Sustainable Water Management and Treatment: Systems, Processes and Technologies

Environmental Science and Engineering • Book Chapter • 2025 • DOI: 10.1007/978-3-031-85327-2_7

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Abstract

Global water resources are rapidly diminishing, driven by population growth, climate changeClimate change, and expanding industrialization. Experts estimate that by 2050, 52% of the projected 9.7 billion people worldwide will reside in areas experiencing water stress or scarcity. The global challenge of accessing clean, potable water will persist as sustainable solutions remain elusive. Water sustainabilitySustainability involves meeting the current generation's water needs without jeopardizing future generations' ability to meet their own. Water is the cornerstone of sustainable developmentSustainable development, serving as a common thread linking global challenges such as energy, food securityFood security, health, peace, security, and poverty eradication. Our survival and well-being depend heavily on effective water resource systems. However, with growing development pressures on land in watersheds and increasing demands for water in streams, rivers, lakes, and aquifers, it is unrealistic to expect these water systems to return to or maintain their pristine, most productive states. Sustainable water managementWater management (SWM) is crucial for addressing these pressures and achieving sustainable development goalsSustainable Development Goals (SDGs). SWM ensures that current water needs are met for all users without compromising the ability of future generations to meet their own needs. This concept aligns with broader sustainability principlesSustainability principles, addressing both present and future water challenges. Enhancing the efficiency of conventional membrane technologies for water treatment is now crucial to minimizing their environmental impactEnvironmental impact.

WastewaterWastewater treatmenttreatmentWastewater treatment removes pollutants, coarse particles, and toxic substances while killing pathogens and producing bio-methaneMethane (CH_4) and manure for agricultureAgriculture. It is crucial in reducing water waste, easing pressure on natural water sources, and supporting clean energy, forming the foundation for sustainable waste managementWaste management. Membrane technologies are increasingly favored forSustainable wastewater treatmentwastewater treatmentWastewater treatment due to their sustainabilitySustainability advantages, including cost-effectiveness, operational ease, and safety. Sustainable water treatment technologies utilize innovative methods such as membrane filtrationMembrane filtration, advanced oxidation processesAdvanced Oxidation Processes (AOPs), and nanotechnologyNanotechnology. Techniques like reverse osmosisReverse osmosis and ultrafiltration are highly effective in removing contaminantsContaminants, microorganisms, and nanoparticles from water. Sustainable water technologies include wastewater treatmentWastewater treatment plants, intelligent irrigation systems, fog catchers, rainwater harvestingRainwater harvesting, tap aerators, seawater desalinationDesalination, portable filters, and solar-powered desalinationDesalination units.

Author keywords

Electro deionization; Membrane technology; Water management; Water pollution; Water scarcity; Water Stress Index; Waterborne diseases

Indexed keywords

Engineering controlled terms

Agriculture; Cost effectiveness; Environmental technology; Microfiltration; Population statistics; Potable water; River pollution; Sustainable development; Sustainable development goals; Wastewater treatment; Water conservation; Water filtration; Waterworks

Engineering uncontrolled terms

Electro-deionization; Future generations; Global challenges; Sustainable water; Sustainable water management; Water needs; Water scarcity; Water stress indices; Water-borne disease; Waters managements

Engineering main heading

Membrane technology

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Indexed keywords

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Circular economy and agriculture: mapping scientific productivity, research pattern and future research direction

Environment, Development and Sustainability • Review • 2024 • DOI: 10.1007/s10668-023-03963-x

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Abstract

This study aims at assessing the global research productivity and discovery of knowledge clusters on circular economy and agriculture using bibliometric analysis. A total of 757 articles have been retrieved from the Scopus database covering the period from 2008 to 2022 on the theme of circular economy and agriculture. The analysis reveals interesting theoretical and practical implications of scientific publications on circular economy and agriculture. The idea of a circular economy in agriculture started gaining importance after 2015 and gradually received significant focus from the scientific community with exponential growth in research publications and citations. Out of the top 10 leading publishing countries on circular economy and agriculture, 6 countries belong to the European Union. The keyword analysis identified four key research areas of CE and agriculture. Highly relevant and less developed research themes such as agricultural sustainability, waste management & recycling, anaerobic digestion and food security have been identified as future research focus areas. The thematic research evolution indicates the merging of multiple themes over time and the emergence of circular agriculture as a core model. A comprehensive knowledge synthesis about circular agricultural practices may help in the

adoption of strategic, operational, and competitive advantages, and motivate researchers to undertake further scientific investigations to strengthen the circularity in agriculture.

Author keywords

Agriculture; Bibliometric analysis; Circular economy; Recycling; Sustainability; Waste

Indexed keywords

GEOBASE Subject Index

anaerobic digestion; emergence; food security; growth rate; recycling; sustainability; waste management

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Potential of confocal micro-Raman spectroscopy for the nutrient profiling of kidney beans

National Academy Science Letters • Article • 2023 • DOI: 10.1007/s40009-022-01199-3

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Abstract

Vibrational spectroscopic techniques like confocal Raman micro-spectroscopy have immense potential in the field of nutrition science for the rapid and non-destructive analysis of feed involving minimal sample preparation steps. The study describes the applicability of confocal micro-Raman spectroscopy for the profiling of multiple nutrient components of kidney beans non-destructively, simultaneously, rapidly without sample pre-processing. The analysis of acquired Raman spectrum of the kidney beans shows the fingerprints of carbohydrates, cell wall polysaccharides and proteins. The spectral features and nutrients profile obtained are advantageous for nutritionists and scientists for tackling malnutrition and maintaining healthy nutrient-rich diet. © 2022, The Author(s), under exclusive licence to The National Academy of Sciences, India.

Author keywords

Confocal micro-Raman spectroscopy; Kidney beans; Non-destructive techniques; Nutrient profiling

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Non-Destructive Assessment of the Nutrient Profile of Underutilized Seeds Using Spectroscopic Probes

Analytical Letters • Article • 2023 • DOI: 10.1080/00032719.2022.2099414

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Abstract

The population of the world is increasing rapidly, and it is challenging to fulfill the nutritional requirements of an overpopulated world. Therefore, it is necessary to identify underutilized food alternatives that are nutritious, have health-promoting properties, and are widely available. Seeds of mango, drumstick, and jamun are reported to have immense health promoting constituents. Despite this, they are largely discarded as waste due to lack of knowledge about their nutrient profile. Therefore, the present study aims at demonstrating the potential of nondestructive, rapid, and label free spectroscopic probes: attenuated total reflectance Fourier transform infrared spectroscopy, confocal micro Raman spectroscopy, and synchrotron radiation based X-ray fluorescence for determining the phytochemical and elemental profile of the mango, drumstick, and jamun seeds. The infrared and Raman spectra show that these seeds are rich sources of cell wall polysaccharides, amino acids, carbohydrates including glucose and starch, fatty acids, and antioxidants such as carotenoids and flavonoids. In addition, the X-ray fluorescence spectra show that these seeds are rich sources of calcium, potassium, magnesium, iron, copper, zinc, and manganese. The study highlights the potential of the nondestructive spectroscopic probes for the rapid, sensitive, cost effective and accurate assessment of nutrient profile of the seeds. The spectral information is highly beneficial for the administrators and nutrition scientists for assessment of diet quality, tackling malnutrition in an effective manner, and exploring use of these seeds. © 2022 Taylor & Francis Group, LLC.

Author keywords

Attenuated total reflectance–Fourier transform infrared (ATR-FTIR) spectroscopy; confocal microRaman spectroscopy; nutrient profiling; seeds; synchrotron radiation based x-ray fluorescence (XRF)

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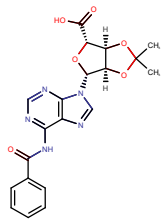 View details

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Non-Destructive Monitoring of Ripening Process of the Underutilized Fruit Kadam Using Laser-Induced Fluorescence and Confocal Micro Raman Spectroscopy

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Abstract

Underutilized fruits like kadam are bio-reserves of numerous biochemical and minerals and have the potential to be used as food alternatives and supplements to fulfill the needs of malnourished populations. The production of quality fruits needs monitoring throughout the growth and ripening in order to build consumer and industry confidence. The nondestructive optical spectroscopic techniques have immense potential to monitor the growth and ripening indices of the fruits. Hence, this study explores the potential of laser-induced fluorescence and confocal micro Raman spectroscopy for the reliable and cost effective monitoring of growth and ripening of kadam fruits. The analysis of the laser-induced fluorescence measurements reveals that the ripening of the kadam fruits may be monitored by analyzing the fluorescence emission of chlorophyll and carotenoids. The decrease in the intensity of chlorophyll fluorescence accompanied by the increase in the intensity of the carotenoid bands is the characteristic fluorescence signature associated with the ripening of the kadam fruits. Hence, upon the ripening of the fruits, the concentration of chlorophyll decreases considerably with the accumulation of carotenoids. This fact is further complimented by confocal micro Raman measurements, which show that as the fruit ripens, the intensity of carotenoid bands increases dramatically.

The observed spectral features may be used by the horticulture scientists and nutritionists to monitor the growth, maturity, and ripening of underutilized fruits like kadam in order to maximize the quality and minimize postharvest losses. © 2022 Taylor & Francis Group, LLC.

Author keywords

Confocal micro Raman spectroscopy; kadam; laser-induced fluorescence spectroscopy; ripening process; underutilized fruit

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