Effects of treated urban waste digestates on hydroponically grown tomato (*Solanum lycopersicon L)*

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INTRODUCTION

Sustainable municipal solid waste management is a critical issue for cities all over the world, especially for mega-cities that generate millions of tons annually. Historically, landfill disposal was deemed to be the most conventional way to deal with collected MSWs. However, it consumes and pollutes a considerable amount of land, and sometimes causes hazardous liquid leakage and gas emission (He et al., 2017).

Anaerobic digestion is a widely used technique for the treatment of various organic waste materials to produce energy in the form of biogas and nutrient-rich residue, digestate (Tampio et al., 2016).

Another use of municipal waste made-up of household and other yard waste is in agriculture. The use of these materials minimizes the waste, kills pathogens and reduces weeds germination in cultivated lands, leading to enhanced crop productivity. Application of municipal waste in agriculture is gaining popularity due to its possitive effect on biological, physico-chemical properties of soil (Ansari & Mahmood, 2017).

Other studies showed that direct application of the liquid fraction of urban waste is the most suitable strategy to achieve highest yields in crops. This also would reduce transport costs due to the lower volume the liquid fraction has compared to the solid fraction and its addition to soil is easier (Prays & Kaupenjohann, 2016).

OBJECTIVES

This study consists in the exhaustive characterization of the physicochemical properties of 3 materials obtained in the biological treatment of organic matter, specifically the digestate of biomethanization plants, in the Valdemingómez Technology Park complex (PTV, Madrid, Spain). The objective is to provide sufficient data to consider its possible commercialization after several treatments that could be received for its correct management and use as a fertilizer for plant growth. We have also evaluated the possible agronomic applicability and valuation of those fertilizers generated from the treatment of waste digestates with the addition of specific acid and basic treatments.

MATERIALS AND METHODS

The digestates (LPC and LDC) were obtained from process of biomethanization of two different plants located in PTV and a waste product (LPA) which was obtained after a biostabilization process.

A physico-chemical characterization of LPC, LDC and LPA was performed including particle size, pH, electrical conductivity (EC), organic Carbon (OC), organic Nitrogen (ON), humic substances, P, K, soluble anions and cations, biological oxygen demand (BOD) and concentration of heavy and toxic metals.

After acid (ATr) and basic (BTr) treatments of LPC, LDC and LPA in a ratio solid waste: diluted acid (or base) 1:1 (w/v), the liquid obtained after filtration was used to irrigate tomato plants (*Solanum lycopersicon L.*) during 4 weeks. Two growth control treatments were used, with deionized water and with an optimized nutrient solution prepared with conventional commercial fertilizers (NS). SPAD indices as plant chlorophyll content and plant (stems and roots) fresh weight were used as growth indicators.

RESULTS AND DISCCUSSION

The results of the characterization of materials are shown in table 1. The highest percentage of the particles size of LPC, LPD and LPA correspond to diameters of less than 5 mm, which is suitable in terms of physical pollution. The concentration of heavy metals was under the toxicity levels allowed by the Spanish regulation and the percentages of OC and ON were high enough to be used as a source of nutrients in crops. The BOD analysis of wastes tested (40 mg O_2 L^{-1}) shows that microorganisms are present in these materials and this should be taken into account in fertilizers production. pH and electric conductivity levels are high so a dilution and a pH adjustment should be done.

Table 1. Characterization of the urban waste digestates (LPC, LPD) and biostabilized waste (LPA) (average values from 4 replicates ± SD).

	LPC	LDC	LPA	mg/Kg	LPC	LDC	LPA
pH 1:5 w/v	8,6 ± 0,1	8,4 ± 0,1	8,1 ± 0,1	**Cd**	1,08 ± 0,04	0,94± 0,07	1,7 ± 0,2
CE (dS/m)	5,7 ± 0,2	4,6 ± 0,3	3,3 ± 0,1	**Cu**	107 ± 10	192 ± 2	238 ± 13
C Total (%)	24 ± 1	25 ± 3	36 ± 2	**Ni**	28,2 ± 0,1	46 ± 5	36 ± 3
ON (%)	1,95± 0,09	1,22 ± 0,08	2,25± 0,03	**Pb**	58 ± 5	76 ± 4	75± 16
OC (%)	32,5 ± 0,9	29 ± 0,5	32 ± 1	**Zn**	341 ± 9	245 ± 3	360 ± 38
C/N	13,5± 0,5	19,2 ± 0,7	19 ± 2	**Hg**	0,41 ± 0,02	0,50± 0,07	0,56± 0,27
P citrate (g/Kg)	2,74±0,02	3,1± 0,4	2,78±0,04	**Mn**	300 ± 5	328± 2	168 ± 12
K (mg/kg)	8121± 350	8260± 54	6889±600	**Fe g/kg**	13,12 ± 0,09	19,1± 0,3	6,8 ± 0,5

After the diluted acid or basic treatment of wastes tested, most of the liquid used was absorbed by the solid phase. The volume of extract obtained after the filtration were the 37 % of the initial acidic and 35% of the alkaline solutions.

The results of using these liquid extracts as fertilizers in plant growth are shown in table 2. The liquid fertilizer obtained after the acidic treatment (ATr) shows the best plant growth with higher SPAD and plant fresh weight.

Table 2. Plant biometric parameters obtained after 4 weeks of treatment (n=6).

Treatment	**SPAD**	**Plant fresh weight (g)**	
		Stem	**Root**
Control Water	18,7 ± 0,5	0,6 ± 0,1	0,27 ± 0,03
ATr	36,7 ± 0,3	1,0 ± 0,2	0,4 ± 0,2
BTr	23 ± 3	0,9 ± 0,2	0,5 ± 0,1
ATr+BTr	25 ± 3	1,0 ± 0,2	0,53 ± 0,08
Control Nutrient Solution (NS)	34 ± 3	1,4 ± 0,2	0,5 ± 0,2
NS + ATr	36 ± 2	1,8 ± 0,9	0,6 ± 0,5
NS + BTr	33 ± 2	1,4 ± 0,1	0,8 ± 0,2

CONCLUSIONS

Plant biometric parameters (SPAD and plant fresh weight) of this research demonstrate that liquid extracts (both acidic and alkaline) obtained from digestates and biostabilized waste can be used as fertilizers. Municipal solid waste represents a promising raw material to develop new liquid fertilizers although, further investigation is required to optimize the nutrient base of these materials. Considering the problem that exists now with the amount of urban waste generated by the population, this solution could help significantly in terms of their reduction. The acidic and alkaline treatment also implies a stabilization of the solid phases due to the significant reduction of microorganisms. This could allow to both a safer storage of waste in landfills with no risk of self-heating and their revalorization as fertilizer.

BIBLIOGRAPHY

Ansari, R. A., & Mahmood, I. (2017). Optimization of organic and bio-organic fertilizers on soil properties and growth of pigeon pea. *Scientia Horticulturae*, *226*(September 2016), 1–9. https://doi.org/10.1016/j.scienta.2017.07.033

He, Z., Xiong, J., Ng, T. S., Fan, B., & Shoemaker, C. A. (2017). Managing competitive municipal solid waste treatment systems: An agent-based approach. *European Journal of Operational Research*, *263*(3), 1063–1077. https://doi.org/10.1016/j.ejor.2017.05.028

Prays, N., & Kaupenjohann, M. (2016). Initial effects of differently treated biogas residues from municipal and industrial wastes on spring barley yield formation. *PLoS ONE*, *11*(4), 1–14. https://doi.org/10.1371/journal.pone.0154232

Tampio, E., Salo, T., & Rintala, J. (2016). Agronomic characteristics of five different urban waste digestates. *Journal of Environmental Management*, *169*, 293–302. https://doi.org/10.1016/j.jenvman.2016.01.001.