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# Unveiling

# Nature's Bounty:

## Subcritical Water Extraction and its Transformative Impact on Humanity



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In the field of scientific research, there are various innovations that hold as much promise to transform lives and empower humanity. One of these is subcritical water extraction (SWE), a revolutionary extraction method that can unleash the therapeutic or healing potential of plant materials in a sustainable and transformative way. This pioneering extraction method, stemming from the ground-breaking research of Hawthorne et al. in 1994, initially gained recognition for its ability to extract organic pollutants from environmental substances under subcritical water conditions. However, more recent literature has consistently shown that SWE is also effective in extracting bioactive compounds from plant materials from most parts of plants and herbs, from the peel to the leaf, stem, root, seed and flower [1].



To brief, SWE method works under certain subcritical conditions where water acts as a solvent within a certain temperature range (100 °C at 1 bar to 374 °C at 221 bar) and represents a new approach to extraction [2]. The exploration of SWE in a variety of plant materials, including *rumpai laut perang* [3], *rizom lempoyang* [4], [5], *ketumbar* [6], *kayu gaharu* [7] and many more, highlights the potential of SWE to revolutionise the way we use the gifts of nature for the benefit of humanity. Furthermore, the researchers emphasise the importance of tailoring the extraction conditions (temperature, time, pressure, solid-solvent ratio and use of co-solvents, etc.) to each individual plant material. Therefore, various industries, including the pharmaceutical and nutraceutical industry, the food and beverage industry and the cosmetics industry, can benefit from the extracted bioactive compounds that are carefully extracted by SWE using optimised variables.

SWE has expanded opportunities for transdisciplinary scientific innovation, healthcare, food safety and nutrition, economic and social empowerment, and environmental sustainability by transforming the management of plant resources and their various applications. The technology is crucial in changing lives and empowering people through **promoting scientific discovery and interdisciplinary collaboration**. Experts from different fields such as chemistry, biology, engineering, environment, economics, and agriculture come together to optimise extraction processes, identify new phytochemicals, and explore innovative applications. By harnessing the collective power of



interdisciplinary collaboration, investigation on SWE for plant material extractions produce findings which are well-recorded in impactful journal articles as well as research products. The findings benefit many players and society by transforming our understanding and use of plant resources, leading to better outcomes in many aspects.

The centrepiece of SWE is its profound significance for modern medicine. The phytochemical substances extracted from various plant materials using this method have special pharmacological values such as antioxidants, anti-inflammatory agents, anti-cancer substances and many others, all of which have the potential to **revolutionise the prevention and treatment of diseases** [1], [8], [9]. Currently, herbal medicines developed from edible plants have become part of the pharmaceutical world. Furthermore, phytopharmaceuticals are gaining popularity as a natural and healthy substitute for synthetic medications, appealing to individuals seeking safer treatment options for ailments [9]. SWE can revolutionise healthcare by creating cutting-edge medications and nutraceuticals that enhance patient results and enable individuals to manage their health and wellness.

SWE also holds the potential to **enhance food safety and nutrition**, in addition to its healthcare applications [10]. The phytochemicals obtained via this process can serve as a natural medical resource and can also be utilised as an extra ingredient or natural colouring agent to enhance meals with advantageous ingredients. By enriching meals with bioactive phytochemicals such phenols, alkaloids, terpenoids, flavonoids, and other related

groups taken from plants, SWE improves nutritional content, ensures food safety, and encourages healthier eating habits [10]. It can also decrease society's reliance on artificial compounds that are harmful to public health. Introducing phytochemically valued products from SWE into the local cuisine in regions facing food instability or malnutrition can improve the health and well-being of the community and provide access to nutritious and culturally meaningful food.

In addition, SWE has the potential to **strengthen economies and communities** [11], particularly in areas with rich biodiversity. This method enables farmers and indigenous people to generate income by sustainably gathering and extracting resources from indigenous plant species and traditional knowledge systems. Moreover, fostering local industries centred around SWE can boost economic growth, create job opportunities, and encourage entrepreneurship, ultimately aiding in poverty alleviation and sustainable development. When communities acknowledge the economic value of their natural resources, they achieve autonomy and resilience, enabling them to shape their own future and create a better life for themselves and future generations. This aligns with Sustainable Development Goals (SDG 1: No poverty) of the 2030 Agenda, aiming to eradicate poverty by fostering economic growth in rural regions.

Furthermore, SWE promotes water as an environmentally friendly solvent that provides a sustainable solution to urgent **environmental issues and reduces the ecological impact** of phytochemical extraction [2], [6]. SWE does not use organic solvents or harsh chemicals, instead producing safer solid residues that are environmentally friendly and contribute to a greener future. Furthermore, the environmental implications of the solid residues generated by the SWE process complies to environmental requirements. The technology's possible environmental impact guarantees adherence to laws set by the Malaysian Department of Environment (DOE) and the United States Environmental Protection Agency (USEPA), in accordance with SDG 12 (Responsible Consumption and Production) by decreasing carbon emissions linked to the extraction procedures. SWE also contributes to worldwide initiatives addressing climate change (SDG 13: Climate Action) and works to minimise the environmental impact of industrial operations.

In summary, the implementation of SWE signifies a substantial advancement in our pursuit of sustainable solutions to worldwide concerns. This disruptive technology has the potential to harness the healing properties of plants, while focusing on environmental conservation, economic empowerment, and scientific collaboration, with the aim of improving lives and creating a better future for humanity. Utilising phytochemicals extracted by SWE can transform healthcare, enhance food safety and nutrition, and boost economic and social empowerment in communities. Moreover, SWE's ecologically friendly strategy aligns with global sustainability goals, serving as a crucial instrument in combating climate change and promoting responsible consumption and manufacturing practices. Let us keep investigating the vast capabilities of SWE and strive to harness the resources of nature for the well-being of present and future generations.

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