

## **Transforming Food Processing and Preservation: Emerging Technologies for a Low-Carbon Future**

Global food systems are under increasing pressure to simultaneously address food security, nutrition, safety, and climate change. In many developing economies, including Indonesia, postharvest losses, short product shelf life, dependency on imported ingredients, and rising demand for functional foods require transformative technological solutions. Integrated research and innovation strategies have been developed at the Research Center for Food Technology and Processing, National Research and Innovation Agency (BRIN), Indonesia, to build a low-carbon and sustainable food processing ecosystem.

The presentation highlights emerging green and energy-efficient technologies, including cold plasma, ozone treatment, gamma irradiation, controlled fermentation, advanced bioprocessing, commercial sterile packaging systems, functional biodiversity utilization, and biomass-derived preservatives such as liquid smoke (wood vinegar). These approaches reduce energy consumption, minimize chemical inputs and waste, extend shelf life, and enhance food safety without compromising nutritional quality. Case studies include plasma-assisted postharvest preservation and drying, resistant starch enhancement through controlled microbial fermentation, ulvan polysaccharide extraction as a marine prebiotic ingredient, development of bio-based antimicrobial absorbent pads for meat, edible coatings for horticultural commodities, and valorization of agricultural by-products into high-protein fermented foods.

This work demonstrates practical pathways for reducing food loss and waste while strengthening nutritional resilience and supporting smallholder livelihoods through the integration of green processing technologies, smart and biodegradable packaging, functional ingredient development, and circular bioeconomy principles. Technological innovation in food processing and preservation is therefore positioned not merely as a tool for shelf-life extension, but as a strategic instrument for decarbonizing supply chains, improving public health, and advancing sustainable development across the region.

**Keywords:** Low-carbon food systems; Green preservation technologies; Functional foods; Food loss and waste reduction; Circular bioeconomy