LOW TEMPERATURE OXIDATION OF FERMENTED MUNICIPAL BIOWASTE TO OBTAIN VALUE ADDED CHEMICAL SPECIALITY AND PLATFORM MOLECULES

Montoneri , E., Fabbri, G. , Boero V., Negre, M.

Università di Torino, Dipartimento di Scienze Agrarie, Forestali e Alimentari, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

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INTRODUCTION

Soluble biobased lignin-like polymeric substances (SBO) isolated from the alkaline hydrolysates of fermented municipal biowaste (www.biochemenergy.it) have been reported promising chemical auxiliaries for multiple uses (Montoneri, 2017), e. g. in the formulation of detergents, textile dyeing baths, flocculants, dispersants and binding agents for ceramics manufacture, emulsifiers, auxiliaries for soil/water remediation and enhanced oil recovery, nanostructured materials for chemical and biochemical catalysis, plastic materials, soil fertilizers and plant biostimulants for agriculture, and animal feed supplements. These results offer the perspective to turn a municipal biowaste treatment plant into a biorefinery integrating biochemical and chemical technology to produce biofuel and valued added bio-based chemicals.
To upgrade processes, properties and uses for the above SBO, a low temperature oxidation through ozonisation has been developed.

MATERIALS AND METHODS

SBO preparation
The starting materials for the preparation of different SBO were an aerobic digestate from a biogas plant and a 12 weeks compost prepared by mixing the same digestate with green wastes. The materials were reacted 4h with KOH solution at pH 13, 60°C and 4 v/w water/solid ratio. The liquid/solid hydrolysate mix was allowed to settle to separate the supernatant liquid phase containing the soluble substances (SBO) from the insoluble substances (INS). The soluble substances were fractionated by ultrafiltration.

Ozonization
Solutions of SBO were treated with a 2 L min^{-1} O_3 flow for different reaction times (from 4 to 62 h). The pH was maintained to 10 by addition of the required amounts of KOH. At the end of the process, the precipitate was separated by centrifugation and the supernatant (SBOoz) was fractionated by ultrafiltration.

Characterization
The raw and transformed materials were characterized by determination of pH, salinity, volatile solids, total carbon and nitrogen contents (Regione Piemonte, 2012). Surface pressure was measured with a platinum plate based tensiometer. Identification of the soluble low Mw compounds was performed by LC –MS/MS.

RESULTS AND DISCUSSION

Compost and digestate hydrolysates (SBO) were mainly high Mw materials (> 30 KDa). In solution, they strongly decreased the water surface tension, therefore behaving as surfactants. However, the commercial application of the SBO as natural surfactants, as for example in the dyeing industry was not practicable because of the brown black color of their solution.

Oxidation of the SBO by ozonization leaded to a whitened solution (SBOoz) which was further fractionated by ultrafiltration. The main fractions obtained were low Mw (< 200 Da) and high Mw (> 30 KDa) compounds while the compounds with intermediates Mw were not quantitatively relevant. The higher the ozonization time, the higher the low Mw /high Mw ratio.

Surface tension measurements have confirmed that the > 30 KDa fractions had maintained the surfactant properties of the sourcing material but the advantage of the oxidation process was the whitening of the materials making possible their application as natural surfactant.

The < 200 Da fractions were rich of polar compounds which chemical composition depended on the starting material used to produce the hydrolyzates: dicarboxylic acid and hydroxydicarboxylic acids were the major constituents of the ozonizated SBO from compost while the ozonizated SBO from digestate contained also amidic compounds.

CONCLUSION

This ozonisation process, coupled to hydrolysis of biomasses, allows obtaining polymeric surfactants with improved properties and a range of hydroxy dicarboxylic acids suitable to manufacture biodegradable polymers.

REFERENCES

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