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# Potentials of orange wastes in wastewater treatment technology: A comprehensive review

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## Highlights

- Comprehensive study of orange waste-derived materials for water treatment and gas adsorption.
- Surface modifications and mechanistic insight of orange waste adsorbents.
- Critically discussed the thermodynamics parameter calculation methods.
- There is a detailed discussion on the isotherm and kinetic models used in adsorption study.
- Future directions of research in orange waste-derived adsorbents are proposed.

## Abstract

Oranges are popularly consumed globally because of their high nutritional values and antioxidant properties. The leftover orange wastes, readily available as a raw material, can be effectively utilized to produce adsorbents and catalysts that can scavenge and break down a diverse spectrum of pollutants from aqueous solutions. This study explores the potential use of orange waste as a raw

material for the preparation of an adsorbent to remove heavy metals, dyes, pesticides, herbicides, polycyclic aromatic hydrocarbons (PAHs), aromatic hydrocarbons, inorganic contaminants, and radioactive ions from water. Additionally, it explores the use of orange waste in treating gaseous pollutants and preparing catalysts for degrading dye, pharmaceutical, and plastic pollutants. Recent research has focused on developing low-cost adsorbents from orange waste and studying its isotherms, kinetics, and thermodynamic properties against pollutants. Critical discussions have been conducted on the isotherm model, kinetic model, and thermodynamic parameters calculations for orange waste-derived adsorbents. Conclusions are drawn from the data presented in the preponderance of published articles on the use of orange waste-derived materials against environmental pollutants. There is a lack of comprehensive review articles on the adsorption and catalytic properties of orange waste-derived materials against various contaminants. Recent research has demonstrated that orange waste could serve as a potential eco-friendly material for the remediation of environmental pollutants.

## Graphical abstract



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## Introduction

Nature's greatest boons to mankind are vegetation and water. One cannot imagine the existence of life on this planet without water and food obtained from natural vegetation, including fruiting plants, herbs, and shrubs. Water is one of the most vital components for the survival of human beings and other living organisms on Earth. Despite the fact that natural water from mountain and underground sources was considered pristine and clean, burgeoning industrialization, use of synthetic chemical-based products, and use of highly poisonous weapons in wars slowly contaminated most of the pristine sources of potable water bodies throughout the world. The mindless use of chemicals and pesticides in agriculture and the dumping of domestic and industrial waste have further deteriorated the quality of water bodies. Getting clean and safe drinking water will be a major challenge for the coming generation, as the water quality deteriorates with much faster rates than the last decades. With the increase in air pollution and global warming, the weather pattern changes significantly. Some parts of the world have received heavy rainfall that causes floods and waterlogging in residential areas, while other parts of the globe are suffering from unbearable heat wave and water scarcity. The irregular rain fall across the globe causes water