Recovery of valuable products from food waste fermentation via sonocavitation and hydrothermal intensification: effectiveness comparison, regulatory mechanism, and modeling (REVAMP)

Food waste (FW) can be generated in the whole food supply chain, i.e. from the production to serving of food. Food wastage and its accumulation have become a global concern due to continuous increase of the world population. The current global population is 7 billion, generating approximately 1.3 billion tons of FW annually worldwide. The estimated amounts of households FW in the European Union and Poland are respectively 76 and 54 kg per person per year, whereas FW production in China accounts for 16 kg per person per year. The exponential growth in FW is imposing serious threats to our society, including environmental pollution, health risk, and scarcity of dumping land. FW has emerged as a priority in the global and national political agenda, such as the United Nations Sustainable Development Goal 12 (responsible consumption and production) and the European Commission Circular Economy Action Plan.

Anaerobic digestion is one of the technologies that has commonly been used for processing FW. Traditionally, the target was to maximize energy recovery as biogas, but that approach has been questioned in terms of its economic benefits and sustainability. Instead of renewable energy production, a viable solution would be FW valorization through the recovery of the high-value added compounds, such as carboxylic acids, during acidogenic fermentation of FW. These compounds are very important from an economic standpoint and their derivatives have variable applications. In general, carboxylic acids and their derivatives are important for their synthetic utilization in the production of polymers, pharmaceuticals, solvents, food additives, etc. The global market for carboxylic acids is predicted to grow annually by 5%, reaching about $20 billion in 2023.

FW contains natural fibers, carbohydrates, proteins, fats & lipids, vitamins and minerals in a complex matrix that is readily biodegradable, reusable and rich in nutrients. The composition of FW vary largely between the regions and nations which have their own unique food cultures. For example, rice and wheat food as two main staples in Chinese diet contribute to the high carbohydrate contents (22.4–70.2%) and high carbon to nitrogen (C/N) ratio (20-35) in FW. In contrast, in Poland, the share of meat and fat is high in the diet, resulting in a high protein content of FW with a low C/N proportion (<15) and high cellulose composition (>20%) from fruits and vegetables. The nutritional structure (carbohydrate, protein, fat) of FW significantly impacts the fermentation efficiency.

The main aim of the REVAMP project focuses on fermentation of FW with a high efficiency and strong robustness towards high-value added products (carboxylic acids). Valorization of FW with different characteristics will be compared in terms of the effectiveness of two pretreatment methods, including sonocavitation or hydrothermal pretreatment. Moreover, key pretreatment by-products and micro-aeration strategy will be investigated in terms of regulation of the mechanisms of FW fermentation. A simulation model of the combined pretreatment-fermentation systems will be developed as a tool for process evaluation and optimization.

The added values of the project may be viewed in two dimensions: (1) interdisciplinary approach, (2) complementary knowledge and skills of the Chinese and Polish researchers. The joint project will contribute to enhance scientific background of the improved FW fermentation aimed at recovery of valuable products.