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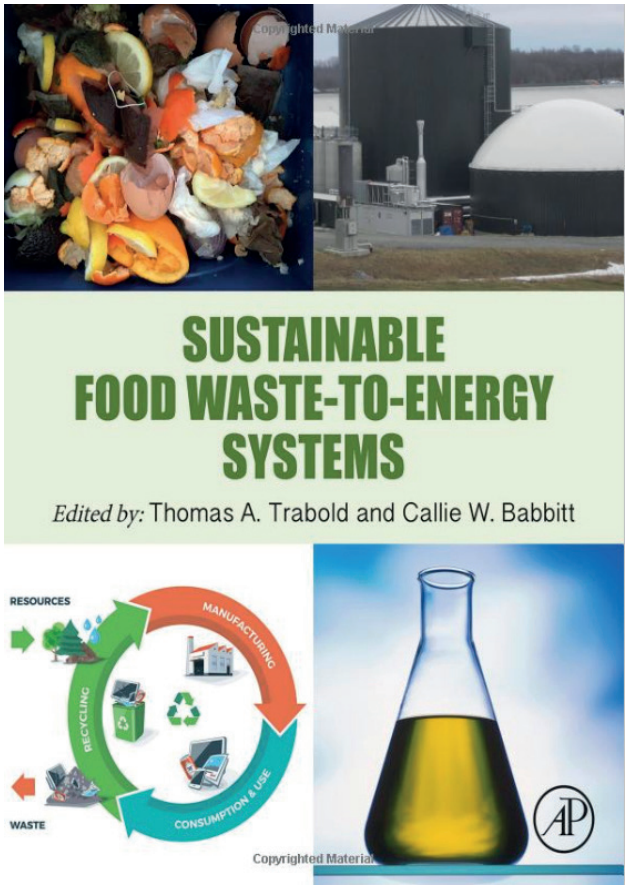
BOOKS REVIEW



SUSTAINABLE FOOD WASTE-TO-ENERGY SYSTEM

Edited by Thomas A. Trabold and Callie W. Babbitt

The relationship between human beings and food has evolved considerably throughout the ages.

Food has assumed a huge significance in representing cultural and religious traditions, ethnicity and national identity; however, in developed economies the population has very little direct involvement in the production of food, thus failing to view wastage of this commodity as particularly arrogant or vulgar.

Taking into account all contributions provided by wastes ranging from agricultural residues to postconsumer waste, the food waste fraction is estimated at 30 to 40% of total food produced, the majority of which is sent to landfill. Whilst much of the developed world faces issues related to minimization of food wastage, other much larger populations continue to be affected by severe food insecurity.

"Sustainable Food Waste-to-Energy System" is an extensive overview focused on the production and general management of food waste and conventional and innovative waste-to-energy technologies. The figures and examples reported refer largely to a US context, thus resulting in a series of evident differences compared to the European, and particularly South European Mediterranean Area, where food preparation is a large part of daily life. Nevertheless, the technical solutions discussed for promoting food waste-to-energy systems are valid worldwide.

Despite the interest in discussing the political and social implications of food waste production and reuse, this book approaches the problems from a technical point of view and, highlighting the imbalance between food supply and demands, indicates the inefficiencies present in the global system (Chapter 1). To develop a viable strategy to address the food waste issue, a series of trends have been considered, including: - the abundance of food (upward trend in per capita food supply); - the inexpensive cost of food (average food expenditures have dropped by 23% of disposable income in 1929 to 11% since 2000); - the production of food is minimally labor-intensive (agriculture employs less than 3% of available labor force); - it is no longer only a local resource (in 2013 the US imported 19% of food based on volume). Increasing food production, transport and consumption have all impacted on packaging and food waste production and greenhouse gas emission.

Available waste resources (Chapter 2) are defined by the FAO as "food loss" caused by inefficiencies in the food supply chain, "food waste" indicating food discarded by humans, and "food wastage" food affected by deterioration. On a global perspective, consumption losses in industrialized economies are much higher than throughout the developing world, where the majority of food waste is generated during the production, handling and storage processes. It is highlighted that despite the differences in distribution, in Europe, industrialized Asia and sub-Saharan Africa the percentages of food waste are similar (22-25%), and lower than those detected in North America and Oceania (42%).

Conventional food waste management options (Chapter 3) are described using a modified waste hierarchy (following source reduction as the preferred alternative). Food donation and animal feed production are viewed on a par with waste-to-energy (WtE) technologies, whilst less desirable management alternatives include composting, wastewater treatment (liquid food waste), incineration, and landfilling. Successful policies applied in Japan and Korea in the development of animal feed products from food waste are illustrated, and it is reasonable to expect that this waste management strategy will play a bigger role in the future. Composting is discussed related to US databases,

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but also as a simple technology acknowledged worldwide for its effectiveness in restoring nutrients to soil.

Anaerobic Digestion (AD) (Chapter 4) for methane production is presented through process parameters and operating conditions, biogas production potential, performances of the different type of reactors (the table on key design parameters is particularly well described), co-digestion with animal manure and biogas utilization. On the contrary, the discussion on digestate fate - one of the main features of AD - is completely lacking.

Fermentation (Chapter 5) as a biochemical process used to convert organics into bioethanol is mainly discussed as the most common commercial system in use, although biobutanol and biohydrogen production are also mentioned, closing the chapter with a brief discussion on future perspectives based on US data.

Transesterification (Chapter 6) is an acid or base-catalyzed reaction performed to convert triglycerides from oil into biodiesel. The potential waste streams suited to biodiesel production are discussed, with waste cooking oil deemed the main feedstock. The chemical reactions and operating parameters are described by a series of comprehensive tables and use of the by-product glycerol utilization is also discussed.

Bioelectrochemical systems-BES (Chapter 7), including microbial fuel cells (MFCs) and microbial electrolysis cells (MECs), using bacteria to convert organic and inorganic matter and directly produce electrical current or hydrogen are perhaps the most interesting systems presented in the book due to the innovative aspects relating to food waste-to-energy conversion. A wide range of feedstocks is illustrated by means of an extensive literature review, in addition to the MFCs and MECs processes, potentiality, current limitations and perspectives.

Gasification and Pyrolysis (Chapter 8) as thermochemical conversion of specific biomasses such as animal-sourced food waste, poultry and fish processing residues, vegetable skins, rice and corn residues, featuring a less than stoichiometric level of oxygen required for full combustion or incineration, are discussed. Production of hydrogen-rich syngas, liquid bio-oil, and biochar are potential options, although additional research, particularly bench-scale to pilot-scale studies, should be conducted to investigate any food waste technology combination in order to avoid scale-up problems.

Hydrothermal liquefaction (Chapter 9), in the same way as the chapter on BES, this technology is relatively new and highly promising for the conversion of food waste, particularly wet biomass, by depolymerization under conditions of moderate temperature and high pressure into a high energy density bio-oil product. Conversion of carbohydrates, lignin, oils, fats and proteins as single materials are discussed, as well as source-specific food waste (plant based, animal based, mixed food waste). Further research should be undertaken due to the complexity of food waste, in an attempt to better understand the influence of different operational conditions and successfully market the end-product.

Other chapters of the book present a series of environmental and economic aspects, as well as the regulatory framework based largely on US cases.

This book provides a collection of excellent contributions covering numerous aspects of the food waste-to-energy systems. It represents a useful resource for professionals (researchers, managers, engineers, technicians, operators) working in the field of waste management, energy systems, energy supply and management, and process systems.

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Thomas A. Trabold is an Associate Professor and Department Head of the Golisano Institute for Sustainability (GIS) at Rochester Institute of Technology (RIT). Dr. Trabold's primary research focus is in development of alternative energy technologies, including fuel cells, bio-fuels, and food waste-to-energy processes. Prior to joining RIT, he had 20 years of experience in industrial research and development at General Electric, Xerox, and most recently in research and demonstration of proton exchange membrane (PEM) fuel cell systems for advanced zero-emissions vehicles at General Motors. In the latter position, he was a Professional Technical Fellow and Laboratory Group Manager, with responsibility for engineering research activities in the U.S. (New York and Michigan) and Germany. Dr. Trabold has a strong record of accomplishment in sustainable energy research, with more than 100 technical publications and 50 U.S. and international patents.

Callie W. Babbitt

Dr. Callie Babbitt is an Associate Professor in the Golisano Institute for Sustainability (GIS) at Rochester Institute of Technology (RIT). Her research group focuses on developing and applying tools to understand and manage the life cycle implications of emerging technologies. Specific focal areas are consumer electronics, nanomaterials, photovoltaics, and lithium ion batteries, and food waste-derived biofuels. These sectors represent complex sustainability challenges, as they are characterized by rapid development, adoption, and evolution; high potential for environmental impact across all life cycle stages; and a lack of comprehensive data that can be used to accurately quantify potential environmental impact. Dr. Babbitt is a recognized expert in environmental assessment of emerging technologies, and was awarded an NSF CAREER Grant in 2013.

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