Investigating the utilisation of Household Food Waste for the production of biogas and ethanol in the context of circular economy

K. Valta[(1)], J. Novakovic[(1)], K. Katsibouras[(2)], G.Antonopoulou[(3)], M.Alexandropoulou[(3,4)], Maria Loizidou[(1)], G.Lyberatos[(4)], E. Topakas[(2)]

[1]Unit of Environmental Science and Technology, School of Chemical Engineering, National Technical University of Athens, 9 IroonPolytechniou Str., Zographou Campus, GR-15773 Athens, Greece
[2]Biotechnology Laboratory, School of Chemical Engineering, National Technical University of Athens, 9 IroonPolytechniou Str., Zographou Campus, GR-15773 Athens, Greece
[3]Institute of Chemical Engineering Sciences (ICEHT/FORTH), P.O. BOX 1414, 26504, Patras, Greece
[4]Department of Synthesis and Development of Industrial Processes, School of Chemical Engineering, National Technical University of Athens, 9 IroonPolytechniou Str., Zographou Campus, GR-15773 Athens, Greece

Keywords: household food waste, biogas, bioethanol, circular economy
Presenting author email: katvalta@gmail.com

Food waste prevention, management and utilisation has attracted much attention at international, European and national level, as it has been estimated that one third of globally produced food is wasted. Food waste arises from the entire value chain including primary production, processing, distribution, retail, preparation and consumption of food in restaurants, catering facilities and households. Unsustainable food production and poor management of food waste has negatively impacted the global economy, society and environment which has progressively led to the need to move towards a more circular economy.

The present research work aims at investigating through a holistic approach the alternative utilisation pathways of household food waste (HFW) produced in Greece in accordance with the principles of circular economy. To this end, laboratory work was carried out in order to investigate the physicochemical characteristics, the biomethane potential and the bioethanol potential of HFW from Greek households after mild drying(~60 °C); through mild drying the chemical content of HFW is maintained due to the inhibition of microorganisms' and enzymes' activity (d-HFW).

Results of the compositional analysis of HFW collected from five Greek households in the Prefecture of Attica for a period of twenty-eight days using the method of 'food waste diary', showed that HFW is mainly composed of fruits (> 50%) and vegetables (~ 30%) and that one-third of the total HFW weight could have been avoided. As confirmed by the bio-methane potential test for twenty samples, methane yield ranged from 248 to 464 L CH_4/kg d-HFW (265 to 500 LCH_4/kg VS d-HFW) which corresponds to 264 to 518 L CH_4/kg TS (282 to 558 LCH_4/kg VS) with the vast majority (> 70 %) of the methane produced during the first 20 days for all samples. In addition to biogas production, laboratory research has revealed that household food waste (after mild drying) is also a valuable raw material for the production of second-generation bioethanol. In particular, Non-Isothermal Simultaneous Saccharification and Fermentation (NSSF) was applied. The process involved enzymatic hydrolysis (6 h) of d-HFW (25 % w/v) through commercial amylases and cellulases followed by fermentation with *Saccharomyces cerevisiae* (8 h) resulting in ethanol production ranging from 11 g/L to 42,4 g/L. Ethanol production of different d-HFW samples ranged from 43 % to 97 % of the theoretically value. The achieved values are high in comparison with those mentioned int the literature.

To sum up, the laboratory researchproved that dried household food waste constitutes a valuable substrate for biogas production as well as bioethanol generationin line with the principles of bioeconomy and circular economy.