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# Zero waste food processing: Valorization of by-products into nutraceuticals and functional ingredients

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**Abstract**

Discarding food residues from agriculture and food processing in landfills lead to soil pollution, biogas emission and contributes to climate change. To lessen the environmental harm of food waste disposal, the zero waste food processing approach aims to reduce food loss and waste during production and foster sustainability. Sustainable food production requires efficient resource use, reduced environmental footprint, economic viability and minimized food wastage. By-products from food industries such as pomace, peels and seeds of fruits and vegetables are repurposed to isolate phytochemicals. Phytochemicals are plant derived bioactive molecules with nutritional or therapeutic potential to prevent or treat certain illnesses. Bioactive groups including polyphenols, phytosterols, dietary fibre and flavonoids exhibit nutritive and pharmacological actions against chronic and metabolic disorders such as cardiovascular diseases, cancer, diabetes, obesity and oxidative stress. These molecules are increasingly recovered by green extraction technologies rather than by conventional approaches, since traditional methods are time consuming and green techniques can often achieve higher recovery. Bioactive compounds such as polyphenols, carotenoids and phytosterols can be recovered using green extraction technologies including supercritical fluid extraction, ultrasound-assisted extraction, microwave-assisted extraction and pressurized-liquid extraction. A key principle of green extraction is the replacement of toxic petroleum based solvents with environmentally friendly alternatives such as water, ethanol and supercritical $CO_2$, enhances extraction efficiency while ensuring safety for nutraceutical and food applications. The recovered compounds can be incorporated into value-added products like functional ingredients, fortificants, edible coatings and dietary supplements.

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