since 1995. Specifically, in Portugal, the rate of wastes generation increased 34.7%. The variations reflect differences in consumption patterns and economic wealth, but also depend on how municipal waste is collected and managed [1]. Manage the deposition of organic fraction of municipal solid waste on landfill, new treatments and applications to the subsequent leachates must be developed. Several successful demonstrations of leachate application by irrigation of energy crops were reported in different parts around Europe [2–4].

Leachate is a waste product without associated direct production costs, instead it implies expensive treatment to be discarded. The use of leachate in agriculture also means that the costs at waste treatment plants can be reduced, since processes for the removal of nitrogen, phosphorus and other substances would not be necessary. However, due to the nature of the leachates, they may contain, in addition to elements of interest, heavy metals, phytotoxic substances such as ammonia, organic compounds of low molecular weight and/or high salt content [5, 6]. The aim of this work is the development and design of a sequence of processes to convert a specific leachate with a variable composition, collected from the composting line of a mechanical and biological treatment facility, into commercial fertilizers which fit the composition requirements of the European Legislation. However, to effectively design these processes, it is necessary to assess the typical composition of the liquid leachate and to predict its possible variability, for the evaluation of the composition alteration needs.

Therefore, in the present work the data gathered for the characterization of the leachate is presented and discussed for the conversion sequence of processes is proposed.

## MATERIALS AND METHODS

The samples were obtained from the leachate storage tank from a composting line of a mechanical and biological treatment plant of organic wastes at the company Resíduos do Nordeste, EIM (Mirandela, Portugal). The samples were collected in June 2018 and February 2019, and then were stored at 4°C in 5 L PET bottles. The concentration procedure was performed using simple distillation. The ratio between the initial and final volume is given as the concentration factor which is used for the identification of each sample. pH and conductivity were determined using a pH electrode SenTix 41 and a conductivity cell TetraCon 325. TOC analysis was performed with 1:500 dilution, in a Shimadzu TOC-L equipment. Density assessment was done using Anton Paar DMA5000M densimeter at 20°C. Dry mass percentage was obtained using an oven from Scientific Series 9000 at 105°C for 48 h while Ash percentage was performed at 450°C until constant mass. Heavy metals quantification was performed by digesting the samples with HNO<sub>3</sub>/HCl during 48 h at 60 °C, filtrated using a 0.45 µm syringe filter in a 50 mL volumetric flask and analysis by atomic absorption spectroscopy Varian SpectrAA 220. Ammoniacal Nitrogen was characterized through distillation of the initial sample. Total Kjeldhal Nitrogen (TKN) analysis was performed using the same procedure with previous digestion with H<sub>2</sub>SO<sub>4</sub>. Organic Nitrogen was calculated through the difference between Total and Ammoniacal Nitrogen. Phosphorous analysis was performed by digesting the sample with HNO<sub>3</sub> and HClO<sub>4</sub>, and the absorbance measurements were carried out in a Jasco UV/VIS spectrophotometer at 400 nm, using vanadate molybdate solutions as colorants.

## RESULTS AND DISCUSSION

Chemical properties of original and concentrated leachates are summarized in Table 1 for samples collected in June 2018 and February 2019, respectively, from the compost leachate storage facility.

**Table 1.** Chemical properties of original and concentrated leachates.

Samples	% TOC	pH	Density [g/cm <sup>3</sup> ]	Dry Mass [%w/w]	Ash [%w/w]	
EU 2016	3.00	-	-	<60	-	
June 2018	Original	1.22	7.95	1.01	2.76	1.36
	3.19x	3.64	6.43	1.04	8.26	4.31
	3.23x	3.63	6.44	1.04	8.21	4.23
	3.33x	3.46	6.40	1.04	8.58	4.39
	4.23x	4.65	6.48	1.06	11.19	5.64
	4.39x	4.63	6.49	1.06	11.26	5.81
February 2019	Original	2.81	7.53	1.03	6.49	3.07
	Original Filtered	2.79	7.81	1.03	6.02	2.96
	1.19x	3.27	7.98	1.04	7.03	2.93
	1.85x	5.36	6.55	1.06	11.43	5.59

The original leachate obtained at February 2019 showed a TOC concentration 2 times greater than the leachate obtained at June 2018, which makes evident the high heterogeneity of the leachate produced. Both original leachate samples must be concentrated to satisfy the requirements of the EU fertilizers legislation to reach 3% of TOC for liquid organo-mineral fertilizers. pH and density shown low variation between the original and the concentrated samples, remaining neutral with water removal. The original sample showed a higher content of dry mass and ashes compared to the original sample from June 2018. However, it is visible that the original sample from February 2019 needs less water removal to reach the target specifications.

Heavy metals content was determined for all samples in order to verify the fulfillment of the EU legislation for organo-mineral liquid fertilizers. The results are presented in Table 2.

**Table 2.** Heavy metals content of original and concentrated leachates.

Samples	Zn (mg/kg)	Cu (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Ni (mg/kg)	Cr (mg/kg)
EU 2016	1500	600	3	120	50	2
Original	468.60	101.60	0.37	4.76	116.33	10.74

Original Filtered	252.78	241.15	0.91	4.11	148.93	9.83
1.19x	1077.56	56.07	0.69	15.77	155.51	11.08
1.85x	1299.82	11.27	0.41	11.10	62.81	10.47

The concentration of each heavy metal is highly variable mainly due to the significant heterogeneity of the leachate samples and the visible differences in the compositions of its liquid and solid fractions. However, it is noticeable that the content of Zn, Cu, Cd and Pb fulfill the requirements of the EU legislation in concentrated samples, while Ni and Cr must be removed to achieve EU requirements. The characterization of nitrogen and phosphorous (NP) species was carried out to obtain the parameters for the leachate as shown in Table 3.

**Table 3.** NP content.

Sample	TKN	Organic	P <sub>2</sub> O <sub>5</sub> [%w/w]
	N [%w/w]	N [%w/w]	
EU 2016	2	0.5	2
June 2018	0.0588	0.0453	<0.02
February 2019	0.3391	0.2617	<0.02

The original leachate obtained at February 2019 showed a nitrogen concentration 20 times greater than the leachate obtained in June 2018. The values obtained for total phosphorus are below the detection limit for the analysis even in more concentrated samples. According to European Union legislation, a liquid organo-mineral fertilizer must contain at least one of the following declared nutrients in the minimum quantities: 2%w/w of total N, of which 0.5%w/w must be organic nitrogen; 2%w/w of total P<sub>2</sub>O<sub>5</sub>; and 2%w/w of total K<sub>2</sub>O. Therefore, the nitrogen and phosphorous values do not fit the requirements in the legislation; it is necessary to carry out the potassium analyses to verify possible conformances in at least one of the required nutrients.

## CONCLUSION

The concentrated leachate cannot be used, at this point, as fertilizer, because it does not fit all the legislation requirements, but it still display potential to be used after simple processing. It shows high concentration of total organic carbon (TOC). Heavy metals content must be assets with adsorption materials and nitrogen and phosphorous nutrients are present in low levels even after the concentration procedure. Ultrafiltration or reverse osmosis could be viable solutions to remove the excess of water without affecting significantly the content of the product in other compounds, especially nutrients. Potassium determination remains to be carried out and if it fits the legislation specification. However, the potential use of these wastes as fertilizers is significant, especially because it promotes the use of liquid wastes with high organic carbon content for agricultural applications with the possibility of producing a high value-added material.

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