EDITORIAL

Transforming Meat Industry Waste into Value: A Sustainable Upcycling Approach

The meat sector produces substantial volumes of waste and by-products worldwide. In Europe alone, approximately 18 million tons of meat industry waste are generated annually, with retail operations accounting for nearly 70% of daily retail waste. These waste streams—comprising blood, bones, trimmings, skin, fatty tissues, and internal organs—are costly to treat and environmentally burdensome. Their underutilization not only results in economic losses but also contributes to pollution and health risks, such as the historical emergence of transmissible spongiform encephalopathies. Simultaneously, the rising demand for protein must be met within the constraints of limited land and water resources, necessitating sustainable waste management solutions. Inefficient resource use at slaughter further undermines global food security goals. To mitigate these challenges, innovative waste-free approaches are needed. Upcycling, particularly through advanced processing technologies, offers promising solutions. As an eco-friendly technology, enzymatic hydrolysis can convert low-value by-products into high-value components such as protein hydrolysates, collagen, and fatty acids, thereby improving both digestibility and nutritional value. Additional methods, including high-pressure processing and fermentation, contribute to improved extraction efficiency and elevate the nutritional value of animal by-products. Thermal technologies, including incineration with heat recovery and ash-based fertilizer production, offer energy-efficient recycling options. The integration of recycled water systems in meat plants also significantly reduces water usage and waste discharge.

Upcycled by-products have diverse applications across sectors. In the food industry, they are used to develop nutrient-enriched products, protein supplements, and flavorful stock bases. The feed and pet food industry continues to utilize these by-products in high-protein animal feeds and pet treats. In the pharmaceutical and nutraceutical sectors, compounds such as collagen, gelatin, and bioactive peptides—recognized for their antihypertensive, antioxidant, and antimicrobial properties—can be extracted from animal skins and bones. Furthermore, animal fats can be repurposed for biodiesel production, while ash derived from incinerated by-products serves as a valuable source of mineral fertilizers.

Effective upcycling provides environmental, economic, and nutritional benefits. It reduces waste disposal burdens, minimizes pollution, and improves resource efficiency. Economically, it converts waste into marketable, value-added products, thereby enhancing profitability. Nutritionally, it enables the recovery of essential compounds—proteins, amino acids, lipids, vitamins, and minerals—supporting food and nutrition security. Additionally, thermal energy recovery systems reduce energy costs in processing facilities. Despite its

promising potential, meat upcycling faces several challenges. These include regulatory barriers, limited access to specific by-products, and microbial safety concerns. The high cost and complexity of certain processing technologies also hinder adoption, particularly in low-resource settings. Nevertheless, continued R&D and innovation hold strong promise. Current research is also evaluating the feasibility of feeding food by-products to livestock, further contributing to nutritional security and circularity. The valorization of by-products into functional ingredients, bioactive peptides, and specialty supplements presents considerable opportunities for the meat industry.

Meat upcycling is a transformative strategy that aligns with sustainability goals by reducing waste and environmental burdens, while simultaneously generating economic value and enhancing food system resilience. Its wide-ranging applications across food, feed, pharmaceutical, and energy sectors demonstrate its potential as a cornerstone of a circular meat economy. Future success will depend on overcoming regulatory, technological, and safety hurdles through sustained research and innovation.

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