Environmental Research, Technology Demonstration and Conference Project

ECF Project:	ECF 2017-85
Project Title:	Incorporating metabolites based organosolv pretreatment in reducing the recalcitrant of lignocellulosic biomass to saccharification in food/yard/timber waste treatment processes
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Total Approved Grant:	$1,152,800
Duration:	1/2/2018 to 31/1/2020
Project Status/Remarks:	Completed
Project Scope:	This project aims to investigate the feasibility of developing and adopting a few state-of-the-art pretreatment techniques to maximise the efficiency of the organic waste treatment facilities in Hong Kong. Saccharification is a critical step to the bioconversion of organic wastes, i.e., the large molecular-weight biopolymers in the plant cell wall like crystalline glucan is hydrolysed to form rapidly-degradable carbohydrates for further metabolisms. The efficiencies of hydrolysis are affected by two factors, i.e., the biological and the substrate-related factors. Studies in Hong Kong have focused on the former for treating high sugar-content wastes; the impacts of the lignin induced inhibition to bioconversion, and strategies to overcome this problem, however, have not yet been identified. In this project, a few new pretreatment techniques to enhance the digestibility of the high recalcitrant wastes will be tested. Designed experiments, physiochemical analyses, and modeling works will be conducted to provide numerical information to the development for sustainable waste management. The merits of the project are to use the primary metabolites as reagents for low impact pretreatment, followed by biological processes to "recharge" the chemicals, which shall make best use of the facilities, excessive heat, and recovered resources.
Summary of the Findings/Outcomes:	This project investigated the feasibility of a few thermochemical pretreatment techniques to enhance the digestibility of urban-waste-derived-biomass in bioconversion processes. The biological wastes produced from selected municipal, commercial and industrial sectors were classified into five categories based on their recalcitrant to biodegradation, i.e., Type-A: post-consumer starchy wastes; Type-B: low-lignin-content yard wastes; Type-C: preconsumer food processing wastes; Type-D: biomass from food/beverage producing industries; and Type-E: highlignin-content woody biomass. Pretreatment strategies were designed and tested to fractionate the plant cell wall structure of selected waste in each category. The feasible pretreatment approaches for biomass with increasing recalcitrant were hot water, dilute alkaline, and acidified organosolv processes. The efficiency of the overall conversion ranged between 71.6% and 99.5% for the feedstock, and the conversion yields were up to 51.6-53.4 g/L (i.e., bioethanol). A pilot-scale bioreactor system was established to

	demonstrate the biorefinery process, for which 10 kg of example waste from each category were selected and converted into value-added products. Techno-economic analysis suggested that governmental coordination is still mandatory when considering the process in a centralised facility, while public subsidy or comprehensive supporting facilities is important if profit making is of a major concern to the recyclers.