JOURNAL OF FOOD QUALITY & HAZARDS CONTROL
SHAHID SADOUGHI UNIVERSITY OF MEDICAL SCIENCES & HEALTH SERVICES

Journal of Food Quality and Hazards Control 13 (2026) 154-5

Editorial

Novel Strategies for Overcoming Quality and Safety Limitations in Plant-Based Yogurts

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Although traditional dairy products can provide essential nutrients such as high-quality proteins and bioavailable minerals, they can pose health challenges to certain consumers. Consequently, the transition toward sustainable food systems has driven the development of various plant-based dairy substitutes to cater to specific dietary restrictions, such as lactose intolerance, cow milk protein allergy, and cardiovascular problems. These products are free of cholesterol and saturated fatty acids, alongside being rich in antioxidants, dietary fiber, minerals, prebiotics, vitamins, and suitable for vegan and vegetarian diets (Wang et al., 2025; Xu, Maina and Wang, 2026; Yin et al., 2024). Among these, yogurt holds a special position as it can be made by a vast array of plant matrices, encompassing legumes (e.g., soy, pea, and fava bean), cereals (e.g., quinoa, oat, rice, and corn), nuts and highly nutritious seeds (e.g., almond, cashew, chia, and sesame) (Rashwan *et al.*, 2025). Although plant-based yogurts are categorized as healthy and nutritious products, their broader acceptance is constrained by quality and safety challenges (Xu, Maina and Wang, 2026).

Textural limitations (e.g., grainy texture, high syneresis, and poor consistency) and sensory restrictions (e.g., off-flavors) remain a major barrier to consumer acceptance (Xu, Maina and Wang, 2026; Yin *et al.*, 2024). The main nutritional challenge of these products is mostly related to low protein quality such as weak amino acid profiles, low protein digestibility, and antinutritional factors (Horlacher *et al.*, 2025; Sohlberg *et al.*, 2026). In addition, while raw materials are highly susceptible to mycotoxin contamination and the accumulation of toxic heavy metals, the physicochemical properties of the plant-based matrix itself favor the survival and growth of pathogenic microorganisms and spores (Martín-Miguélez *et al.*, 2025; Sohlberg *et al.*, 2026).

To address the textural and sensory challenges, several advanced processing and biotechnological strategies have been proposed. High-pressure homogenization and ultrasonic treatment reduce particle size and increase protein dispersion. As demonstrated using specific legume models such as mung bean, these interventions facilitate the formation of a tighter gel matrix and a more ordered dispersed structure (Alzhaxina *et al.*, 2026; Xu, Maina and Wang, 2026). Applying transglutaminase and treating the dietary fiber with citric acid improve cross-linking, hardness, and water-holding capacity, resulting in a significant decline in syneresis and a more homogeneous product texture (Cheng *et al.*, 2025; Xu, Maina and Wang, 2026; Yin *et al.*, 2024). Microbial synthesis of dextran by specific lactic acid bacteria used as starter cultures and targeted precision fermentation can effectively increase viscosity and gel strength, and enhance flavor, emerging as promising natural solutions for improving the sensory quality (Xu, Maina and Wang, 2026). The strategic integration of these biological, physical, and enzymatic interventions has been shown to be effective (Xu, Maina and Wang, 2026; Yin et al., 2024). Ultimately, this multipronged approach can yield plant-based yogurts with superior textural integrity and enhanced sensory acceptability.

In parallel, nutritional limitations can be addressed through targeted ingredient blending, advanced processing, and genetic modification of raw materials. Blending complementary plant proteins can achieve a nutritionally complete amino acid profile, whereas fortification with essential minerals and vitamins ensures nutritionally complete alternative products comparable to dairy products (Horlacher *et al.*, 2025; Sohlberg *et al.*, 2026). Furthermore, emerging non-thermal technologies (e.g., pulsed electric fields) combined with microbial fermentation effectively degrade antinutritional factors and improve protein digestibility while preserving heat-

To cite: Sadeghizadeh-Yazdi, J., Arab, M., and Shahi, M.B. (2026) 'Novel Strategies for Overcoming Quality and Safety Limitations in Plant-Based Yogurts', *Journal of Food Quality and Hazards Control*, 13(3), pp. 154-5.

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[DOI: 10.18502/jfqhc.13.3.23161]

sensitive nutrients (e.g., vitamins) (Horlacher et al., 2025). At the genomic level, clustered regularly interspaced short palindromic repeats technology offers a fundamental solution by knocking out specific genes in the source crops. According to recent studies on molecular strategies, this tool primarily targets off-flavor-producing enzymes (e.g., lipoxygenase) alongside fermentable oligosaccharides, thereby improving both sensory profiles and digestive comfort (Kirtil, 2025). Additionally, microencapsulation technology is utilized to protect sensitive fortified nutrients, such as polyunsaturated fatty acids, thereby improving their oxidative stability and preventing rancidity-induced off-flavors (Wang *et al.*, 2025). To mitigate the risks of microbial and mycotoxin contamination, combining non-thermal technologies with biocontrol methods offers a natural means of reducing pathogen survival, while internal transcribed spacer barcoding provides a precise genomic tool for tracking mycotoxin-producing fungi and identifying contamination sources (Martín-Miguélez *et al.*, 2025; Wang *et al.*, 2025). Overall, the integration of these advanced formulation, bioprocessing, and biocontrol strategies provides a feasible path to produce plant-based yogurts that are both nutritionally adequate and reliably safe.

In conclusion, overcoming the inherent textural, sensory, nutritional, and safety challenges of plant-based yogurts requires a strategic shift toward combined biotechnological approaches. To advance future product development, it is recommended that the food industry and research programs prioritize the synergistic application of precision fermentation, non-thermal processing, and targeted raw material blending to engineer clean-label and nutritionally dense matrices. Furthermore, integrating advanced biocontrol methods and genomic tracking must become standard practice to ensure continuous microbiological and chemical safety. However, addressing the industrial scalability and cost-effectiveness of these novel technologies, and establishing appropriate regulatory frameworks, will be just as crucial as their scientific validation. Ultimately, embracing these processing interventions will enable researchers and manufacturers to design highly acceptable, safe, and sustainable functional dairy alternatives such as plant-based yogurts.

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