ID: 309

Extraction of Anthocyanins from Food Waste Using Ultrasound- and Microwave-Assisted Methods

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Abstract

Anthocyanins are natural plant pigments responsible for the vibrant red to blue-purple colors in various foods and beverages. They are found abundantly in fruits such as blackberries, blueberries, and strawberries, as well as vegetables like red cabbage and eggplant. Beyond their role as natural colorants, anthocyanins are valued for their significant health benefits. This study explores the definition, sources, biological activities, and applications of anthocyanins in the food industry, with a specific focus on two innovative extraction techniques: ultrasound-assisted extraction (US) and microwave-assisted extraction (MW). US and MW represent advanced, eco-friendly alternatives to conventional extraction methods, offering enhanced speed and efficiency. MW utilizes microwave energy to rapidly heat solvents and plant material, enabling swift extraction, reduced solvent usage, and energy efficiency. However, the technique presents challenges, such as thermal degradation of heat-sensitive compounds and limited compatibility with non-polar solvents. US employs ultrasonic waves to create cavitation, facilitating high extraction yields within shorter timeframes. Several studies highlight the superior performance of US and MW in extracting anthocyanins from food waste. These methods deliver higher yields, reduced extraction times, and lower solvent consumption compared to traditional techniques. By enabling the recovery of valuable bioactive compounds from food waste, these approaches promote sustainable food production systems. Nevertheless, certain limitations persist, including the co-extraction of unwanted compounds, the potential formation of toxic by-products, and the heat sensitivity of anthocyanins. Additionally, scaling up laboratory findings to industrial applications remains a challenge. Overall, US and MW hold immense promise as sustainable and efficient extraction techniques for the food industry. Addressing their limitations through further research and development will pave the way for broader applications and advancements in sustainable food systems.

Key Words: