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Evaluation of the biodegradability of chlordecone during mesophilic and thermophilic organic waste treatment via anaerobic digestion

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Anaerobic digestion (AD) has long been studied as an effective treatment strategy for organic wastes contaminated with recalcitrant pollutants. The bioremediation potential of AD was tested on digestates supplemented with chlordecone (CLD, $C_{10}Cl_{10}H_2O_2$), a persistent organic pollutant that has been applied in the French West Indies (1972-1993) against the banana black weevil *Cosmopolites sordidus*. Its application has resulted in an extensive long-term environmental contamination; concentrations between 0.03-24.2 mg.kg⁻¹ of soils are still recorded¹. CLD has been shown to accumulate in the food chain² triggering harmful acute and chronic toxicities in humans³.

Anaerobic digestates from animal and plant origins were spiked with 20 mg.L⁻¹ of CLD and incubated, in batch mode, under mesophilic (37.5°C) and thermophilic (55°C) conditions, respectively. This concentration was chosen to facilitate the detection and/or quantification of transformation products (TPs) at early stages as well as the quantification of CLD after 40 incubation days. A sacrificial approach was followed in which the bottles were stopped at different incubation days (0, 5, 20, and 40), extracted with a developed QuEChERS⁴ protocol, and analyzed with a combined GC-MS and LC-HRMS approach.

The Biochemical Methane Potential (BMP), followed throughout the entire experiment, showed that a concentration of CLD as high as 20 mg.L⁻¹ did not alter the production of biogas, as evidenced by the absence of a statistically significant difference between the bottles filled with CLD-treated digestates and the control bottles. Moreover, a redox potential lower than -350mV was maintained, providing thus sufficient reducing conditions reported to be needed for efficient CLD degradation⁵. Indeed, a significant reduction of around 87 +/- 4% of CLD under

thermophilic conditions, after 40 days, was observed. Under mesophilic conditions, the reduction of CLD was rather moderate with a decrease in CLD concentration of 32 +/- 7%. Various TPs, with a similar profile to that obtained with previous microbiological degradation studies^{6,7}, appeared in a concomitant manner with CLD's removal. Hydrochlordecones ($C_{10}Cl_{10-n}O_2H_{2+n}$, $n=1,2$), arising from reductive dechlorination, as well as polychloroindenes ($C_9Cl_{6-n}H_{2+n}$, $n=1,2$), formed after ring-opening, were quantified. Polychloroindenecarboxylic acids ($C_{10}Cl_{5-n}H_{3+n}O_2$, $n=1,2$) were also detected.

The anaerobic digestion, in our experimental conditions, has therefore provided the adequate conditions needed not only to dechlorinate CLD but also to open its ring structure which is partially responsible for its persistence in the environment. AD could thus possibly be considered as an effective treatment technique for CLD-contaminated organic wastes. The fate of the obtained TPs as well as their possible toxicity will be explored in subsequent works.

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