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European congress  
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30 June - 3 July 2024

De Doelen International Congress Center

Rotterdam, The Netherlands



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# Abstract book



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BMC-034

## Valorisation of wastewater treatment sewage scum through the production of biofuels

**Martinez G**<sup>1</sup>, Jones E<sup>1</sup>, Swamilingappa Annaiah A<sup>1</sup>, Bertin L<sup>1</sup>, Raspolli Galletti A<sup>2</sup>, Pastore C<sup>3</sup>, Fava F<sup>1</sup>

<sup>1</sup>Department of Civil, Chemical, Environmental and Materials Engineering (DICAM), University of Bologna, Bologna, Italy

<sup>2</sup>Department of Chemistry and Industrial Chemistry, University of Pisa, Pisa, Italy

<sup>3</sup>Water Research Institute (IRSA), National Research Council (CNR), Bari, Italy

The ReFil project (PRIN MUR, Italy) aims to valorise sewage scum separated by flotation in the primary stage of municipal wastewater treatment plants (WWTP). Due to its origin and composition (45% grease and 26% cellulose-hemicellulose), it could represent a raw material for producing biofuels. While the grease is employable for biodiesel production, the cellulose/hemicellulose fraction could be used for producing sugar-rich liquor via enzymatic saccharification. Despite these sugars may serve as substrate for bioethanol production, new alternative valorisation approaches are being investigated due to the high energy consumption of ethanol distillation (spending 22% of its combustion energy) whose feasibility relies only on an economy of scale. In such a scenario, transporting sugar-rich liquor to large centralized ethanol production plants would be necessary. However, this approach may not be economically sustainable, especially when considering the multitude of WWTP spread across large territories. Therefore, this work investigates the feasibility of fermenting a sugar-rich liquor for hexanoic acid production by employing an anaerobic mixed culture system. A pseudo-continuous bioreactor (8-L) was used for producing carboxylic acids (CAs) under acidogenic fermentation conditions (12 days of HRT, 37°C). It was inoculated (10% v/v) with a digestate arising from a commercial anaerobic digester and is being fed with a laboratory prepared glucose-rich solution mimicking the actual liquor. After achieving process stability with high CAs and no methane productions, the bioreactor will be fed with the actual liquor. Moreover, experiments will be dedicated to screening best operational conditions for maximising hexanoic acid production.

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Gonzalo A. Martinez<sup>1\*</sup>, Emma Jones<sup>1</sup>, Akarsh Swamilingappa Annaiah<sup>1</sup>, Lorenzo Bertin<sup>1</sup>, Annamaria Raspolli Galletti<sup>2</sup>, Carlo Pastore<sup>3</sup>, Fabio Fava<sup>1</sup>

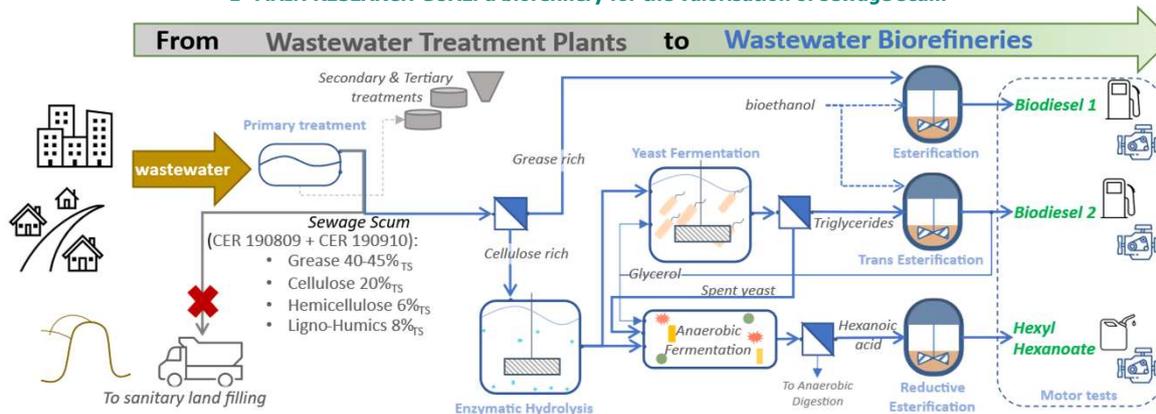
<sup>1</sup>Department of Civil, Chemical, Environmental and Materials Engineering (DICAM), University of Bologna (Italy)

<sup>2</sup>Department of Chemistry and Industrial Chemistry, University of Pisa (Italy)

<sup>3</sup>Water Research Institute (IRSA), National Research Council (CNR; Italy)

\*corresponding author: [gonzalo.martinez3@unibo.it](mailto:gonzalo.martinez3@unibo.it)

## 1- MAIN RESEARCH GOAL: a biorefinery for the valorisation of sewage scum



- While grease is employable for biodiesel production, the cellulose/hemicellulose fraction could be used for producing sugar-rich liquor via enzymatic saccharification.
- New alternative valorisation approaches for non-edible sugars are being investigated due to the high energy consumption on bioethanol production (distillation spends 22% of its combustion energy) whose feasibility relies only on an economy of scale which requires transporting the sugar-rich liquor from the many WWTPs to large centralized ethanol production plants would be necessary (i.e. increasing environmental and economic costs).
- This work investigates the feasibility of fermenting a sugar-rich liquor for hexanoic acid production by employing an anaerobic mixed culture system

## 2- PREMISES & PREVIOUS WORKS

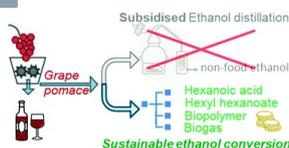
### Green Chemistry



#### PAPER


 Upgrade grape pomace contained ethanol into hexanoic acid, fuel additives and a sticky polyhydroxyalkanoate: an effective alternative to ethanol distillation†

Gonzalo A. Martinez,<sup>1</sup> Salvatore Puccio,<sup>2</sup> Joana M. B. Domingos,<sup>3</sup> Elena Morselli,<sup>4</sup> Claudio Gioia,<sup>5</sup> Paola Marchese,<sup>6</sup> Anna Maria Raspolli Galletti,<sup>7</sup> Annamaria Celli,<sup>8</sup> Fabio Fava<sup>9</sup> and Lorenzo Bertin<sup>10</sup>



### energies

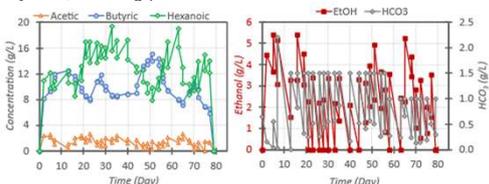
Article  
 Synthesis of 1-Hexanol/Hexyl hexanoate Mixtures from Grape Pomace: Insights on Diesel Engine Performances at High Bio-Blendstock Loadings

Stefano Frigo<sup>1</sup>, Anna Maria Raspolli Galletti<sup>2</sup>, Sara Fulgnati<sup>2</sup>, Domenico Licursi<sup>2</sup>, Lorenzo Bertin<sup>3</sup>, Gonzalo Agustín Martínez<sup>4</sup> and Gianluca Pasini<sup>5</sup>

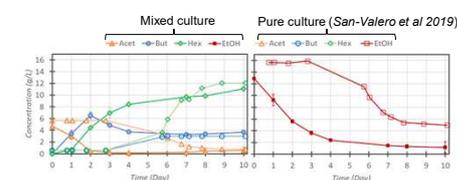
- Ethanol can be upgraded into highly concentrated hexanoic acid (C6; 87 % purity)
- Preliminary costs estimation indicated that such process results potentially competitive with the C6 market.
- The highly concentrated C6 was assessed for the first time as a reagent and as a fermentation substrate
- Positive effects of bio-additive on Diesel engine were: reduction of CO and soot emissions (up to 40% when compared with Diesel alone)
- 1-hexanol + hexyl hexanoate + Diesel blends could remarkably improve the quality of combustion in Diesel engines, highlighting the possibility of obtaining such oxygenated bio-additives through fully sustainable and tunable conversion processes.

## 3- PRELIMINARY RESULTS

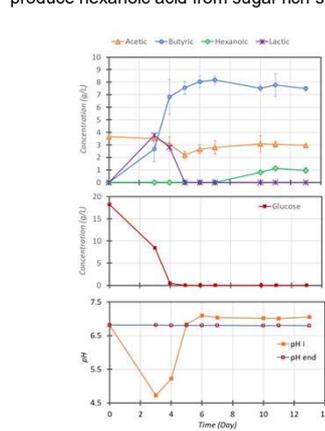
3.1- Selection & maintenance of EtOH chain elongating microbial consortium by using pseudo continuous culture system, following previous work



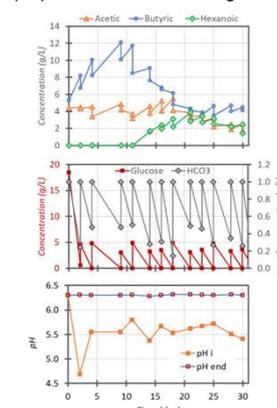
3.2- Selected chain elongating microbial consortium with same performance in batch tests as pure culture.



3.3- Despite the ethanol elongating microbial consortium good performance, it does not produce hexanoic acid from sugar rich stream



3.4- An ad-hoc microbial consortium is being selected in pseudo continuous culture system by using an inoculum from a commercial anaerobic digester and a laboratory prepared solution simulating the sugar rich broth.



3.5- Outlook:

- Microbial consortium (sugar specific) will be selected, tested and operational parameters optimised
- Idem for microbial consortium for glycerol
- Down-stream process is also being considered

