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THE USE OF MANURE-BASED HYDROTHERMAL CARBONIZATION (HTC) BYPRODUCTS IN SOILLESS CULTIVATION SYSTEMS

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INTRODUCTION

The anaerobic digestion (AD):

is a biological process, in which bacteria gradually convert the organic biomasses releasing CO_2 and CH_4. The resulting digestate is often land-spread as fertilizer with negative impact on the environment, due to NO_3^- leaching and NH_3 volatilization.

The hydrothermal carbonization (HTC):

is a thermal post-treatment of the manure-based digestate, which could be of considerable importance to limit the problems related to land spreading. The HTC is, indeed, a promising thermochemical process through which wet biodegradable residues can be directly transformed into value added products. The AD-HTC produces both a solid (hydrochar) and liquid (Aqueous HTC Liquid, AHL) fraction rich in nutrients.

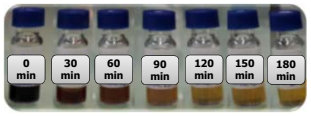


Fig. 1: Example of AHLs spilled in continuous at 220 °C and used for subsequent HPLC analysis.

Fig. 2: Example of oven-dried hydrochar.

OBJECTIVES

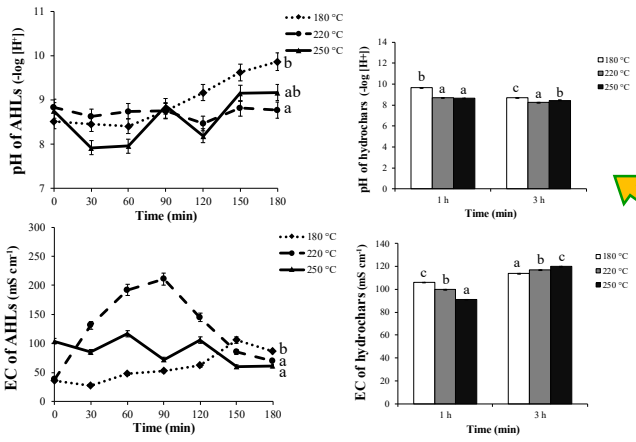
The aim of this study was to characterize both AHLs and hydrochars in order to evaluate their potential use in a soilless cultivation system (SCS).

MATERIALS and METHODS

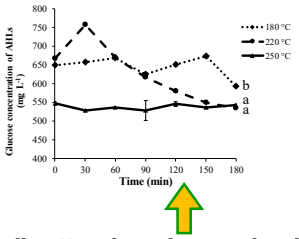
HTC process:

- ❑ performed in a reactor prototype;
- ❑ feedstock used: manure-based digestate;
- ❑ operating parameters: feedstock treated at 3 different temperatures (180, 220, and 250 ° C), and at 2 different times (1 and 3 h).
- ❑ sampling: AHLs were collected every 30 minutes, starting from when the temperature reached the set point (T=0 min). Thus, a total of 7 liquid samples (Fig. 1), and 2 different hydrochars (Fig. 2), were collected at 1 and 3 hours for 3 different processing temperatures (180, 220, and 250 ° C).
- ❑ the AHLs were stored at 4°C, while the hydrochars were dried at 105°C for 24h until constant weight. Both these byproducts have been characterized from a chemical and physical point of view.

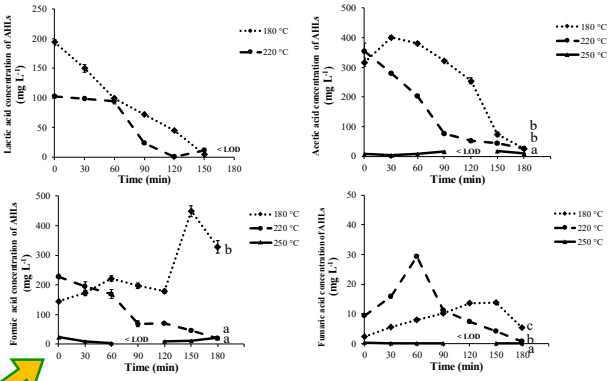
RESULTS



At the end of the HTC process the lower temperature increased the value of electrical conductivity of AHLs, while reduced that of hydrochars.



At all pHs the glucose level maintained high and constant, but the concentration of organic acids (i.e. lactic, formic, acetic, and fumaric acid), and furan-type compounds (i.e. HMF and furfural), reduced.



In general, with increasing processing temperature and time, a decreasing organic acid concentration was observed.

HMF concentration of AHLs
Value ± SEM (mg/L)

Temperature (°C)	0 min	30 min	60 min	90 min	120 min	150 min	180 min
180	5.2 ± 2.1	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
220	5.2 ± 0.1	2.1 ± 0.0	2.1 ± 0.0	2.1 ± 0.1	< LOD	< LOD	< LOD
250	< LOD	< LOD	2.0 ± 0.0	2.0 ± 0.0	2.0 ± 0.0	2.0 ± 0.0	2.0 ± 0.0

Furfural concentration of AHLs
Value ± SEM (mg/L)

Temperature (°C)	0 min	30 min	60 min	90 min	120 min	150 min	180 min
180	4.6 ± 0.1	< LOD	< LOD	< LOD	< LOD	< LOD	4.4 ± 0.1 b
220	405.8 ± 5.1	34.2 ± 0.2	5.9 ± 0.1	5.0 ± 0.0	5.9 ± 0.1	5.3 ± 0.0	6.1 ± 0.0 c
250	4.2 ± 0.0	4.2 ± 0.2	< LOD	< LOD	< LOD	< LOD	< LOD a

CONCLUSIONS

Since the growing media of the future must be available, affordable, and sustainable and we need a waste management strategy, aimed at reducing, reusing, and recycling, the coupling of AD with HTC could represent a sustainable practice in the field of biomass and waste conversion.

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