

Circular Economy Approaches for Food Waste Valorization in Water Purification Technologies: A Critical Review

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Abstract: Two major challenges for sustainability have arisen: a rise in food waste and the lack of clean water. Recent estimates project that almost one-third of the world's food production is lost or wasted each year, with serious environmental, economic and social impacts. At the same time, industrialization, urbanization and the growth of population has further led to the deterioration in water quality, with the discharge of dyes, heavy metals, pharmaceuticals, pesticides and other harmful chemicals in aquatic systems as major sources of water pollution. Although effective, conventional water treatment technologies are usually high operating cost, high energy requirement, and secondary waste production. To address these challenges, the concept of the circular economy has received significant attention as a sustainable solution that aims to recover resources, reduce waste, and convert waste materials into valuable products.

The valorization of food waste has been identified as a promising method for circular economy to produce low cost and environmentally friendly materials to be used in water purification applications. A diverse range of food waste materials, such as fruits and vegetables skins, coffee grounds, tea waste, eggshells, agricultural waste, etc., contain high levels of both the lignocellulosic material and surface functional groups which are suitable for the adsorption and removal of a wide variety of water pollutants. These waste materials can be modified physically, chemically, thermally, and by biochar production and converted into highly efficient adsorbents that can compete with the conventional commercial adsorbents.

This review critically discusses the recent advances of valorization of food waste for water purification technologies under the framework of the circular economy. The generation of food waste, valorisation options, preparation and modification methods, adsorption mechanisms, pollutant removal efficiency, environmental and economical benefits, and sustainability aspects are discussed. In addition, issues and limitations of current implementation, as well as future research opportunities and challenges for large-scale implementation are examined. The results suggest that the materials derived from food wastes have great potential to not only tackle the food waste problem, but also provide sustainable water treatment options. The combination of circular economy concepts and water purification technologies offers a potential avenue to resource efficiency, environmental protection, and sustainable development.

Keywords: Circular economy, Food waste valorization, Water purification, Biosorbents, Wastewater treatment, Biochar, Sustainability