**RETASTE Conference Abstracts**
Vol. 3 RETASTE-LCA-428-Oral
Athens, Greece, 27-29 September, 2023


rethink food resources, losses, and waste 2023 retaste

# Sustainability Assessment of Biorefineries for Waste Valorization from Juice Industries

[1]Pantelis Manakas, [2]Athanasios T. Balafoutis, [3]Constantina Kottaridi and [1]Anestis Vlysidis

[1]*School of Chemical Engineering, National Technical University, Iroon Polytechneiou 9, Zografou 157 80, Athens, Greece*
[2]*Institute of Bio-Economy & Agro-Technology, Centre of Research & Technology Hellas, Dimarchou Georgiadou 118, Volos, 38333, Greece*
[3]*University of Piraeus, Department of Economics, 80, M. Karaoli and A. Dimitriou Street, Piraeus, PC: 18534, Greece*



## Abstract

Bioeconomy, circular economy and sustainable development refer to actions, regulations, frameworks and policies which have recently been introduced into our lives, sharing the common purpose of meeting the Sustainable Development Goals by 2030. While waste volumes reduction is in the core of the above goals, significant quantities are generated from the food processing industries inducing harsh environmental burdens and raw materials scarcity. Around 17 Mt of fruit waste, mainly deriving from juice industries, is produced every year in the EU at the processing and manufacturing stage of the food supply chain. Oranges are among the main fruits being processed in the juice industry, with around 50% of their mass ending up as waste, generating around 2.5 Mt of orange waste in the EU every year. This waste, mainly consisting of peels, internal tissue and seeds, although rich in valuable organic compounds, is treated in a non-sustainable manner, both environmentally and economically, including landfilling, animal feeding and incinerating. Waste management through a biorefinery concept would result in a spectrum of products such as high value-added bioactive materials, biofuels, biochemicals and bioplastics, via the fractionation of the waste into particular waste segments and the implementation of integrated waste valorization technologies. A meta-analysis of the available technologies valorizing waste streams from the orange juice industry is conducted in the context of this study, followed by a comprehensive sustainability analysis of waste management scenarios, evaluating the most critical environmental, economic, energy and mass indicators. Primarily, a mass flow analysis is conducted to determine the orange waste quantities in the EU and its member states individually. Subsequently, incumbent and emerging technologies are compared in terms of their product yield, energy consumption and extraction time. The emerging technologies perform better in energy consumption and extraction time which ranges from 37.4% to 93.0% less time in pectin and essential oil extraction, respectively. Product yield does no show a constant trend in favor of emerging technologies indicating the low

TRL of the latter as a presumptive explanation. In terms of the environmental performance, emerging technologies extracting essential oils, pectin and phenolic compounds present 85.1%, 97.5%, 47.9% lower $CO_2$ equivalent values respectively than the conventional ones. The same pattern seems to apply also on the rest of the environmental indicators such as photochemical ozone formation (POF), ozone depletion (OD), terrestrial acidification (TA) and freshwater eutrophication (EUF). In addition, the traditional orange waste management scenario of landfilling seems to be the least environmentally benign alternative, followed by thermochemical treatment scenarios and those of biological conversion. Also, cost production seems to be inverse proportionate with the complexity of the scenarios which in turn is analogous to the environmental performance and energy consumption. Finally, trade-offs analysis between the under-study indicators drew critical conclusions, as to the sustainability performance linkage between orange waste management scenarios.

**Keywords:** waste management, sustainability analysis, juice industry, biorefinery