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9th International Food Safety Congress

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Grand Cevahir Hotel & Convention Center

"Access to Safe Food:
Everyone's Right, Everyone's Responsibility"

ABSTRACT BOOK



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SCIENTIFIC PROGRAM

KEYNOTE

Gastrophysics: The New Science of Eating

Charles Spence

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Gastrophysics, the new science of eating, focuses attention on 'the everything else' apart from the food that nevertheless still influences the multisensory tasting experience, be it in a high-end restaurant or in the home: Everything from the colour of the plate (or food package) on/in which the food is served (and the 'gastroporn' thereon), through to the weight of the cutlery that is used to consume it, not to mention the music that happens to be playing in the background ('sonic seasoning'; Spence, 2017). Gastrophysics (standing for gastronomy + psychophysics), the new science of eating, aims to bring a scientific approach, inspired by the latest insights from multisensory perception research concerning the roles of taste, smell, touch, sight, and sound, together with the best in culinary artistry, in order to help design more engaging, more enjoyable, and ultimately more memorable food experiences no matter where in the world one might be (Spence, 2024). Gastrophysics focuses on what is going on in the mind of the diner. Ultimately, the hope is that the insights emerging from the new field of gastrophysics can be used to help nudge diners toward a more sustainable diet both for them as individuals as well as for the planet as a whole. In this talk, I will also consider what gastrophysics can contribute to questions of the perception of food safety and quality amongst consumers (Spence, 2025).

Spence, C. (2017). *Gastrophysics: The new science of eating*. London, UK: Penguin; Winner of the 2019 Le Grand Prix de la Culture Gastronomique from Académie Internationale de la Gastronomie.

Spence, C. (2024). *Delicious or interesting? On the changing aims of contemporary cuisine and its role in food adoption*. *In* A. I. de Almeida Costa, M. J. P. Monteiro, & E. Lamy (Eds.), *Consumer acceptance and sensory evaluation of new food products: Principles and applications* (pp. 530-544). Cambridge, UK: Royal Society of Chemistry. https://doi.org/10.1039/BK9781839166655-00529.

Spence, C. (2025). Unveiling the health-promoting power of bioactive compounds in herbs and spices. *Current Food Science and Technology Reports,* **3**:2. https://doi.org/10.1007/s43555-024-00046-4.

KEYNOTE

Making our Food Safe : Individual and Collective Action to Make our Food Safe from Farm to the Table

Francesco Branca

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The 2026 edition of the global burden of foodborne disease has estimated that every year unsafe food is responsible for 866 million illnesses, 1.52 million deaths and 57.2 million DALYs. While most illnesses (666 million) are due to diarrhoeal diseases, mainly due to Campylobacter and non-typhoid Salmonella, most deaths (1.1 million) and diseases (29.8 million DALYs) are due to noncommunicable diseases caused by chemical hazards, mainly exposure to inorganic arsenic and lead. Almost 1 in 9 people in the world fall ill after eating contaminated food. Children under 5 years of age experience 29% of the health burden due to unsafe food, and 143 000 died in 2021. US$ 310 billion is lost each year in productivity and medical expenses resulting from unsafe food worldwide. Foodborne disease burden has been reducing worldwide, but still Sub-Saharan and South Asia are heavily affected.

In 2022, WHO launched a Global Strategy for food safety[1], that includes five strategic priority areas : (1) strengthening national food control systems; (2) identifying and responding to food safety challenges resulting from the transformation and global changes in food system transformation; (3) increasing the use of food chain information, scientific evidence ad risk assessment in making risk management decisions; (4) strengthening stakeholder engagement and risk communication; (5) promoting food safety as an essential component in domestic, regional and international trade.

Food safety is a shared responsibility among different actors of food systems. Governments should develop regulatory frameworks and establish effective food control systems. Food producers, food manufacturers, retailers and restaurant operators should implement standard food safety practices and establish adequate monitoring systems.

Consumers should know how to safely handle food and practice at home, following the WHO Five keys to safer food: keep clean, separate raw and cooked, cook thoroughly, keep food at safe temperatures, use safe water and raw materials.

[1] WHO global strategy for food safety 2022–2030: towards stronger food safety systems and global cooperation. Executive summary. Geneva: World Health Organization; 2022.

Every year, on June 7th, we celebrate world food safety day. In 2026, FAO and WHO called to action all actors. They requested governments to ensure food safety remains a priority; to prioritize preventive actions using burden estimates, and to strengthen foodborne disease surveillance. They requested food businesses to strengthen employee training and education on the latest food safety practices and emerging risks and to use Hazard Analysis and Critical Control Point (HACCP) to identify and control hazards and manage food safety risks from production to consumption. They requested health professionals to improve the diagnosis and clinical management of foodborne diseases. Finally, they requested consumers to practice safe food handling at home; to check food recalls and outbreaks, and alert authorities about unsafe food.

ORAL

Towards Digital Food Fingerprinting: AI-Assisted Lab-on-a-Chip Analysis for Brand-Specific Authenticity

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İstanbul Technical University, Türkiye

Food traceability is evolving beyond safety compliance and adulteration detection toward continuous quality intelligence, production optimization, and brand value management. However, its widespread adoption remains constrained by the operational costs of data acquisition and the computational complexity of transforming measurements into actionable knowledge. These two interdependent challenges often limit the economic sustainability of digitalization, particularly when conventional laboratory-based analyses cannot provide continuous, affordable, and timely assessments. Recent advances in miniaturized spectroscopy, feature engineering, and artificial intelligence create an opportunity to transform established analytical techniques into scalable digital services capable of generating economic value throughout the food supply chain.

This study explores the emerging concept of Digital Food Fingerprinting, demonstrating how conventional Electrical Impedance Spectroscopy (EIS), combined with carefully engineered features and machine learning, can evolve from a laboratory measurement technique into an intelligent, potentially chip-integrated platform for brand-specific authenticity and continuous product monitoring. Rather than focusing exclusively on detecting adulteration or spoilage, the proposed approach aims to establish multidimensional digital representations of product identity, enabling the assessment of brand consistency, ingredient variations, and deviations from characteristic production patterns.

Experimental investigations involving four commercial orange juice brands employed impedance measurements across 201 frequency points between 1 kHz and 1 MHz. Through statistical feature engineering, 804 raw measurement features were reduced to just 20, achieving a 97.5% reduction in feature dimensionality without sacrificing predictive performance. Machine learning models achieved 96.3% accuracy in brand identification, an R^2 of 0.964 for water adulteration estimation, and an R^2 of 0.958 for predicting blending ratios between brands. These results demonstrate that the practical intelligence of a measurement system depends not necessarily on sensor complexity or computational scale, but on extracting the right information from established physical sensing

principles. Observed differences in within-brand electrical fingerprints further suggest opportunities for monitoring manufacturing consistency and raw material variations over time.

Beyond authenticity verification, preliminary sensory experiments indicate the potential to associate physical fingerprints with consumer preference classes, opening possibilities for linking measurable product characteristics with perceived quality and brand value without necessarily relying on dedicated electronic-tongue systems.

The broader vision is to transform food fingerprinting into an accessible, service-oriented intelligence infrastructure, combining low-cost lab-on-a-chip-compatible sensors, edge-based feature extraction, and Artificial Intelligence as a Service (AIaaS). Such an architecture could enable distributed, near-real-time authenticity assessments while minimizing data transmission, computational requirements, and dependence on centralized laboratories. With appropriate contextual calibration and industrial validation, digital fingerprints could become continuously updated indicators supporting quality assurance, ingredient sourcing, logistics optimization, brand consistency, and value-driven production decisions.

Ultimately, this study positions Digital Food Fingerprinting as a pathway from periodic laboratory verification to continuous, economically sustainable food intelligence, where established sensing technologies gain transformative capabilities through AI and feature engineering, turning physical measurements into persistent digital assets for traceability, operational efficiency, and brand value creation.

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ORAL

Ensuring Food Safety from Farm to Fork through Digitalization, AI, and Traceability

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Food safety is fundamental to public health, business continuity, and trust in food systems. Increasingly complex supply networks, rising expectations for transparency, and evolving regulatory requirements demand reliable and verifiable information throughout the food value chain. For food producers, the challenge is no longer limited to establishing scientifically sound controls; these controls must also be applied consistently, monitored continuously, and demonstrated through accessible and trustworthy records.

Digitalization, artificial intelligence (AI), and end-to-end traceability can help translate food safety principles into consistent operational practice by strengthening data continuity, process visibility, and evidence-based decision support. The value of technology lies not in generating more data, but in connecting reliable, contextualized information and making it available for timely and informed action. Technology provides the means to generate, connect, and protect data, while scientific knowledge and food safety expertise give that data meaning and direction.

End-to-end traceability provides the information framework required for this continuity. It connects raw-material origins and lot identifiers with analytical results, acceptance decisions, material consumption, production conditions, process measurements, cleaning records, deviations, product-release decisions, storage conditions, and distribution movements. When these records remain digitally connected, the history of a product lot can be reconstructed across operational and organizational boundaries. This supports backward and forward tracing, helping organizations understand where a product came from, how and under what conditions it was processed, and where it was distributed.

This capability becomes particularly important when a potential food safety concern arises. Connected records can support the rapid identification of affected products, related materials and production conditions, available inventory, and distribution destinations. Effective traceability, however, depends not only on the speed of information retrieval but also on the completeness, integrity, and consistency of the underlying records. Recall exercises therefore provide a practical way to test whether information can be retrieved quickly, completely, and reliably before an actual incident occurs.

AI adds a powerful analytical and decision-support layer to this digital foundation. By bringing together data from sensors, cameras, laboratory results, processes, and traceability systems, AI can reveal patterns, deviations, and emerging risk signals that may be difficult to identify when these data sources are considered separately. This creates opportunities not only to analyze events after they occur, but also to identify potential risks earlier, direct investigations to the right areas, and support faster, data-informed decisions. In this way, AI can contribute to a shift from predominantly reactive control toward a more predictive and proactive approach to food safety. Realizing this potential

reliably requires high-quality and interoperable data, validation, explainability, continuous performance assessment, and human expertise. With these foundations in place, AI can complement scientific knowledge and food safety expertise by making risk signals visible earlier and helping organizations prioritize appropriate action more effectively.

Ultimately, digitalization, AI, and traceability can help make food safety more visible, connected, and proactive. Their value lies in strengthening the link between scientific evidence, operational execution, and verifiable information, enabling risks to be identified earlier and appropriate action to be taken with greater confidence. Technology supports this approach by making the evidence needed for informed decisions accessible, connected, and traceable throughout the product journey from farm to fork.

ORAL

Towards Continuous Quality: Agentic AI in Food Safety

Bora Tosun
CERTI, Istanbul, Türkiye

Food safety and quality systems have traditionally been managed in cycles. Evidence is gathered, documents are revised and gaps are closed in the weeks before an audit, after which attention returns to production until the next cycle begins. Continuous quality replaces this rhythm with a different premise: a site's food safety management system should reflect its actual state at every moment, with records complete, procedures current, deviations investigated and requirements mapped as operations run. The difference matters. Periodic readiness leaves long intervals in which nonconformities accumulate unseen, knowledge is held by individuals rather than systems, and compliance work competes with growth for the same scarce quality staff. For manufacturers supplying multiple retailers and export markets, while facing overlapping GFSI scheme revisions such as FSSC 22000 Version 7, SQF Edition 10 and BRCGS Issue 10, the gap between being certified and being ready has become a commercial risk.

Digitalization has so far concentrated on the measurable layer of food safety: sensors, automation, traceability and enterprise data. Software has digitized the records, but not the work. Most quality work is judgment and follow-up carried out across procedures, records, certificates, specifications and questionnaires. Agentic AI changes what is possible here. Specialized AI agents can work directly from the documents, spreadsheets and drives a site already uses, reason against a standard, draft the required output and follow it to closure. For such systems to be credible to auditors, three conditions are essential: every statement must cite the source record it came from, the system must state what is missing rather than guess, and no record may be filed or closed without an attributed human approval.

The talk then examines nine functional areas where this approach turns continuous quality into daily practice. In document control and change management, a single standard revision or process change can be traced through every procedure, work instruction, HACCP step and form it affects, with revisions drafted, approvals routed and retraining needs identified. In GFSI compliance, records can be mapped clause by clause to every standard a site holds, so gaps surface continuously, ranked by exposure, and evidence is assembled on demand. In quality investigations, agents can propose a root cause from the plant's own records, draft corrective and preventive actions, follow them to closure,

verify corrective action effectiveness and detect recurrence. On the production floor, paper CCP and PRP checks can become digital forms that keep their familiar layout while blocking invalid entries at the point of capture, and environmental monitoring programs can be scheduled, trended against history and linked to an immediate corrective response when a pathogen positive occurs.

Across the supply chain, certificates of analysis can be checked against specifications at intake, supplier certificate expiries tracked and approved suppliers ranked on performance. Lots can be traced both ways from a single query across key data elements and critical tracking events, so unannounced mock recalls can run anytime rather than once a year. Allergen labels, claims and specifications can be validated against each customer's requirements and the applicable regulation before printing, and retailer technical questionnaires can be answered from the plant's own records, with each answer cited and unmet requirements shown as gaps rather than blank fields.

Drawing on implementation experience with food and packaging manufacturers, the talk closes with practical guidance on where to begin, which areas deliver early value, and how to evaluate such systems against the expectations of auditors and regulators. The aim is a food safety system that is maintained continuously, with quality assurance teams freed to concentrate on prevention, food safety culture and improvement.

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ORAL

Bacillus cereus and Cereulide: A Risk-Based Testing Strategy for Global Food Supply Chains

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Bacillus cereus is a ubiquitous environmental aerobic spore-former capable of colonizing food-processing plants and forming resilient biofilms. The organism poses two distinct clinical threats: diarrheal syndrome (caused by enterotoxins synthesized in the gut) and emetic syndrome (caused by cereulide, a highly lipophilic dodecadepsipeptide toxin pre-formed in food matrices). Cereulide is exceptionally stable, withstanding extreme thermal processing (e.g.,121°C for 80'), acidic environments and proteolytic degradation. While conventional pasteurization at 72°C for 15" and standard UHT treatments at 135°C-145°C eliminate vegetative cells, bacterial endospores often survive (typical D 95°C values range from 1.5' to >30') while preformed cereulide persists intact into finished matrices such as infant formula. Furthermore, the adoption of low-heat processing technologies and novel ingredients (e.g., precision fermentation derivatives) may introduce unexpected contamination vectors. The recent global emergence of contamination with cereulide in dairy powder has highlighted key vulnerabilities. In response, the food industry has reacted with high-volume, systematic end-product screening for cereulide. However, effective risk management of cereulide requires an in-depth review of manufacturing processes and their impact on the physiological state of *Bacillus cereus*.

This presentation analyzes recent supply chain disruptions and outlines a framework for transitioning from reactive end-product screening to a scientifically structured, risk-based testing approach.

Grounded in microbial ecology, industrial case observations, and process-mapping principles, the model shifts focus from retrospective analysis to upstream engineering adopting the following strategy:

- **Baseline Ecological Mapping:** Identifying persistent environmental niches and harborage sites in manufacturing environments.
- **Supplier & Upstream Qualification:** Implementing strict risk-profiling for raw materials (such as ARA oil additives) and novel processing technologies.

- **Targeted Process Surveillance:** Monitoring critical process control points rather than relying on indiscriminate finished-product sampling.
- ***B.cereus* Physiological and Genetic Tracking:** Monitoring vegetative population dynamics typically associated with cereulide synthesis (frequently reported around 10E5 CFU/g), accounting for strain genetic variation (i.e., presence of *ces* gene cluster)~~,~~ matrix characteristics and toxicological reference thresholds.

Demonstrating that food safety must be engineered at the process level rather than verified solely at the end-product stage, this communication recommends the adoption of a more structured and economically sustainable model for controlling spore-forming pathogens and heat-stable toxins in complex global supply chains.

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ORAL

PMA-dPCR Enables Improved Viability-Based Quantification of Salmonella enterica in White Cheese: Comparison with Conventional qPCR

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Reliable detection of viable *Salmonella enterica* in dairy products is essential for accurate food safety assessment. We hypothesized that coupling propidium monoazide (PMA) with digital PCR would improve viability-based quantification by excluding DNA from non-viable cells and providing more selective estimates of bacterial contamination than conventional qPCR.

The study evaluated the applicability of PMA-dPCR for viability-based detection of *Salmonella enterica* in a dairy matrix. A reference strain, *Salmonella enterica* PCM 930, was cultivated and standardized to a defined cell concentration. White cheese samples previously confirmed as *Salmonella*-free were artificially inoculated with 400 µL of a standardized bacterial suspension (OD600 = 1.0; approximately 10^8 CFU/mL) and homogenized. To distinguish viable from non-viable cells, selected samples were thermally inactivated (95°C for 10 min). Propidium monoazide treatment was applied before DNA extraction to prevent amplification of DNA originating from membrane-compromised cells, while untreated samples served as controls. The experiment was performed in three independent biological replicates. Quantitative PCR and digital PCR assays targeting the single-copy *invA* gene were used to quantify bacterial populations in pure cultures and cheese samples. Serial ten-fold dilutions ranging from 10^7 to 10^1 CFU/mL were analyzed to evaluate analytical sensitivity and the influence of PMA treatment on viability assessment.

Conventional qPCR successfully detected *Salmonella enterica* across a broad range of bacterial concentrations in both pure cultures and cheese samples. However, comparable amplification profiles obtained for viable and thermally inactivated cells demonstrated that qPCR alone was unable to distinguish viable from non-viable bacteria, confirming that residual DNA from inactivated cells contributes substantially to the analytical signal.

The incorporation of PMA prior to amplification markedly improved differentiation of bacterial populations according to their physiological status. Digital PCR enabled absolute quantification of the single-copy *invA* gene and demonstrated a substantial reduction in detectable target copies

following PMA treatment. At 10^5 CFU/mL, heat-inactivated pure cultures showed a decrease from 1475.3 ± 97.1 to 9.2 ± 6.0 copies/µL, while heat-inactivated cheese samples became undetectable after PMA treatment. In contrast, viable cheese samples remained quantifiable following PMA treatment (1190.4 ± 50.5 copies/µL at 10^5 CFU/mL). Similar trends were observed throughout the analyzed dilution series, indicating effective suppression of DNA originating from membrane-compromised bacteria while preserving detection of viable cells.

Overall, the PMA-dPCR workflow provided improved selectivity for viability-based quantification of *Salmonella enterica* compared with conventional qPCR by substantially reducing amplification of DNA originating from inactivated bacteria while maintaining detection of viable cells. As PMA primarily reflects membrane integrity rather than viability itself, the method should be considered a proxy for viability assessment. Nevertheless, PMA-dPCR represents a promising approach for rapid quantitative food safety monitoring and microbiological risk assessment of dairy products.

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ORAL

Rapid Detection of Beer Spoilage Bacteria in Beer Matrix by Real-Time PCR: Method Validation and Food Safety Applications

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Beer spoilage caused by lactic acid bacteria represents a significant challenge for the brewing industry due to product deterioration, reduced shelf life, and economic losses. Conventional culture-based detection methods are often time-consuming and may fail to detect stressed or slow-growing microorganisms. We hypothesized that Real-Time quantitative PCR could provide a rapid, sensitive, and reliable approach for detecting beer spoilage bacteria directly in beer matrices, thereby strengthening preventive food safety and quality assurance systems.

A beer spoilage detection model was established using Levilactobacillus brevis HUF18ZN2R1004 obtained from the HUFCC. The strain was propagated in MRS broth and inoculated into commercial lager beer samples to generate two independent biological replicates. Genomic DNA was extracted using the commercial genomic DNA purification kit.

DNA concentration and purity were evaluated using A260/A280 and A260/A230 ratios. Real-Time PCR analyses were performed using the GEN-IAL® QuickGEN P1 Screening and Hop Resistance kit on a Roche LightCycler® 96 platform. Serial dilutions of both bacterial DNA and kit-provided control DNA were prepared to construct calibration curves and evaluate assay performance.

Method validation parameters included linearity (R^2), amplification efficiency, LOD, and LOQ. Amplification data were analyzed using Ct values and standard curve characteristics. Assay reproducibility was assessed through technical replicates, while qualitative detection of beer spoilage bacteria was determined based on fluorescence signal generation in the FAM channel relative to appropriate controls.

High-quality genomic DNA suitable for molecular analysis was successfully recovered from inoculated beer samples despite the presence of potential PCR inhibitors such as polyphenols, residual carbohydrates, and hop-derived compounds. DNA purity values were generally within acceptable ranges for downstream qPCR applications, demonstrating the suitability of the extraction protocol for complex beverage matrices.

All inoculated beer samples generated clear amplification signals, whereas negative controls remained undetected throughout the analysis. The assay successfully detected Levilactobacillus brevis in both biological replicates, yielding Ct values of 18.87 and 18.31, respectively. Positive control DNA produced the expected amplification profile (Ct = 25.09), confirming correct assay performance.

Analytical validation demonstrated assay linearity. Standard curves generated using bacterial DNA and control DNA yielded R^2 values of 0.999 and 0.9994, respectively. Amplification efficiencies were calculated as 80.79% for bacterial DNA and 95.53% for control DNA. The lower amplification efficiency observed in beer-derived samples likely reflects matrix-associated inhibitory effects commonly encountered in complex food systems.

The bacterial DNA calibration curve produced a LOD of 0.377 ng/µL and a LOQ of 1.142 ng/µL. For the control DNA calibration curve, substantially lower values were obtained, with an LOD of 0.011 ng/µL and an LOQ of 0.034 ng/µL, demonstrating high analytical sensitivity under optimized conditions.

The validated qPCR assay demonstrated high sensitivity, reproducibility, and applicability in a complex beer matrix. Rapid molecular detection of beer spoilage bacteria offers a practical tool for preventive food safety management, enabling earlier intervention, improved process control, and enhanced protection of product quality and shelf-life stability within the brewing industry.

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ORAL

Electrospun ZIF-67-loaded Nanofibers for Rapid and Sensitive Electrochemical Aptasensing of *Salmonella Typhimurium* in Chicken

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Salmonella Typhimurium is a major foodborne pathogen that poses a significant risk to public health. Traditional detection techniques typically depend on complex laboratory equipment and are often slow, limiting their practical use in real-time monitoring. Therefore, there is a growing need for pathogen detection technologies that are not only rapid and accurate, but also highly sensitive to ensure food safety. Biosensors offer a promising approach due to their ability to detect pathogens quickly and sensitively. Electrospinning has emerged as a versatile and cost-effective technique for fabricating nanofiber interfaces for biosensor applications, due to its operational simplicity, scalability, and wide range of available polymeric materials. The integration of zeolitic imidazolate frameworks (ZIFs) into electrospun nanofibers creates a porous structure with a high surface area, providing abundant active sites and promoting efficient analyte-surface interactions. This synergistic combination enhances aptamer loading capacity and improves target recognition by increasing the accessibility of binding sites, while the functional groups of the ZIFs facilitate aptamer immobilization. In this work, an impedimetric biosensor was fabricated using polylactic acid (PLA) nanofibers incorporated with ZIF-67 nanoparticles and an aptamer with two different approaches for the detection of *Salmonella* Typhimurium. In the first approach, ZIF-67 nanoparticles were incorporated into PLA nanofibers through direct electrospinning of a PLA/ZIF-67 solution. In contrast, the second approach involved the surface functionalization of electrospun PLA nanofibers by electrospraying ZIF-67 nanoparticles onto the fiber surface. The surface properties of the pencil graphite electrode modified with ZIF-67-loaded PLA nanofibers were investigated through FTIR spectroscopy, SEM imaging, and electrochemical techniques. Electrochemical impedance spectroscopy was used to evaluate the interfacial charge-transfer characteristics and sensing performance of the PLA/ZIF-67 nanofiber-modified electrode. The repeatability, reproducibility, and storage stability of the biosensor were evaluated through intra-day, inter-day, and independently

fabricated biosensor measurements. Selectivity was assessed using non-target bacteria (*Escherichia coli, Listeria monocytogenes* and *Staphylococcus aureus*) against the target pathogen. The practical applicability of the developed aptasensor was assessed in chicken samples spiked with *Salmonella* Typhimurium. The biosensor successfully detected *Salmonella* Typhimurium over a concentration range of 10^1 to 10^5 CFUmL^{-1}, with a detection limit as low as 0.49 and 0.66 CFUmL^{-1} for the first and second approaches, respectively. These results indicate that the direct incorporation of ZIF-67 into the PLA nanofibers in the first approach resulted in a lower detection limit compared with the second approach. The developed nanofiber-based aptasensor exhibited excellent repeatability, reproducibility, and stability, with low RSD values obtained from intra-day, inter-day, and sensor-to-sensor measurements. Selectivity experiments revealed negligible interference from non-target bacteria, confirming the high specificity of the aptamer-based recognition strategy for *Salmonella* Typhimurium. The biosensor enables rapid detection within 12.8 minutes and achieves recovery rates exceeding 90% in chicken samples, demonstrating significant potential for the detection of *Salmonella* Typhimurium in real food matrices. After 30 days, the ΔRct value decreased by 0.83% for the electrodes produced using the first approach, whereas a smaller decrease of 0.59% was observed for those produced using the second approach. These findings demonstrate that the proposed biosensor combines rapid response, high sensitivity, and long-term stability with a simple electrospinning-based fabrication strategy, offering strong potential for scalable biosensor production.

Acknowledgements

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ORAL

The Impact of Soil Pollution and Soil Exhaustion from Agriculture and Land Use on Food Security

İbrahim Ortaş

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Soil is a fundamental natural resource that supports sustainable plant production, ecosystem functions, and food systems.

Soil, shaped by interactions among mineral components, organic matter, water, and living organisms, provides habitat and a growing environment for plants and performs key ecosystem functions, including carbon sequestration, water filtration, nutrient cycling, and support for biodiversity. Therefore, protecting soil health, as a living system, is critical to ensuring agricultural productivity, environmental sustainability, food security, and public health.

The demand for food and housing, which began with the human population increasing exponentially every 40 years in the last century, coupled with rapidly developing technology, the formation of megacities, energy requirements, and the burning of fossil hydrocarbons, has led to environmental problems, with soil and water resources being among the most affected. Since 97% of human food comes directly from the soil, soil-related environmental problems affect plants and human health through the food chain. Intensive agricultural production inputs initiated in the last century to ensure food security, deep tillage, excessive use of chemical fertilizers and pesticides/herbicides, industrial and mining activities, unplanned urbanization, and the uncontrolled disposal of all kinds of urban waste, plastics, and other toxic waste constitute the main sources of soil pollution. Furthermore, stubble burning and spills from oil transportation negatively affect soils' physical, chemical, and biological properties, limiting their functions. These processes harm ecosystems, primarily by decreasing microbial diversity, disrupting nutrient cycles, and reducing soil fertility through the long-term accumulation of heavy metals, persistent organic pollutants, microplastics, pesticide residues, and antibiotics from animal waste. Furthermore, intensive monoculture reduces mineral nutrient concentrations in the soil, preventing plants from receiving sufficient micronutrients; this leads to lower yields and poorer food safety. This situation, in turn, affects public health and creates hidden hunger. Currently, approximately 2.5 billion people suffer from malnutrition and unbalanced diets.

Deteriorating soil health affects food security, agricultural production capacity, nutritional quality, and economic access to food. Loss of organic matter and degraded soil structure limit long-term

productivity, while higher production costs and environmental damage can drive up food prices. This situation more clearly reveals the relationship between food security, which refers to the consumption of safe and healthy food, and food security, which refers to continuous access to sufficient, nutritious, and accessible food.

One significant consequence of soil pollution is the transport of pollutants into the food chain through plants, animal products, and water sources. Nitrate seepage into groundwater from the indiscriminate use of nitrogen fertilisers threatens the quality of drinking and irrigation water. Heavy metals, some pesticides, and persistent organic pollutants are associated with health problems such as neurological, endocrine, and developmental disorders, as well as some types of cancer, depending on the nature and level of exposure.

In conclusion, intensive human activities have polluted and degraded a natural system that formed over millions of years in the last 100 years. Soil degradation and pollution are multifaceted problems with ecological, economic, and social health dimensions. Protecting soil health is fundamental to sustainable agricultural production, public health, and food security for future generations. Because ecosystem functioning and human health depend directly and indirectly on soil health, prioritising soil health is urgent. Soil, water, and atmospheric pollution arising from political decision-making processes requires an ecopolitical approach that focuses on managing soil through regenerative, nature-based mechanisms. An ecopolitical approach should address sustainable agriculture, soil and environmental problems, and food security. It should give as much importance to protecting the natural structure of soil, the largest ecosystem component, and preventing pollutants at their source as it does to addressing global climate change. In particular, this requires managing agricultural inputs based on scientific principles, conducting regular monitoring and inspections, and integrating environmental and agricultural policies.

ORAL

Chemical Safety in the Circularity of Food Packaging

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The circular economy approach is reshaping not only the end-of-life management of packaging, but the entire lifecycle, including raw material selection, design, manufacturing, use, collection, recycling, conversion back into secondary raw materials, and their subsequent safe use.

This presentation will address the fundamental principles of chemical safety for recycled plastics intended for food contact, within the framework of the Packaging and Packaging Waste Regulation (PPWR) – Regulation (EU) 2025/40, Regulation (EU) 2022/1616, Regulation (EC) No 1935/2004, and the current and draft provisions of the Turkish Food Codex, together with Türkiye's ongoing alignment with EU food contact legislation.

From a circularity perspective, the critical question is therefore not only "How much recycled content are we using?", but also "Which chemicals are we introducing into the cycle, which are we removing, and how can we control those that remain?"

In a circular system, chemical safety cannot be limited to migration testing of the final product alone. Safety must be assessed throughout the entire value chain, starting with the origin of the recycling input and extending to collection and sorting systems, the quality and history of the raw material, process control, decontamination efficiency, traceability, compliance documentation, and the intended conditions of use of the final food-contact material.

Key areas requiring chemical control include substances that may originate from previous uses, cross-contamination between different material streams, additives and their transformation products, degradation products resulting from processing and thermal ageing, and non-intentionally added substances (NIAS). The mere presence of such substances does not in itself constitute a safety concern; the key requirement is an appropriate risk assessment based on migration, actual consumer exposure, and the relevant toxicological evidence.

The presentation will emphasize that sustainability, recycling, and food safety are not competing objectives. On the contrary, clean and well-defined material streams, effective decontamination,

analytical control, migration and NIAS assessment, traceability, and safe-by-design approaches together form the foundation of a high-quality circular packaging system.

The objective is not to avoid circularity, but to build material cycles that are better defined, more controlled, and chemically cleaner from the outset.

Because the quality of tomorrow's secondary raw materials will be determined by the chemistry we place into the cycle today.

ORAL

Managing Agricultural Inputs to Improve Food Safety on Farms

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Agricultural production requires strategies that balance water sustainability with microbial food safety. Groundwater depletion, climate pressures, and population growth heighten the importance of alternative irrigation-water sources, including harvested rainwater, reclaimed wastewater, and surface water. Surface water is an important source for U.S. agricultural irrigation but contain foodborne pathogens that can contaminate fruits and vegetables if consumed raw. Use chemical sanitizers, filtration or emerging biological interventions can be important tools in improving surface water quality and making them suited for irrigation of fruits and vegetables. Similarly, reclaimed wastewater offers a comparatively consistent supply but can have high microbial quality following secondary or tertiary treatment, although its use presents infrastructure and monitoring challenges. This presentation examines the microbial quality of conventional and alternative agricultural waters and approaches for managing associated risks in the Mid-Atlantic region of the United States. While results focus on the U.S., these results could be instructive to other regions of the world when evaluating the food safety risks of different sources of irrigation water.

The microbial quality of conventional and alternative agricultural waters and approaches for managing associated risks. Twelve sites on the eastern and western shores of Maryland, representing rivers, agricultural ponds, reclaimed wastewater, and produce-wash water, were investigated over 24 months. *Salmonella* spp., *Listeria monocytogenes*, Shiga toxin-producing *Escherichia coli* (STEC), indicator organisms, enteric viruses, and antimicrobial-resistant organisms were evaluated. Non-pathogenic *E. coli* concentrations in reclaimed wastewater were similar to those measured in surface waters and were reported as compliant with the microbial guidelines and recommendations from several organizations (Leafy Greens Marketing Association, World Health Organization). These findings demonstrate the importance of considering both water source and sampling methodology when characterizing microbial hazards.

Differences in microbial hazards were observed among water sources. *Salmonella enterica* and *L. monocytogenes* concentrations were greater in surface waters than in reclaimed treated wastewater.

Salmonella levels were more influenced by recent rainfall events and *L. monocytogenes* levels greater in surface waters with colder temperatures.

Increasing the volume of water examined generally improved detection of these bacterial pathogens at several locations. Non-culture recovery based microbial methods were effective in recovery pathogens in some sources of water, but were not clearly better than culture-based / recovery methods.

Enteric viruses, including norovirus GII, hepatitis A virus, and Aichi virus, were detected more frequently in reclaimed wastewater than in surface water. Pepper mild mottle virus (PMMoV), a plant RNA virus present in human feces, was also detected more frequently in reclaimed-water samples than in surface water samples. PMMoV detection was significantly associated with enteric-virus detection in reclaimed wastewater. These results highlight limitations in relying exclusively on *E. coli* as an indicator of contamination of human pathogens and fecal contamination.

These studies demonstrate that alternative water sources can contribute to agricultural water sustainability, but microbial risks differ by source and organism.

Sustainable mitigation technologies can further improve agricultural-water quality. The use of chemical sanitizers can reduce levels of bacterial and viral pathogens in irrigation water that directly contacts fruits and vegetables. Combining adding zero-valent iron (ZVI) to sand filters reduced *E. coli* and other foodborne concentrations more effectively than sand filtration alone in trials, and may be appropriate for irrigation water applications where high flow rates are not required.

Effective irrigation water management when water availability is stressed requires risk-based assessment, appropriate microbial monitoring, and practical mitigation strategies. Longitudinal investigations can support decisions about when alternative water sources can be safely incorporated into agricultural production while protecting both food safety and increasingly constrained water resources.

ORAL

One Health at the Field Scale

Linking Water Quality, Wastewater Reuse and Food Safety in Central Asia

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Globally, water connects the health of people, animals, plants and ecosystems. It supports food production while carrying pollution between settlements, farms and downstream users. Water quality therefore provides a practical entry point for One Health and for understanding how conditions before harvest can influence food safety. This presentation examines these connections, considers their relevance to Central Asia and introduces ongoing methodological work in Tajikistan as an illustrative example.

Increasing pressure on freshwater resources is encouraging greater attention to wastewater reuse in agriculture. Reuse can provide water and nutrients, but its benefits depend on appropriate management. Inadequately treated wastewater may introduce pathogens and chemical contaminants into agricultural environments, creating potential exposure pathways for workers, communities and consumers. The relevance of each hazard depends on water quality, crop characteristics, irrigation practices and post-harvest handling. A One Health approach brings these considerations together while recognising the importance of ecosystem health and environmental flows.

Central Asia illustrates the interaction between water scarcity, intensive irrigation and water quality. Salinity, agricultural drainage, municipal wastewater and other discharges create overlapping pressures on rivers, groundwater and soils. Treatment capacity and monitoring coverage vary, while information on informal reuse and associated exposure remains incomplete. Salinity primarily affects irrigation suitability and agricultural productivity, whereas pathogens and certain chemical contaminants raise more direct food safety questions. Addressing these different pressures requires locally appropriate evidence rather than a single regional risk classification.

Antimicrobial resistance adds an emerging dimension. Human and animal wastes can carry antibiotic residues and resistant microorganisms into water and soil, potentially connecting wastewater management with agriculture and public health. However, residues, resistant bacteria, resistance genes and health outcomes are distinct endpoints. Establishing the links among them requires combined chemical and microbiological investigation. Water management can help identify and interrupt possible pathways, alongside responsible antimicrobial use and improvements in sanitation and treatment.

The presentation introduces an approach under development to connect available data, environmental modelling and targeted field investigation. It draws on HydroFATE, a published contaminant fate model developed by researchers at McGill University, which estimates river concentrations from domestic contaminant emissions and their subsequent transport. Such models can organise assumptions about wastewater pathways, dilution and contaminant losses, helping identify candidate

locations for monitoring. They cannot, on their own, determine food safety risks or replace direct environmental measurements.

Ongoing work in Tajikistan provides an example of how this approach might be applied. The pilot combines national antibiotic consumption data with population, sanitation, treatment facility and river network data to explore possible spatial patterns under different flow assumptions. The locally adapted methodology remains under development and has not been validated against local environmental measurements. Uncertainties in discharge locations, treatment performance and historical flow data limit interpretation. Illustrative outputs are presented to explain the workflow and its information needs, without drawing definitive conclusions about contamination, resistance transmission or food safety.

The proposed direction is to combine model-based screening with field confirmation of local sources and water uses, followed by sampling during contrasting flow conditions. Linking this evidence with crops, irrigation methods and exposure pathways can inform further assessment and the design of appropriate safeguards. The presentation concludes by considering how coordinated monitoring across water management, agriculture, veterinary services, food safety and public health can support safer reuse and more integrated One Health action in Central Asia.

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ORAL

Utilization of Protein Derived from Tomato Processing Byproducts in the Food Industry Using a Circular Economy Approach: Applications in Prepared Meals

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Incorporating tomato pomace (pulp and seeds)—the most significant byproduct of industrial tomato processing—and tomato leaves, which are classified as agricultural waste, into circular food systems is of strategic importance for ensuring a sustainable food supply, reducing the environmental footprint, and enhancing industrial efficiency. To produce pilot-scale functional proteins from these agro-industrial sources, innovative extraction and physical/biological pretreatments were investigated alongside their techno-functional potential in food formulations.

As part of the methodology, conventional alkaline extraction and isoelectric precipitation (pH 11 alkaline conditions, pH 3.9 isoelectric point, and a 1:10 solid-to-solvent ratio) were selected as the reference methods to optimize protein extraction efficiency. Tomato pomace is an abundant by-product of the tomato processing industry and represents a promising source of plant-based protein for sustainable food systems. In this study, proteins were extracted from tomato pomace using conventional alkaline extraction, microwave-assisted alkaline extraction, and ultrasound-assisted alkaline extraction, and the methods were compared in terms of protein content, recovery yield, functional properties, structural characteristics, and amino acid composition. The total protein contents of the protein extracts obtained were verified using the Kjeldahl method; to predict their technological performance in food matrices such as ready-to-eat meals and sauces, parameters including Oil-Holding Capacity, foaming ability/stability, and colour (L*, a*, b*) were characterized. Protein content (%) and protein recovery yield (%) of tomato pomace proteins extracted using CAE (conventional alkaline extraction) are 44,46% and 28,20% respectively. For MWAE (microwave-assisted extraction) we have 45,12% and 36,31% respectively. And for USAE (ultrasound-assisted extraction) they are 42,61% and 31,8% respectively.

The analysis results showed that the different pretreatment and extraction parameters applied caused significant variations in the degree of protein denaturation, oxidation levels, and interactions with non-protein components, thereby directly affecting the techno-functional and visual properties. These structural advantages (strong fat-binding and foam stability) enable these proteins to function as natural stabilizers preventing phase separation, and texturizers reducing cooking losses while

preserving texture. For tomato soup applications, this study will examine how the hydrophobic/hydrophilic balance of the proteins incorporated into the system effectively prevents serum separation (syneresis) that may occur during storage, optimizes the product's viscosity to provide a smooth mouthfeel, and enriches the nutritional protein profile. In future studies, we are conducting process optimizations for bleaching to improve solubility, amino acid composition, FTIR structural characterization, and product colour, with the aim of enhancing the final sensory adaptation of proteins in soup and ready meals matrices.

In conclusion, the production of value-added functional proteins from tomato processing byproducts and leaves is expected to provide sustainable ingredients that align with the "clean label" trend in the food industry, while also directly contributing to zero-waste production by addressing agro-industrial waste management in accordance with the principles of the circular economy. The finished tomato soup product is a commercial one which is enriched with vegetative source of protein replacing industrial modified starch as a binder. It has nutritional benefits with long shelf life where minimum thermal processing criteria applied for food safety and product quality. This study is conducted within the framework of the international PROXIMED project.

In addition to developing products with clean ingredients, protein-enriched formulations, or those that can be marketed as high-protein, the study aims to investigate changes—such as protein denaturation and syneresis (serum separation)—that may occur in products following thermal processing in industrial production. Monitoring the binding capacity of these proteins is a critical limiting factor for commercialization regarding regulatory compliance, allergen risks, and food safety. Product development trials are ongoing focused on protein powder dissolving, dispersion rate, colour intensity, taste and texture.

In the context of food safety and risk assessments, the detection of specific allergens in tomato pulp protein extracts necessitates mandatory labeling and strict monitoring requirements for the developed ready-to-eat meal and soup formulations.

ORAL

Gıda Dolum Makinalarının Hijyenik Tasarımı

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Bu kılavuz, makine ve gıda üreticilerinin düşük ve yüksek viskoziteli sıvı gıda dolum makinelerinin hijyenik tasarım gereklilikleri hakkında ortak bir anlayış geliştirmelerine katkı sunmayı amaçlamaktadır. Gıda işleme sistemlerinin hijyenik tasarımı, ürün kalitesi ve gıda güvenliğinin sürdürülebilirliği açısından kritik öneme sahiptir. Hijyenik tasarım, gıda ile temas eden ve etmeyen tüm gıda işleme ekipmanlarını odağına almakla birlikte özünde bütüncül bir hijyenik kalite felsefesini içermektedir. Bu yaklaşım, gıda üretimi gerçekleştirilen binanın tasarımı, işletme içi hijyenik zonlama, proses ekipmanlarının seçimi ve proses hatları arası entegrasyon, temizlik ve sanitasyon başta olmak üzere birçok noktanın hijyenik gereklilikler ekseninde buluştuğu bir ortak paydayı kapsamaktadır. Gıda işlemede kullanılan bir kısım ekipmanın hijyenik tasarım ilkelerine uygunluğuna ilişkin test, onay ve sertifikasyon süreçleri mevcuttur. Bununla birlikte, bir gıda işleme tesisine ve/veya bir üretim/dolum hattına hijyenik tasarım onayı verilmesi söz konusu değildir. Dolayısıyla, bir gıdanın kalite ve gıda güvenliği hedeflerine sahip olması gıda ve gıda proses makinası üreticisi firmaların bütüncül bir hijyenik tasarım felsefesini içselleştirmesini gerekli kılmaktadır. Sıvı gıda dolum makinelerinin hijyenik tasarım gereklilikleri; dolumu gerçekleştirilen gıdanın kimyasal, fizikokimyasal ve mikrobiyolojik özellikleri, ürünün hedeflenmiş raf ömrü, temizlik/dezenfeksiyon/sterilizasyon koşulları ve gıda güvenliğinin temel ilkeleri tarafından belirlenmektedir.

Steril olmayan sıvı gıdaların dolumunda kullanılan makinelerin (Standart, Temiz ve Ultra Temiz dolum makineleri) sınıflandırılması ve tanımlanmasında bir bütünlük bulunmadığı gibi dolum makinelerinin tasarımları ve dolayısıyla hijyenik yeterlilikleri de belirgin farklılıklar gösterebilmektedir. Aseptik dolum makineleri konusunda ise küresel ölçekte bir tanım ve anlayış birliğinden söz edilebilmektedir. Aseptik dolum makineleri ağırlıklı olarak raf ömrü uzun ürünler (UHT süt, UHT meyve suyu, ortam sıcaklığında depolanan/pazarlanan sıvı gıdalar vb.) ile spesifik tüketici gruplarına yönelik ürünlerin (enteral beslenme ürünleri, özel amaçlı beslenme ürünleri vb.) dolumunda kullanıldığından mikrobiyolojik açıdan "*sıfır tolerans*" prensibine göre tasarlanmaktadır. Aseptik dolum makinelerinin tasarımı *de facto* yasal regülasyonlarca yönetilmektedir.

Bu kılavuz, dolum makinesi üreticileri ile son kullanıcılar arasında hijyenik tasarım ekseninde ortak bir anlayışın geliştirilmesine katkı sunmayı hedeflemektedir.

ORAL

Cleaning-in-Place (CIP) in Food Processing Plants: Validation and Cost Optimization

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Cleaning-in-place (CIP) is a core hygiene operation in food processing plants, yet it is often managed as a routine step with fixed durations. In practice, CIP simultaneously determines food safety, cleaning performance, production time, water, energy and chemical consumption, and wastewater load; in the dairy industry it may occupy up to 10–20% of production time. Optimization attempted without a validated reference point, however, risks compromising hygiene. This presentation addresses how CIP can be validated first and then optimized systematically. Validation ("Is what I am doing correct?") is distinguished from verification ("Am I doing what I claim to do?"), and a DQ–IQ–OQ–PQ qualification model, in line with EHEDG Guideline 50, is outlined. It covers hygienic design, installation conformity, operational control of temperature, flow, pressure, chemical concentration and time, and performance proof against predefined acceptance criteria using residue, ATP, protein and microbiological tests at risk-based sampling points. Each of the 4T parameters (time, temperature, turbulence, titration) has both a cleaning effect and a cost counterpart (downtime, steam/energy, pump energy, chemical consumption); therefore, optimization cannot be single-parameter. Demonstrating removal under worst-case conditions, i.e. the most viscous, particulate, fat/protein-rich, allergenic or microbiologically risky products combined with the lowest temperature, concentration and flow and the longest holding time, creates a safety margin for normal operation. A shift from time-based to result-based CIP, in which sensor signals such as conductivity end a phase once the acceptance criterion is reached, is discussed. In published examples, sensor-supported phase management in a UHT heat exchanger reduced CIP duration from 142 to 66 min and waste liquid from 8,300 to 4,400 L (Alvarez et al., 2010), and a modelled dairy CIP water network combining reverse osmosis and reuse indicated potential reductions of 33% in fresh water and 85% in wastewater. These results are plant-specific, and since conductivity alone cannot prove organic or microbiological cleanliness, sensor signals must be validated. Six strategic areas for cost optimization are presented: product recovery, pre-rinse optimization, chemical concentration control, flow, temperature and phase termination with a measurable endpoint, tracked through a KPI panel covering hygiene and quality, operation, resource use and economics. Finally, biofilms, which protect cells within an EPS matrix, resist chemicals and cause recontamination, are highlighted as a hidden threat

to be managed before they form. In conclusion, the best CIP is not the shortest one, but the one that sustainably delivers the required hygiene result at the lowest total cost: validate, measure, then optimize.

ORAL

Enzymatic Cleaning and Biofilm Control in the Food Industry

Ece Culum

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Biofilms are complex structures formed when microorganisms such as bacteria, yeasts, and molds attach to surfaces and proliferate within a protective matrix composed of extracellular polymeric substances (EPS). In food manufacturing facilities, biofilm formation can significantly affect product safety, production efficiency, equipment lifespan, and operational costs while also increasing the risk of foodborne illnesses. Microorganisms embedded within biofilms exhibit considerably greater resistance to cleaning and disinfection procedures compared to their planktonic counterparts. Therefore, understanding and effectively controlling biofilm formation has become a critical component of modern food safety management systems. This study evaluates the mechanisms of biofilm formation, key microorganisms encountered in the food industry, conventional and innovative biofilm control strategies, and the effectiveness of enzymatic cleaning.

Biofilm development occurs through three main stages: initial microbial attachment to a surface, development of the EPS matrix, and maturation of the biofilm structure. During this process, microorganisms coordinate their behavior through a cellular communication mechanism known as quorum sensing, which allows them to detect population density and regulate biofilm formation, virulence factor production, and adaptation to environmental conditions. Biofilms provide protection against disinfectants, desiccation, ultraviolet radiation, acidic conditions, and other environmental stresses. Studies have shown that microorganisms within biofilms can be hundreds or even thousands of times more resistant to certain disinfectants than free-floating cells.

The principal microorganisms associated with biofilm formation in food processing environments include Listeria monocytogenes, Salmonella spp., Escherichia coli, Staphylococcus aureus, Bacillus cereus, and particularly Pseudomonas aeruginosa, which is commonly found in water systems. These microorganisms can establish persistent reservoirs in drainage systems, conveyor lines, filters, CIP systems, cold storage areas, and other hard-to-clean locations within processing facilities. Among them, Listeria monocytogenes and Pseudomonas species are considered especially critical due to their strong biofilm-forming capabilities.

The primary approach to biofilm management involves both prevention and effective removal of established biofilms. Hygienic equipment design, appropriate CIP and OPC programs, regular acid cleaning, water quality management, and microbiological monitoring all play important roles in preventing biofilm development. However, mature biofilms cannot always be completely eliminated through conventional chemical cleaning alone. As a result, enzymatic cleaning technologies and quorum quenching approaches have gained increasing attention in recent years. Quorum quenching is an innovative strategy that disrupts bacterial communication systems, thereby inhibiting biofilm formation and reducing the expression of virulence factors.

Enzymatic biofilm cleaning works by degrading the protective EPS matrix, improving the penetration of cleaning chemicals and disinfectants into the biofilm structure. Subsequent disinfection procedures can then effectively eliminate the released microorganisms. Application results presented in this study demonstrated a reduction in total microbial load exceeding 99.9999% following a biofilm removal program, restoring hygienic conditions within the system. In conclusion, successful biofilm control requires a continuous process encompassing prevention, detection, and removal. An integrated approach combining hygienic design, effective cleaning programs, enzymatic treatments, and robust disinfection strategies is essential for ensuring food safety and operational sustainability.

ORAL

Microbial Adhesion to Commonly Used Kitchen Surfaces

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The aim of this study was to analyze the adhesion of different bacterial strengths to commonly used kitchen surfaces and worktop materials. The studay was made with four different bacterial strengths: *Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa* and *L. monocytogenes.* The study was performed on Stainless steel surfaces, glass surfaces, silicone, aluminum, textile and Teflon surfaces. The surfaces were characterized by measuring the roughness of the surface, contact angle and streaming potential. The bacterial adhesion extent was determined from Scanning electron microscopy and staining technique. Finally, new surface coatings like polyelectrolyte multilayers, were proposed to decrease the bacterial adhesion.

The surface roughness was measured by Atomic Force Microscopy and profilometry. The hydrophobicity was measured by tensiometer whereas the streaming potential was measured by kinetic analyzer technique. Similarly, the charge and hydrophobicity of bacteria were measured. The bacterial charge was determined by particle charge detector whereas the hydrophobicity was determined by measuring the advancing and receding contact angles between the droplet and layer of bacteria. From this data the surface energy was determined. The bacterial adhesion extent was determined from SEM micrographs and staining techniques.

We also considered the impact of temperature on bacterial adhesion. The incubation conditions were 22 ^{0}C (room temperature), 37 ^{0}C (body-physical temperature) for 24 and 48 h or 4 ^{0}C (refrigerator temperature) for 192 h. After incubation, the bacterial adhesion extent on the Stainless-steel surfaces was quantified using the crystal violet staining assay.

The results indicate that surface roughness significantly impacts bacterial adhesion; decreasing surface roughness leads to reduced bacterial adhesion. The greater adhesion of bacteria on rough surfaces results from the combination of an increased effective surface area and a higher number of surface defects. In addition there is also an interplay of roughness with the hydrophobicity and surface charge While various parameters affect biofouling, the most promising control measure identified in this study is the influence of low temperatures, which reduces biofouling. These findings could

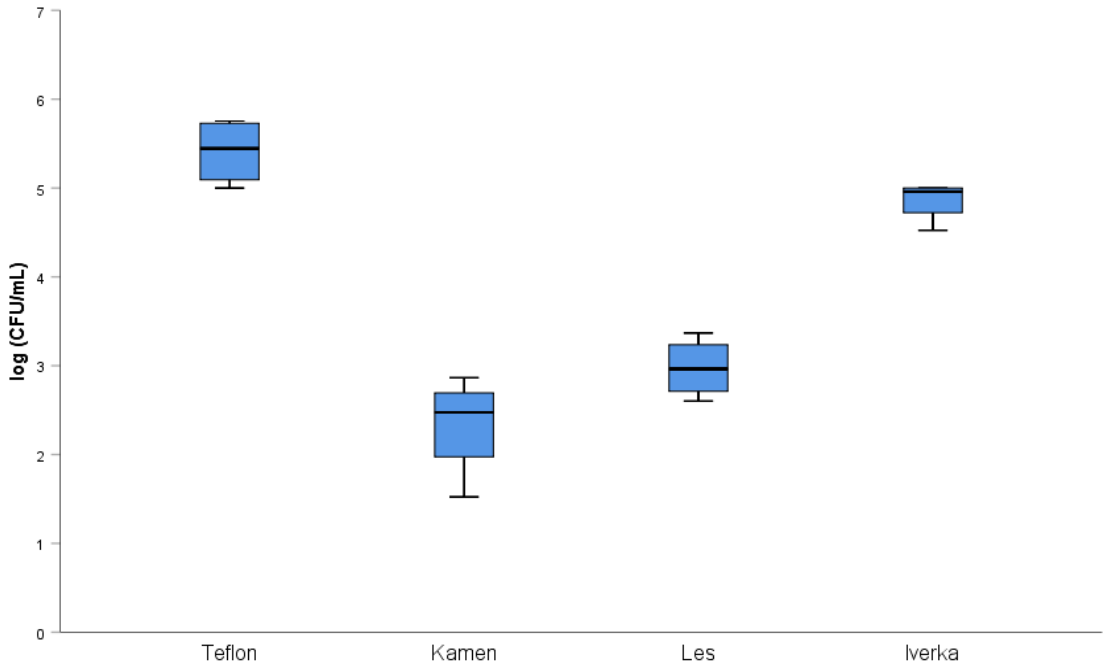
greatly aid in preventing surface contamination and subsequent biofouling by pathogens associated with food and healthcare [1-3].

Results show that among Stainless Steel surfaces the highest bacterial adhesion is obtained for grinded surfaces (bacterial adhesion rate is 1.3±0.2). The lowest bacterial adhesion was obtained for 3D polished surfaces (0.4±0.05). The results follow the roughness with grinded surfaces with the roughness 1 μm and the roughness of 3D surfaces 20 nm. The roughness and the corresponding bacterial adhesion for brushed and electropolished surfaces lies inbetween these two extreme types of surfaces [4].

The surface finishing of kitchen relevant surfaces should follow conditions of the lowest bacterial adhesion. In future the natural nanocoating of surfaces should be developed to decrease the bacterial adhesion to even bigger extent.

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Teflon in iverka ni razlike

Kamen in les ni razlike

	Teflon	granite	beech wood	chipboard
R_a/µm	0.36 ± 0.03	0.04 ± 0.004	2.34 ± 0.32	0.21 ± 0.01
R_q/µm	0.44 ± 0.04	0.08 ± 0.0005	2.90 ± 0.37	0.28 ± 0.02
Contact angle (°)	97.96 ±	53.57 ± 2.01	77.71 ± 8.0	65.1 ± 3.71

ORAL

Two Dimensions of Food: Assessment from Nutri-Score to NOVA

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The evaluation of foods is becoming increasingly multidimensional, reflecting growing interest in how nutritional composition, processing, formulation, and consumption patterns relate to health. As different classification and labeling approaches gain prominence, understanding the dimensions they assess, their underlying principles, and their potential complementarity has become increasingly important. Among the most widely discussed approaches are Nutri-Score and NOVA, which evaluate foods from two distinct perspectives: nutritional profile and the nature, extent, and purpose of processing. Nutri-Score is a front-of-pack nutrition labeling system that summarizes selected aspects of the nutritional profile of foods through a graded, color- and letter-coded classification. Its algorithm considers components such as energy, sugars, saturated fat, and salt together with other nutritional characteristics, including fiber and protein. By translating nutritional information into an easily interpretable classification, Nutri-Score aims to facilitate comparison between products and support consumers in interpreting their nutritional characteristics. From a broader food-system perspective, nutrient profiling may also provide useful reference points for product development, reformulation, consumer communication, and nutrition policy. NOVA approaches food assessment from a different perspective. Rather than focusing primarily on nutrient composition, it classifies foods according to the nature, extent, and purpose of industrial processing. The system distinguishes four groups: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods. Growing scientific interest in ultra-processed foods has broadened the discussion beyond nutrient composition, drawing attention to formulation, food structure, technological processes, ingredient combinations, and patterns of consumption. Nutri-Score and NOVA therefore capture different dimensions of food assessment and may provide complementary information. Foods with similar nutrient profiles may differ substantially in their degree and purpose of processing, while foods within the same processing category may vary considerably in nutritional composition. Consequently, a product may receive a relatively favorable nutrient-based assessment while being classified as ultra-processed, whereas a lower degree of processing does not necessarily correspond to a favorable nutritional profile. Such apparent discrepancies do not necessarily indicate inconsistency between the systems but rather reflect the different characteristics they are designed to

evaluate. This presentation provides a scientific overview of Nutri-Score and NOVA, focusing on their underlying principles, scope, practical applications, and the types of information they provide. Particular attention is given to the relationship between nutritional composition and food processing and to factors that may influence their interpretation, including food matrix, technological function, portion size, consumption frequency, dietary pattern, and cultural context. Considering nutrient profiling and processing-based classification together may offer a broader framework for discussing food quality without reducing food assessment to a single dimension. Such an approach may contribute to clearer scientific communication and a more informed interpretation of food classification systems in the broader context of food quality, safety, nutrition, and public health.

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Ensuring preparedness: EFSA Emerging Risk Identification and Horizon Scanning

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The European Food Safety Authority (EFSA) plays a key role in the early identification and characterisation of emerging risks affecting food and feed safety, animal health and plant health, in line with Articles 23 and 34 of Regulation (EC) No 178/2002.[1] This work is supported by a broad network of partners, including the Emerging Risks Exchange Network (EREN), which brings together Member States, EU agencies and international organisations,[2] as well as the Stakeholder Discussion Group on Emerging Risks (StaDG-ER),[3] ensuring a collaborative and multidisciplinary approach to horizon scanning and emerging risk identification.

Since 2022 and in line with EFSA's priorities[4,5] the Authority has strengthened its anticipatory capacity of future risks and assessment challenges through foresight and horizon-scanning methodologies. Key priorities include the scanning of novel products and technologies and the identification of assessment needs for them, the integration of new evidence streams and the elaboration of multiple-hazard scenarios.

To support these objectives, EFSA has invested in One Health collaboration, innovative methodologies, AI-enabled foresight tools and digital infrastructures. They strengthen knowledge sharing, data integration and collaborative analysis across Europe, presenting resulting findings and activities in annual reports.[7,8] Initiatives such as the Emerging Risk Analysis Platform (ERAP), the FoodSafeR Open Digital Hub[6] and the cross-agency Early Warning and Action System for Emerging Chemicals enhance the detection and assessment of emerging issues and facilitate coordinated responses. Together, these efforts reinforce EFSA's ability to identify signals at an earlier stage, strengthen preparedness and support evidence-based decision-making to protect consumers, animals, plants and the food system as a whole.

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Potential Effects of Biostimulant and Enzyme-Based Biocontrol Applications in Pest Management on Food Safety: A Regenerative Approach in the Era of Climate Change

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Climate change intensifies biotic and abiotic stress simultaneously, while single-target insecticides drive resistance, higher doses and residues. We hypothesised that an enzyme-based contact biocontrol combined with microbial biostimulants, within a regenerative framework, maintains pest control and yield while eliminating residues and improving plant nutrition and soil health.

The model places three layers under a biostimulant umbrella: biotic stress (CORENZA; chitinase EC 3.2.1.14 and subtilisin protease EC 3.4.21.62; water-soluble powder, 1000 U/g, 50 g per 500 L), abiotic stress (KIANA CLIMATE PLUS) and biodiversity (KIANA EARTH PLUS), continuing into regenerative agriculture measured by a 56-parameter Soil Health Index (8 physical, 24 chemical, 14 enzymatic, 4 FAME) and an integrated regenerative score (0.40 soil, 0.20 management, 0.20 plant, 0.10 product, 0.10 water). A split-greenhouse trial in tomato, pepper and eggplant compared a conventional chemical programme (label doses, IRAC rotation) with CORENZA applied at first detection and every 5–10 days, under identical climate, irrigation and fertigation, in four randomised blocks per crop. Pest counts were converted to Henderson–Tilton efficacy. Marketable yield, fruit quality (°Brix, vitamin C, firmness, dry matter, phenolics) and leaf and fruit macro- and micronutrients were analysed by ANOVA and Tukey HSD ($p < 0.05$) with ±10% equivalence testing. Residues were screened by QuEChERS LC-MS/MS (SANTE/11312/2021, LOQ 0.01 mg/kg) and bee toxicity by OECD 214. Regenerative scores were obtained from sugar beet fields in Kayseri (control, lentil cover crop, microbial biostimulant) within a retail supply-chain programme.

In tomato, efficacy of the chemical programme versus CORENZA was 94/89% for Tuta absoluta, 93/88% for whitefly, 93/86% for spider mite, 92/83% for aphid and 88/79% for thrips (means 92% and 85%), with 16–20 versus 5–6 applications. Marketable yield was 16.4 and 15.6 kg/m² (Tukey a, a) against 9.0 kg/m² in the untreated control (b). Fruit from the chemical half carried seven active substances totalling about 660 µg/kg, whereas the CORENZA half was below LOQ; a 660-substance screen found no residue and corrected bee mortality was 0.0%. In pepper, mean efficacy was 93% versus 85% and yield 9.6 versus 10.1 kg/m² ($p = 0.22$); in eggplant 92% versus 85% and 13.1 versus 12.4 kg/m² ($p = 0.31$), both within the equivalence margin. Leaf and fruit nutrient concentrations were 1–25% higher in the CORENZA halves, significantly so for P, K, Fe and Zn, and fruit quality

improved (pepper °Brix 6.2 to 6.8 and vitamin C 123 to 142 mg/100 g; eggplant °Brix 4.0 to 4.7), consistent with published evidence that insecticide and fungicide loads depress leaf photosynthesis by 7–54%. Field observations in rocket (Muğla) confirmed contact mortality of spider mites and armyworm larvae after a single application, and a joint cost study with a national retailer showed 10–12 chemical products and 17–21 sprays replaced by one product and 7 applications, cutting season costs by 52% across five crops. In the regenerative layer, the integrated score rose from 40.8% in the control to 66.4% with the cover crop and 80.4% with the microbial biostimulant, with FAME microbial biomass up 95%; a Soil Health Index trajectory of 46 to 76 over three years moves fields from the Transition to the Advanced certification level, with modelled savings of 2.6–4.9 t CO_2e and 850–1,350 m^3 of water per hectare per year.

The biological model serves both pillars of food safety: sufficient food through maintained yield and safe food through eliminated residues, while restoring plant nutrition and soil health. It depends on application quality, a clear regulatory line between biostimulant and plant-protection claims, contaminant control and independent, replicated data.

ORAL

Food Spoilage Organisms and Why They Concern Everyone

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Food microbiology traditionally focuses on pathogenic microorganisms because of their direct implications for public health. However, spoilage microorganisms represent an equally important challenge for the food industry due to their significant impact on product quality, shelf life, sustainability, and consumer confidence. Unlike pathogens, spoilage organisms do not necessarily cause disease but induce undesirable organoleptic changes, including off-flavors, off-odors, texture defects, discoloration, gas formation, package swelling, sedimentation, and visible microbial growth, rendering products unacceptable for consumption. Their impact is often underestimated despite substantial economic and reputational consequences throughout the food supply chain.

Food spoilage results from a broad diversity of microorganisms, including bacteria, yeasts, molds, and heat-resistant fungi. Common bacterial spoilers include Pseudomonas, *Brochothrix thermosphacta, Bacillus, Clostridium*, and lactic acid bacteria. Yeasts such as *Saccharomyces, Zygosaccharomyces, Candida*, and *Brettanomyces* contribute also significantly to spoilage of foods. Molds including *Penicillium, Aspergillus,* and *Rhizopus*, together with heat-resistant fungi such as *Byssochlamys* and *Talaromyces,* present persistent challenges even in processed products that have undergone thermal treatments.

The mechanisms of spoilage are diverse and often interconnected. Microbial metabolism can cause enzymatic degradation of proteins, lipids, and carbohydrates, leading to changes in texture and flavor. Gas production can result in swollen or burst packaging, while microbial growth may generate turbidity, sediment, discoloration, or visible contamination. In addition, spoilage organisms frequently survive within food manufacturing environments through biofilm formation and resistance mechanisms, creating persistent sources of contamination.

The spoilage ecosystem varies considerably across food categories. Refrigerated meat products are predominantly affected by psychrotrophic bacteria such as *Pseudomonas* and *Brochothrix thermosphacta*. Processed foods are vulnerable to spore-forming organisms that survive pasteurization. Acidic beverages and fruit products are often challenged by acid-tolerant yeasts, molds, and *Alicyclobacillus*, whereas bakery products are frequently spoiled by molds and

osmotolerant yeasts. These differences highlight the need for product-specific spoilage investigations and targeted control strategies.

Case studies presented in this work illustrate the increasing complexity of spoilage events. Investigations in beverages, meat products, and vegetables revealed both expected and unusual spoilage organisms, including *Aureobasidium pullulans, Bacillus subtilis*, and the psychrophilic yeast *Mrakia*. These examples demonstrate that food manufacturers must be prepared not only for known contaminants but also for emerging and previously overlooked microorganisms.

Advances in metagenomics and next-generation sequencing (NGS) are transforming spoilage risk assessment and root-cause investigations. Comprehensive sampling strategies encompassing water systems, raw materials, production environments, packaging, and finished products enable microbiome characterization and source tracking. Coupled with bioinformatic analyses, these tools support a proactive "Spot, Act, Prevent" approach that enhances contamination control and prevents future incidents.

Recent spoilage-related recalls across dairy, beverage, bakery, and prepared food sectors further demonstrate the operational and reputational consequences of inadequate spoilage management. In an era of instant social media exposure, a single spoiled product can rapidly escalate into a significant brand crisis.

In conclusion, spoilage microorganisms are silent yet powerful drivers of food waste and economic losses. Effective control requires a shift from focusing on individual microorganisms to understanding the broader food microbiome and its ecological interactions. Integrating traditional microbiology with advanced molecular tools will be essential for extending shelf life, reducing waste, improving sustainability, and maintaining consumer trust in increasingly complex food supply chains.

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The One Health Approach in Food System Transformation: Implications for Food Safety Governance

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Food systems are essential for food security, economic development, and public well-being; however, they are also associated with significant biological, chemical, and environmental risks affecting human, animal, plant, and ecosystem health. Population growth, climate change, agricultural intensification, globalization, and unsustainable consumption patterns continue to increase pressure on food systems and contribute to emerging food safety challenges worldwide.

Modern food systems are increasingly associated with zoonotic disease emergence, antimicrobial resistance (AMR), chemical contamination, environmental degradation, and unhealthy dietary patterns. Traditional food safety systems have mainly focused on sector-specific and end-product control approaches, often failing to address interactions between agriculture, environmental contamination, animal health, and public health. Consequently, fragmented governance structures limit the effectiveness of preventive food safety strategies.

The One Health approach has emerged as an integrative framework recognizing the interdependence between human, animal, plant, and environmental health. Within food system transformation, One Health provides a systems-oriented framework for improving food safety governance through interdisciplinary collaboration, integrated surveillance, coordinated risk assessment, and preventive interventions across the food chain.

Current transformation agendas increasingly emphasize sustainable agriculture, climate-smart production systems, reduced antimicrobial use, circular food systems, digital traceability, and healthier diets. Integration of One Health principles into these processes may strengthen food system resilience while improving food safety outcomes and environmental sustainability. This compilation contributes to food safety by repositioning food safety governance from a reactive hazard-control model toward a preventive systems-based approach. One Health supports earlier identification of biological and chemical risks, improves multisectoral coordination, and contributes to resilient food systems capable of ensuring equitable access to safe food. Furthermore, it strengthens preparedness against emerging foodborne and zoonotic threats while supporting sustainable food production practices.

Overall, the literature indicates that effective food system transformation cannot be achieved without integrating One Health principles into food safety governance, policy development, and surveillance systems at local, national, and global levels.

Areas on Compilation Related to Food Safety and Not Yet Sufficiently Researched

- Operational indicators for measuring One Health implementation within food safety systems remain insufficiently developed.
- Limited evidence exists regarding integration of environmental monitoring into routine food safety surveillance systems.
- The relationship between climate change, food system transformation, and emerging foodborne hazards requires further interdisciplinary investigation.
- Research gaps remain regarding governance models integrating agricultural, veterinary, environmental, and public health sectors.

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ORAL

Development of Screening Methods and Reference Materials for Contaminants in Food and Recycled Packaging

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To ensure a high level of food safety throughout production and distribution, the development of analytical measurement techniques for the determination of contaminant levels and their harmonized implementation across laboratories are of great importance. Obtaining reliable data regarding the compliance of food products with regulations provides a fundamental basis for resolving disputes within the food industry and minimizing economic losses. In this context, the "23IND13 ScreenFood" project, jointly carried out by TÜBİTAK UME together with 27 partner organizations from 12 European countries, places particular emphasis on recycled materials and aims to develop reference methods and reference materials for the determination of contaminants in both food and food packaging.

The objectives of the project include:

i. The development of protocols for the quantification of mineral oil aromatic hydrocarbon fractions and fractions consisting of substances containing three or more aromatic ring systems (3+MOAH);

ii. The development of sensitive analytical methods for the detection and quantification of per- and polyfluoroalkyl substances (PFAS) in selected matrices, in line with the requirements of Commission Regulation (EU) 2023/915;

iii. The development of highly accurate and traceable reference materials for quality control and quality assurance purposes. These materials will be designed for major contaminants such as MOSH, MOAH, and PFAS in relevant food and food-related matrices, including vegetable oils, infant food, vegetables, and food packaging materials;

iv. The development of screening methods addressing emerging and existing organic and inorganic contaminants in virgin and recycled packaging materials, such as bio-based food contact materials and reusable materials, as well as the implementation of migration studies.

Within the project, TÜBİTAK UME will undertake responsibilities including the production of two candidate reference materials for PFAS, tomato and infant food, the development of a robust,

accurate, and validated analytical method for the quantification of PFAS to be used during the characterization stage, and the organization of an interlaboratory comparison study among project partners and external participating laboratories.

ORAL

Innovative Packaging Films Based on Pea Pod Protein and Agar Enriched with Fruit By-Product Extracts

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Biodegradable packaging systems are developing as alternatives to petroleum-based packaging materials. In order to obtain an enhanced film from a food safety perspective, bioactive materials can be incorporated into these matrices. In this study, different fruit by-product extracts were included into pea protein and agar films to improve film properties.

Pea pod protein and agar-based films were fabricated via the solvent casting method. The control formulation contained 0.15% (w/v) pea pod protein and 0.85% (w/v) agar. The treatment groups were enriched with either 0.5% (w/v) apple pomace or grape pomace extract, or 5% (v/v) pomegranate peel extract. Afterwards, the obtained biodegradable films were characterized in terms of thickness, color, moisture content, swelling degree, transmittance, and antimicrobial analyses. Film thickness was measured using a digital micrometer. Color measurements were carried out using a chroma meter. Transmittance was measured with a spectrophotometer. Antimicrobial analyses were carried out using disc diffusion method. Each analysis was conducted in triplicate and two experimental replicates, and the results were expressed as means ± standard deviation. In order to determine statistical significance ($p < 0.05$), one-way analysis of variance (ANOVA) test was conducted.

All film groups were successfully fabricated, and the addition of extracts significantly altered their properties compared to the control. Film thickness ranged between 0.051 and 0.077 mm, while the incorporation of all extracts markedly reduced moisture content (with the lowest at 9.99% for apple) and water absorption capacity. Specifically, the swelling degree in distilled water dropped from 1935.42% (control) to as low as 913.78% (pomegranate), with a similar decreasing trend observed in the NaCl medium. Color and transmittance analyses revealed that pomegranate films exhibited the highest yellowness (b*), whereas grape pomace films, due to intense natural pigmentation, displayed decreased lightness (L*), increased redness (a*), and the lowest light transmittance (0.35%). Finally, antimicrobial assays showed that the grape pomace film had the highest activity against *Escherichia coli*, while the pomegranate peel extract film excelled against *Staphylococcus aureus.*

Evaluating these biodegradable films offers a sustainable alternative to synthetic packaging, reducing environmental impact. Characterization revealed that extract properties directly influence film structures; while the high sugar content of apple extract modifies the matrix, the intense pigmentation

of grape extract primarily decreases transmittance, demonstrating their customizability for active food packaging. The high antibacterial activities of pomegranate pomace extract and grape pomace extract films can be attributed to their high concentrations of bioactive phenolic compounds, including tannins, flavonoids, and phenolic acids, which are known to disrupt microbial cell membranes, interfere with cellular metabolism, and inhibit the growth of a broad range of pathogenic bacteria.

ORAL

Postbiotics: Innovative Biopreservation Approaches in Clean Label Food Systems

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In recent years, increasing consumer demand for natural, minimally processed, and additive-reduced foods has made the "clean label" concept one of the major research areas in the food industry. Within this context, studies focusing on natural biopreservation strategies as alternatives to synthetic preservatives have gained considerable attention, particularly those involving lactic acid bacteria and their bioactive metabolites. Probiotics, which have long been utilized in functional food applications, are important not only because of their health-promoting effects but also due to their technological and bioprotective functions in fermented food systems. During fermentation, probiotic microorganisms produce organic acids, hydrogen peroxide, diacetyl, reuterin, bacteriocins, and various antimicrobial metabolites that can inhibit the growth of pathogenic and spoilage microorganisms, thereby contributing to product safety and shelf-life extension. Furthermore, they play significant roles in aroma formation, texture development, exopolysaccharide production, viscosity enhancement, and water-holding capacity. However, maintaining the viability of probiotic microorganisms within food matrices remains challenging because they are highly affected by processing conditions, storage, oxidative stress, and low pH environments.

In this regard, the concept of "postbiotics," encompassing non-viable microorganisms and their metabolites, has recently emerged as a promising alternative. According to the International Scientific Association for Probiotics and Prebiotics (ISAPP), postbiotics are defined as "preparations of inanimate microorganisms and/or their components that confer a health benefit on the host." Current perspectives indicate that postbiotics include inactivated microbial cells, cell wall components, peptidoglycans, teichoic acids, exopolysaccharides, short-chain fatty acids, organic acids, bacteriocins, enzymes, and various bioactive peptides. Therefore, their biological activity is associated not only with microbial metabolites but also with structural microbial components.

Postbiotics have attracted considerable attention due to their antimicrobial, antioxidant, anti-inflammatory, and immunomodulatory properties, as well as their technological advantages in food systems. The use of postbiotic compounds such as organic acids and bacteriocins for biopreservation may suppress pathogenic and spoilage microorganisms, improve food safety, and extend shelf life.

In addition, their non-viable nature provides enhanced process resistance and storage stability, making them highly attractive for clean label product development.

Several studies have reported that certain postbiotic fractions positively influence viscosity development, syneresis control, emulsification properties, water-holding capacity, and mouthfeel in fermented dairy products. In particular, exopolysaccharide-containing postbiotic components may function as texture enhancers and fat replacers in low-fat systems while improving product stability, textural characteristics, and sensory quality. Consequently, postbiotics represent promising natural stabilizing and bioprotective agents in addition to their functional properties.

Nevertheless, the standardization of postbiotics, clarification of their mechanisms of action, and evaluation of their stability in different food matrices remain important research challenges. Moreover, the microbial strain, fermentation conditions, inactivation method, and production process directly influence the composition and biological activity of the resulting postbiotic fractions. Overall, postbiotics are considered next-generation biological ingredients with strong potential to support clean label approaches through their natural bioprotective properties, high process stability, and multifunctional characteristics.

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Biomarker-Based Evaluation of Oxidative Stress, Inflammation, and Intestinal Barrier Integrity in Broilers Supplemented with *Saccharomyces boulardii*

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The global restriction of antibiotic growth promoters necessitates effective alternatives to maintain poultry productivity. Dietary *Saccharomyces boulardii* supplementation is hypothesized to enhance broiler performance by establishing intestinal homeostasis through optimized oxidative balance, attenuated systemic inflammation, and reinforced barrier integrity, thereby supporting sustainable poultry practices and safer meat production under the One Health framework.

The experimental design utilized a standard 35-day commercial broiler rearing model, allocating birds into a negative control group and a probiotic-treated cohort receiving optimized dietary *Saccharomyces boulardii* supplementation. At day 35, serum and plasma, alongside localized duodenal and jejunal intestinal tissues were collected. To assess physiological modulation, a targeted biomolecular panel was quantified using validated, poultry-specific ELISA assays. This panel comprehensively evaluated antioxidant enzyme kinetics (catalase and superoxide dismutase), systemic inflammatory cascades (C-reactive protein, interleukin-6, and TNF-α), circulating endotoxin burden (lipopolysaccharide), mucosal homeostatic regulators (netrin-1), and structural barrier proteins (tight junction protein 1). These biochemical profiles were complemented with classical production metrics and histomorphometric analyses, precisely quantifying villus height and crypt depth ratios in duodenum and jejunum. Standard laboratory protocols were followed with appropriate quality controls and statistical analysis (e.g., ANOVA with post-hoc tests; $p<0.05$ significance level). Modifications included matrix-specific optimizations for poultry samples.

Probiotic supplementation is anticipated to improve production parameters (higher body weight, better FCR and EPEF). Biomarker analyses are expected to reveal elevated antioxidant enzyme activities, reduced circulating inflammatory markers and lipopolysaccharide levels, and upregulated netrin-1 and tight junction protein 1 expression in intestinal tissues. These shifts would correlate with enhanced epithelial barrier function and lower translocation risk, providing objective evidence linking gut-level improvements to systemic health benefits. It is anticipated that concrete contributions will include demonstrable reductions in systemic inflammation and oxidative stress markers directly relevant to poultry meat safety and carcass quality, alongside measurable support for a reduced reliance on commercial antibiotics. Consequently, these objective data are projected to validate *Saccharomyces boulardii* as a scalable, antibiotic-free strategy to enhance pre-harvest poultry meat safety, safeguard public health security, and reinforce supply chain resilience.

These findings would mechanistically validate *Saccharomyces boulardii* as a science-driven probiotic alternative, enhancing intestinal integrity and host stability. This supports sustainable poultry practices that mitigate food safety risks, align with One Health principles, and offer practical applications for resilient, antibiotic-reduced production systems.

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ORAL

A Different Perspective on the Use of Plant-Based Curing Agents in Meat Products

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Nitrates and nitrites are important additives in meat products to ensure food safety, achieve the color of cured meats, delay oxidation, and enhance the cured flavor. While nitrates and/or nitrites are used in meat products made from whole pieces, and fermented sausages, nitrite is the sole curing agent in heat-treated meat products. Since nitrite is the primary curing agent, in processes where nitrate is used, it must be converted to nitrite in order for the expected effects of this curing agent to occur. Nitrates and nitrites also play a role in the formation of N-nitrosamines. Therefore, the potential for N-nitrosamine formation in cured meat products is a significant source of concern for consumers. Due to these concerns, the use of juices and powders derived from nitrate-rich vegetables such as celery, Swiss chard, spinach and beetroot in cured meat products has been widely investigated. While vegetable extracts serve as a direct source of nitrate, pre-converted forms of these products are included in the formulation as a natural source of nitrite. In recent years, the use of vegetable-based curing agents has increased significantly in some countries. However, studies have shown that nitrosamines are also formed when meat products are cured with these natural agents, and that these natural products can even lead to an increase in nitrosamine levels. Furthermore, these plant-based sources can contain hazards such as pesticide residues, certain mycotoxins, and heavy metals. Indeed, cadmium contamination has been reported in celery and beets, which are commonly used in meat products. Celery extracts are frequently used in meat products in the US. In fact, the use of naturally nitrate-rich plant extracts in clean label applications is a pseudo-solution. The European Commission states that these extracts should be considered and declared as food additives when used for technological purposes. In recent years, research has been conducted on more effective measures to reduce the use of nitrates and nitrites in meat products, and significant results have been achieved in reducing nitrate and nitrite usage rates. The use of nitrates and nitrites has been reduced in the EU. Legislative initiatives in this regard are also being developed in Türkiye. On the other hand, it has been reported that nitrite is not only involved in the formation of N-nitrosamines but also reacts with thiols to form S-nitrozothiols, which have positive health-promoting effects.

When vegetable extracts are used as curing agents, the conversion of nitrate to nitrite, variations in nitrate content due to geographical and climatic conditions, and accurate control of the amount added are critical for ensuring product safety. Furthermore, these natural curing agents do not completely eliminate the risk of N-nitrosamine formation. Therefore, in addition to plant-based alternatives, greater attention should also be given to the use of organic acids, bacteriocins, bioprotective cultures, and high hydrostatic pressure processing. Furthermore, additional research is needed to optimize hurdle technology.

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Beyond Conventional Food Safety: Co-Creation of Freshwater Fish Spreads with Food-Grade Essential Oils

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Food safety has traditionally been addressed through analytical evaluation and technological risk assessment. However, contemporary food innovation requires broader approaches that incorporate stakeholder engagement, consumer expectations, transparency, and risk communication throughout the food safety chain. The introduction of novel food ingredients requires not only the achievement of technological quality and safety, but also a thorough understanding of consumer needs, and preferences. Food-grade essential oils have gained attention due to their antimicrobial, antioxidant, and flavoring properties. This study hypothesized that multi-stakeholder co-creation supports consumer-oriented product development by enabling the early identification of consumer perceptions, needs, food safety concerns and acceptance barriers regarding the use of food-grade essential oils in fish-based products.

A multi-stakeholder co-creation workshop was organized to ideate innovative fish spreads based on common bream (*Abramis brama*), an underutilized freshwater fish species. The workshop involved 15 participants: consumers (n=4), food technologists and chefs (n=4), food industry representatives (n=4), and policymakers (n=3), allowing different perspectives to be integrated into the product development process Working in four groups, the participants developed based on a common bream base: one prototype without essential oil and one prototype incorporating a single selected food-grade essential oil. Participants were provided with a pre-prepared fish spread base consisting of cooked and homogenized common bream meat, **olive oil, conventional spices, and five food-grade essential oils: basil (*Ocimum basilicum* L.), winter savory (*Satureja montana* L.), black cumin (*Nigella sativa* L.), dill (*Anethum graveolens* L.), and caraway (*Carum carvi* L.).** During the formulation process, group members discussed ingredient acceptance, transparency, perceived naturalness, consumer trust, safe use of essential oils. Formulations were analyzed using descriptive statistics, and participants' observations were summarized using thematic analysis.

The co-creation process resulted in eight fish spread prototypes. Participants incorporated three of the five food-grade essential oils: winter savory (*Satureja montana* L.) was selected for two prototypes, while basil (*Ocimum basilicum* L.) and black cumin (*Nigella sativa* L.) were each selected for one prototype. The remaining prototypes were developed without essential oils. The essential oils were primarily perceived as natural flavoring ingredients with potential technological benefits rather than as conventional food additives. The discussions highlighted that the acceptance of novel ingredients is influenced not only by their technological properties, but also by consumer familiarity, trust, and understanding.

While technological quality and safety remain fundamental requirements in food innovation, they alone do not necessarily ensure consumer acceptance or market success. Multi-stakeholder co-creation provides a complementary participatory approach that enables the integration of consumer and stakeholder perspectives into the early development of innovative food concepts. Rather than replacing analytical and technological evaluations, this approach adds a social and consumer-oriented dimension by identifying perceptions, acceptance barriers, and communication needs associated with novel ingredient use. An integrated perspective combining technological, safety, sensory, and consumer-oriented considerations is essential for the responsible development and successful adoption of innovative food products.

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Effect of UV-C Irradiation Time on Total Aerobic Bacterial Counts in Fresh and Refrigerated Chicken Breast

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Contamination of poultry with *Listeria monocytogenes* and *Salmonella enterica* poses severe public health risks. In this study, the combined application of nisin and UV-C irradiation was investigated as a non-thermal hurdle technology for improving the microbial safety of chicken breast. Nisin compromises cell membranes, while UV-C damages DNA, together yielding greater pathogen reduction than either treatment alone. Fresh chicken breast samples were artificially inoculated with *L. monocytogenes* and *S. enterica* (approx. 10^6 CFU/g). The samples were then subjected to individual and combined treatments: (1) application of Nisin treatment (via dipping in 500-1000 IU/mL solutions), (2) UV-C light exposure (254 nm, 0-0.5 J/cm2) at varying doses and durations, and (3) a sequential combined treatment. Samples were taken from chicken breast slices, prepared in 10 g portions, and four UV-C treatment groups were created: control (0 minutes), 1 minute, 3 minutes, and 5 minutes. After UV-C treatment for different durations on the chicken breast slices, some of the samples were directly subjected to microbiological analysis without any storage, while others were stored at 4 °C for 4 days to simulate the actual storage conditions of chicken products and to evaluate the effect of UV-C treatment on microbial load during cold storage. Inoculated and treated samples were stored at refrigerated temperatures (4°C). Microbial populations were monitored at regular intervals over a 14-day storage period. Color, pH, and lipid oxidation (TBARS) were evaluated to determine the effect on organoleptic properties. Statistical analysis was performed using SPSS 22.0 with one-way ANOVA, Duncan's multiple comparison test, and t-test ($p < 0.05$). The application of UV-C alone caused a notable reduction (up to a 3.5 log CFU/g decrease) in surface microbial loads; however, sublethally damaged cells showed recovery over time. Similarly, Nisin application provided bacteriostatic suppression. When used in tandem, the combined treatment displayed a strong synergistic effect, achieving significant ($p< 0.05$) reductions in both *L. monocytogenes* and *S. enterica* populations compared to control groups. The combined hurdle technique successfully prevented the outgrowth of pathogens throughout the storage period. By physically disrupting microbial DNA and

biochemically targeting cell wall integrity, the combination substantially lowers initial contamination. This non-thermal strategy offers the food industry a viable method to enhance poultry safety without compromising sensory characteristics or employing harsh chemical sanitizers. Samples treated with UV-C showed lower TBARS values compared to the control sample (0.092 mg MDA/kg); the lowest value was obtained after 5 minutes of UV-C treatment (0.002 mg MDA/kg). These data clearly demonstrate that UV C conditions are successful in reducing the presence of microorganisms without stimulating the lipid oxidation process. This study validates the combined efficacy of combining nisin and UV-C as a non-thermal decontamination approach. By safely reducing and stabilizing *Listeria monocytogenes* and *Salmonella enterica* populations, this biopreservation strategy directly contributes to improving microbial safety and extending the shelf life of raw chicken meat.

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ORAL

Effect of Allicin Incorporation on the Microbiological Stability and Shelf Life of Refrigerated Chicken Products

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The growing demand for clean-label poultry products has increased interest in natural antimicrobial compounds as alternatives to synthetic preservatives. This study evaluated the antimicrobial efficacy of allicin in different chicken products during refrigerated storage and its effects on sensory quality.

The antimicrobial activity of allicin was initially investigated in cubed chicken. The reference formulation contained 0.8% fiber and carrageenan, 10% water, and 9% spice sauce, whereas the treatment formulation was supplemented with 0.1% allicin. Subsequently, the applicability of allicin was evaluated in bone-in chicken products, including wings and leg quarters. Total viable count (TVC), *Pseudomonas spp.*, and yeast and mold populations were monitored using standard microbiological methods at defined intervals throughout refrigerated storage (days 1–18 for cubed chicken and days 2–14 for wings and leg quarters). Three independent replicates were evaluated (n=3). Initial microbial loads were approximately 4.5 log CFU/g for TVC and 3.0 log CFU/g for yeast and molds. Samples were packaged under air in 400-µm PET/PE thermoformed trays sealed with 40-µm PET/PE top film and stored at 4 °C.

In cubed chicken, allicin treatment delayed microbial development, with approximately 1 log CFU/g lower TVC from day 16 and a maximum reduction of 1.2 log CFU/g by day 18. Yeast and mold growth was also inhibited after day 9. In wings and leg quarters, TVC, *Pseudomonas spp.*, and yeast and mold populations showed trends consistent with the previous study, indicating that the antimicrobial effect of allicin was maintained in bone-in and sauce-containing poultry matrices during refrigerated storage.

The allicin preparation was obtained from garlic sourced exclusively from the Taşköprü region of Türkiye and had 99% purity. Garlic cloves were processed under oxygen-limited conditions through solvent-based extraction, maceration, filtration, solvent removal, and sequential concentration to minimize oxygen exposure and potential allicin degradation.

Sensory evaluation was conducted with 30 panelists using a 5-point hedonic scale. Allicin incorporation did not adversely affect overall product acceptability, with sensory scores remaining comparable to those of the reference products.

Overall, these findings demonstrate the potential of allicin as a clean-label antimicrobial for delaying microbial spoilage and extending the refrigerated shelf life of poultry products.

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ORAL

Detection of Reactive Red 141 Textile Dye Sold as Hibiscus Extract and Its Analysis in Food Matrices via HPLC-DAD RP

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With the increasing use of natural-origin colorants, hibiscus extract has become widely utilized in processed foods as a natural source of red coloring. In this study, the actual composition of commercial products marketed under the label "Hibiscus-Based Natural Red Color Extract" was investigated after exhibiting unusual color and pH stability. Comparative spectrophotometric screenings with authentic natural hibiscus extracts revealed that the samples did not demonstrate characteristic hibiscus behavior. For advanced analytical confirmation, spectrophotometric and NMR analyses conducted in collaboration with the German Institute of Food Technologies (DIL e.V.) verified that the commercial products contained no natural botanical extract whatsoever; instead, the material sold as hibiscus extract consisted entirely of Reactive Red 141, a synthetic dye permitted exclusively in the textile industry.

Given the insufficient selectivity of standard spectrophotometry and the lack of standard testing methods in routine food control laboratories, the development of a versatile analytical method was targeted. Consequently, a chromatographic method for determining Reactive Red 141 was successfully developed in-house using a Reverse-Phase HPLC-DAD system, achieving a limit of detection (LOD) of 10 ppm, and a patent application has been filed for this novel analytical method.

This method enabled successful quantitative and qualitative analyses across raw materials and various processed foods (black tea, beverages, cakes, and processed meats), supporting the DIL analytical findings. This presentation will discuss the complete workflow from the initial stage of suspicion to analytical confirmation and method development, as well as the implications of total product fraud marketed as natural ingredients on food safety, regulatory compliance, and consumer trust.

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2D-NMR Correlation Experiments as Rapid Markers for Cheese Authentication and Adulteration Detection

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In conventional 1H-NMR of dairy fats, terminal methyl signals of butyric acid and n-3 fatty acids overlap near 0.96 ppm, confusing their distinction. We hypothesized that a short 2D NMR-COSY experiment would enable qualitative classification of samples, by monitoring butyrate specific and n-3-specific cross peaks

Cheese samples were collected from commercial dairies. Model systems included reference triacylglycerols (tributyrin, tristearin). All samples were dissolved in CDCl3 and analyzed on a 600 MHz NMR spectrometer at 25°C using a standard broadband probe. Conventional 1H-NMR spectra were first recorded; subsequently, homonuclear 2D COSY experiments were acquired with a routine gradient selected pulse program, 512 data points and one scan per increment. COSY maps were processed using standard procedures, and the presence/absence of butyrate-specific A-D (0.96/1.64 ppm) and n- 3 specific A-E (0.96/2.02 ppm) cross-peaks was visually evaluated to classify samples into dairy, n-3 rich non dairy, mixed, or saturated non dairy fat categories.

In this study, 1H-NMR spectra of dairy fat, tributyrin, n-3-rich seed oils and non dairy fat blends confirmed that the terminal methyl triplets of butyric and n-3 fatty acids are fully overlapped near 0.96 ppm, preventing reliable marker-based discrimination. In contrast, COSY-NMR maps of the same systems revealed distinct correlation patterns that unambiguously linked the overlapped methyl resonance to its specific vicinal environment. Tributyrin and genuine bovine dairy fat systematically exhibited a butyrate-specific A-D cross-peak between the terminal methyl at 0.96 ppm and the β methylene at 1.64 ppm, whereas n-3-rich vegetable oils (e.g. linseed oil) displayed only the n-3-specific A-E cross-peak between 0.96 and 2.02 ppm. Saturated non-dairy fats lacking both butyrate and n-3 chains showed neither A-D nor A-E correlations.

When dairy fat was blended with n-3-containing vegetable oils, COSY spectra simultaneously displayed both A-D and A-E cross-peaks, providing a clear mechanistic signature of mixed systems, even when the overall 1H-NMR profiles remained visually similar to those of genuine dairy fat. This binary A-D/A-E behavior was further challenged in a "smart adulteration" scenario, where a ternary non dairy fat mimetic was formulated to reproduce the one-dimensional 1H-NMR spectrum of bovine dairy fat. Although the 1D spectra of the mimetic and authentic dairy fat were virtually indistinguishable, their COSY maps were clearly differentiated: dairy fat exhibited the butyrate-type A-D correlation only, whereas the mimetic showed the n-3-type A-E correlation only. Across all tested matrices, the qualitative presence/absence pattern of A-D/A-E cross-peaks allowed consistent classification of samples into four categories: dairy, n-3-rich non-dairy, mixed dairy/non dairy and saturated non-dairy fats.

Although qualitative rather than quantitative, COSY experiments can be completed in approximately 15–20 minutes per sample, require minimal sample preparation, and avoid derivatization or hazardous reagents, making it suitable as a rapid screening tool within dairy product authentication workflows.

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ORAL

Quantification of Major Royal Jelly Protein Variants and Simultaneous Adulterant Identification to Assess Royal Jelly Product Quality and Authenticity

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Royal jelly is a biologically active bee product rich in Major Royal Jelly Proteins (MRJPs), which are considered the major contributors to its nutritional and therapeutic properties. Conventional analytical approaches, including total protein assays and 10-Hydroxy-2-decenoic acid (10-HDA) analysis, are widely used for quality assessment; however, these methods remain insufficient for evaluating fresh royal jelly (FRJ) freshness, authenticity, and protein integrity. Since MRJPs are highly sensitive to processing and storage conditions, structural alterations may occur during preservation and directly affect their biological efficacy. Moreover, total protein assays cannot distinguish individual MRJP variants or detect protein-based adulteration, emphasizing the need for more comprehensive analytical strategies.

In this study, a native LC-SEC-UV-based analytical workflow was developed for the simultaneous quantification of individual MRJPs and the detection of potential adulterants in FRJ samples. Initially, royal jelly proteins were purified using tandem fast protein liquid chromatography (FPLC), and purity was confirmed by SDS-PAGE analysis. Protein annotation was performed through in-gel digestion followed by Orbitrap high-resolution mass spectrometry-based bottom-up proteomics. The validated MRJP standards were subsequently used to calibrate and optimize the native LC-SEC-UV method. Protein sequences were retrieved from the UniProtKB database, while data processing was conducted using Thermo Proteome Discoverer software. The optimized method was then applied to authentic FRJ samples and adulterated samples. The developed LC-SEC-UV method was validated in accordance with the Eurachem guidelines by assessing specificity, linearity, accuracy, precision, and sensitivity. The method demonstrated excellent specificity, with complete separation of MRJP peaks and no observable matrix interference. Calibration curves exhibited excellent linearity over the concentration range of 0.6–80 mg/g ($R^2 \geq 0.997$). Recovery values ranged from 94.7% to 109.5%, while intra-day (RSDr) and inter-day (RSDR) precision ranged from 6.5–9.7% and 8.5–10.2%, respectively. The decision limit (CCα) and detection capability (CCβ) were determined to be 0.7–0.8 mg/g and 0.7–0.9 mg/g, respectively. Overall, the validation results demonstrated that the proposed LC-SEC-UV method is reliable, accurate, precise, selective, and suitable for the quantitative determination of MRJPs in royal jelly.

The results demonstrated that the developed method successfully enabled the individual monitoring of MRJP variants while simultaneously providing total protein evaluation. In authentic FRJ samples *n=6*, MRJP-2 and MRJP-3 levels were determined within the ranges of 19.2–25.0 mg/g and 11.0–21.0 mg/g, respectively. Royalactin, also known as the MRJP-1 monomer, was quantified between 6.0 and 9.0 mg/g, whereas the MRJP-1 oligomeric form (Apisin) ranged between 35.0 and 47.0 mg/g. Among these variants, the MRJP-1 oligomer was identified as the most fragile protein form under unfavorable storage conditions. Elevated temperatures and improper packaging promoted substantial protein degradation, likely associated with Maillard-type reactions. In addition, lyophilization-induced structural modifications were observed, including fragmentation of MRJP-3 and oligomerization of the MRJP-1 monomeric form.

Comparative analyses performed using Bradford, BCA, and Kjeldahl assays revealed considerable limitations of conventional protein quantification methods. While protein alterations and degradation patterns were successfully identified by the native LC-SEC-UV method, traditional assays failed to detect a 43.4% protein loss observed in aged samples. Non-protein components were also found to interfere with BCA and Kjeldahl assays, potentially leading to false-positive estimations, whereas Bradford analysis resulted in underestimations during comparative evaluations. Furthermore, these conventional methods could not distinguish whether proteins remained in their native form or had undergone fragmentation and denaturation. The developed method also enabled the simultaneous detection of adulterants, including egg white powder, skimmed milk powder, and melamine. Overall, the proposed native LC-SEC-UV workflow provides a reliable and comprehensive strategy for evaluating FRJ freshness, authenticity, and protein integrity and may serve as a valuable tool for routine quality control applications

ORAL

A Novel Nanoparticle-Based Automated Immunoanalysis Method for Gluten Quantification in Food and Beverage Matrices

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Gluten quantification in food and beverage products is essential to ensure the safety of individuals affected by celiac disease and other gluten-related disorders. This study presents a novel nanoparticle-based automated immunoanalysis method for the rapid and quantitative determination of gluten in diverse food and beverage matrices. The assay is based on an immunoturbidimetric principle performed on the fully automated BioSystems Y15 analyzer and uses latex nanoparticles coated with a monoclonal antibody specific for the immunotoxic 33-mer peptide of gliadin. Antigen–antibody interaction induces nanoparticle agglutination, generating turbidity proportional to gluten concentration, which is measured spectrophotometrically at 520 nm.

The method was validated according to AOAC Guidelines for Quantitative Gluten Methods using both processed and non-processed matrices, including rice flour, corn flour, sausage, wine, rice cookies, and cornbread contaminated with wheat, barley, or rye gluten sources. Validation parameters included calibration performance, selectivity, recovery, precision, robustness, stability, and detection capability. The assay demonstrated an analytical range from 2.5 to 200 mg/kg gluten using automated dilution protocols, with excellent calibration fit ($R^2 = 0.9998$) and no observed hook effect at high gluten concentrations.

Recovery values generally complied with AOAC acceptance criteria across all tested matrices. Intermediate precision values were typically below 15% RSD in non-processed matrices and remained acceptable in incurred samples. The estimated overall limit of detection (LOD) and limit of quantification (LOQ) were 1.21 mg/kg and 2.40 mg/kg gluten, respectively, supporting reliable quantification below the Codex Alimentarius threshold for gluten-free labeling. The method also showed high specificity, negligible matrix interference, and strong agreement between method developer and independent laboratory studies.

Compared with conventional ELISA-based methods, the proposed nanoparticle-based automated immunoassay considerably simplifies workflow by eliminating multiple manual incubation and washing steps while improving throughput, reproducibility, and operational efficiency. The use of ready-to-use liquid reagents and automated sample processing minimizes operator-dependent

variability and enhances analytical consistency. These findings demonstrate that the developed method is a robust, sensitive, and user-friendly solution for routine gluten monitoring in food industry and quality control laboratories.

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Development of GMO Screening Kit

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In Türkiye, procedures and analyses related to genetically modified organisms (GMOs) and GMO-containing products are carried out in accordance with the provisions of the **Biosafety Law No. 5977**, the **Regulation on Genetically Modified Organisms and Their Products** issued under this Law, the **GMO Analysis Strategy Implementation Guideline**, and the **Biosafety Legislation Implementation Guideline**.

GMO analysis is based on the detection of DNA and begins with the isolation of DNA from submitted food, feed, or seed samples. Following DNA extraction, the analytical workflow involves an initial screening phase to assess the potential presence of genetically modified organisms. Depending on the sample type and the purpose of testing, positive screening results are further investigated through more specific approaches, including plant species-specific gene detection, event-specific gene identification, and the quantitative determination of GMO content.

In this study, a multiplex screening real-time PCR assay was developed to enable rapid, accurate, and reliable GMO screening and subsequent analyses in compliance with the applicable biosafety legislation. The assay simultaneously targets the **Cauliflower mosaic virus 35S promoter (p35S)**, the **Figwort mosaic virus 34S promoter (pFMV)**, and the **nopaline synthase terminator (tNOS)**, while incorporating an internal positive control (IPC). The assay was optimized and subsequently validated in-house. It was established by combining element-specific primer and probe sets from validated singleplex real-time PCR methods recommended by the European Network of GMO Laboratories (ENGL) for GMO screening. The IPC was designed and developed as part of this study. Validation was performed in accordance with the guidelines of the European Union Reference Laboratory for Genetically Modified Food and Feed (EURL-GMFF).

The developed multiplex screening assay is expected to significantly enhance interlaboratory harmonization by reducing analysis time, resource consumption, and laboratory workload. Furthermore, its implementation in public and private food control laboratories performing GMO analyses in Türkiye will contribute to the standardization and efficiency of GMO testing nationwide.

ORAL

The Scientific Basis of Regulation: The Importance of Data Quality in Risk Assessment

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Scientific evidence is the cornerstone of effective regulation and the protection of public health. As scientific knowledge, technologies, societal expectations, and economic activities continue to evolve, regulatory frameworks must adapt to increasingly complex safety questions. In this context, the reliability of risk assessment depends fundamentally on the quality, relevance, and scientific credibility of the data used to support regulatory decisions. The critical evaluation and integration of evidence from diverse sources are therefore essential for establishing a sound scientific basis for regulation. Risk assessment provides the scientific foundation for regulatory action and comprises four interrelated steps: hazard identification, hazard characterization, exposure assessment, and risk characterization. Each step requires appropriate and reliable evidence to ensure that potential risks to human health are accurately identified and characterized. Data uncertainties, methodological inconsistencies, inadequate study designs, and limitations in scientific knowledge may compromise risk estimates and consequently lead to insufficient protective measures or unnecessary regulatory restrictions. Evaluating the reliability, relevance, and limitations of individual studies is therefore essential for ensuring scientifically defensible decisions. The quality of scientific evidence is closely linked to the critical appraisal of individual studies and the weight-of-evidence (WoE) approach, which integrates findings from experimental, observational, epidemiological, and mechanistic investigations. Study design, sample size, statistical analysis, reproducibility, potential bias, and conflicts of interest are among the factors that should be considered when assessing the strength of scientific evidence. The re-evaluation of aspartame and the safety assessment of novel foods illustrate how scientific findings are translated into regulatory decisions. These examples demonstrate that hazard identification alone is insufficient for determining risk and that conclusions must also account for exposure levels, product characteristics, and specific conditions of use. In the assessment of novel foods, product-specific information and evidence concerning production processes, composition, and potential contaminants are particularly important. The transition towards new approach methodologies (NAMs) and new-generation risk assessment (NGRA) further emphasizes the need for scientifically robust, transparent, and fit-for-purpose data. Integrating mechanistic information, omics technologies, computational modelling, and human-relevant approaches may strengthen risk

assessment by improving biological relevance and addressing specific scientific questions. However, the value of these approaches depends on the reliability, applicability, and appropriate interpretation of the evidence they generate. Ultimately, reliable regulation requires a transparent and systematic process that connects high-quality scientific data with risk assessment and regulatory decision-making. Strengthening data quality, critical evaluation, evidence integration, and scientific communication is essential to protecting public health while supporting proportionate, effective, and evidence-based regulatory measures.

ORAL

Evidence-Based Nutrition in the Age of Misinformation: Are We Interpreting the Evidence Correctly?

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The rapid advancement of digital technologies, the proliferation of social media platforms, and the widespread use of the internet have substantially transformed the production, dissemination, and accessibility of food- and nutrition-related information. Although these developments have facilitated access to information and contributed to bridging knowledge gaps, they have also created an environment conducive to the rapid dissemination of scientifically unsubstantiated, inaccurate, and misleading information. The increasing prevalence of food- and nutrition-related misinformation poses significant challenges to individuals' ability to make informed dietary decisions, and may contribute to potentially harmful health behaviours. Furthermore, the widespread circulation of such information may erode public trust in food and health authorities, thereby undermining the effectiveness of public health interventions and initiatives aimed at promoting population health.

The World Health Organization defines an **"infodemic"** as an overabundance of information, including false or misleading information. To mitigate its adverse consequences, WHO emphasizes the importance of infodemic management through the systematic application of risk- and evidence-based analytical frameworks and intervention strategies, with the ultimate aim of minimizing the impact of misinformation on health-related behaviours and public health outcomes.

The concept of **evidence-based nutrition (EBN)** began to emerge in the early 2000s, and encompasses the systematic identification, critical appraisal, and application of the best available scientific evidence to inform nutrition-related decisions and practices. The evaluation of scientific evidence generated from food and nutrition research within an EBN framework can be summarized in six key steps: **(1)** defining the problem and formulating a research question, **(2)** conducting a systematic literature search and identifying relevant evidence, **(3)** critically appraising the retrieved evidence, **(4)** assessing and grading the certainty of evidence, **(5)** disseminating the evidence to relevant stakeholders and seeking their feedback, and **(6)** translating the evidence into clinical practice and monitoring its effectiveness. Each of these steps requires the appropriate application of established methodologies, reliable information sources, and validated assessment tools to ensure the rigorous evaluation and effective translation of scientific evidence into practice. For instance, the

PICOT framework, which comprises Population/Patient/Problem (P), Intervention (I), Comparison (C), Outcome (O), and Time (T), provides a structured approach to formulating clear, focused, and answerable clinical or research questions. Similarly, an understanding of the **hierarchy of evidence** is essential for identifying and prioritizing relevant research during the literature search and evidence retrieval process. Failure to appropriately apply the methodological principles at any stage of the EBN process may lead to misinterpretation, overgeneralization, or misrepresentation of scientific findings, potentially contributing to the dissemination of nutrition misinformation.

Therefore, an evidence-based approach is not merely the aggregation of findings from individual studies; rather, it involves the rigorous, critical, and systematic appraisal and synthesis of the available body of scientific evidence. **The effective implementation of EBN represents one of the most robust strategies for counteracting pseudoscientific claims and nutrition-related misinformation.** In this context, food and health professionals, as well as policymakers and other relevant decision-makers, have a shared responsibility to critically evaluate, accurately interpret, and appropriately translate scientific evidence into practice and policy in accordance with the principles of evidence-based approaches, ultimately promoting and protecting public health.

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ORAL

Development of a Multi-Aptamer-Based Electrochemical Biosensor for the Detection of *Salmonella Typhimurium*

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This study aimed to compare the electrochemical performances of three different aptamers, utilized for the rapid and specific detection of *Salmonella Typhimurium* ATCC 14028, in single and various cocktail compositions. The aptamer cocktail approach was intended to increase the capture probability by recognizing distinct binding sites on the target surface. In the experimental procedure, gold electrodes were employed as the working surfaces. The electrode surfaces were modified with 3,3′-dithiodipropionic acid (DTPA), and the aptamers were covalently immobilized via EDC/NHS chemistry. Single and cocktail groups (binary and ternary), prepared at a total aptamer concentration of 100 nM, were incubated with a *Salmonella* suspension at a concentration of 10^5. Sensor responses were evaluated using Cyclic Voltammetry (CV) and Electrochemical Impedance Spectroscopy (EIS) techniques, based on the differences in charge transfer resistance (ΔRct) before and after incubation.

The results demonstrated that the Sal28 aptamer exhibited the highest response (ΔRct: 643) among the single aptamer applications. Among the aptamer cocktails, the highest electrochemical response was achieved with the Sal11+Sal28 combination (ΔRct: 1073), representing a 66.9% increase compared to the single Sal28 response. The synergistic effect of Sal11 and Sal28 suggests that these two aptamers recognize complementary binding sites on the target surface. Conversely, the ternary aptamer cocktail (Sal11+Sal26+Sal28) exhibited the lowest performance, which was attributed to potential steric hindrance or binding competition.

This study demonstrated that the performance of an aptamer cocktail does not solely depend on the number of components, but also relies on the binding compatibility and molecular interactions of the aptamers on the target surface. To fully validate the analytical performance of the biosensor, a calibration curve was generated across increasing target concentrations, and control experiments were conducted using *Escherichia coli* to verify the sensor's specificity against *Salmonella Typhimurium*.

ORAL

Preliminary Evaluation of the Protective Effects of β-Carotene Extract Against Methylglyoxal- and Glyoxal-Induced Cytotoxicity in Caco-2 Cells

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Reactive α-dicarbonyl compounds, particularly methylglyoxal (MGO) and glyoxal (GO), are important precursors of advanced glycation end products (AGEs) and contribute to intestinal oxidative stress and epithelial dysfunction. β-Carotene has been widely recognized for its antioxidant activity; however, its potential to attenuate dicarbonyl-induced cellular injury remains largely unexplored. This study investigated the anti-dicarbonyl potential of β-carotene in an intestinal epithelial cell model. Caco-2 cells were exposed to increasing concentrations of MGO and GO to determine their cytotoxic profiles using the MTT assay. The calculated IC_{50} values were 1.26 mM for MGO and 1.44 mM for GO. β-Carotene was extracted under light-protected conditions and tested at serial dilutions (1:10–1:50), with vehicle (DMSO) controls included to eliminate solvent-associated effects. Based on viability screening, non-cytotoxic β carotene concentrations were selected for subsequent co-incubation and pre-incubation experiments, using the IC_{50} values for MGO and GO. LC–MS/MS analysis further demonstrated that the β-carotene preparation contained chlorogenic acid (7778.00 ng/mL), quinic acid (2999.90 ng/mL), fumaric acid (1998.80 ng/mL), caffeic acid (769.82 ng/mL), 4-hydroxybenzoic acid (694.82 ng/mL), ferulic acid (212.48 ng/mL) and rosmarinic acid (168.66 ng/mL). β-Carotene alone exhibited minimal cytotoxicity at the selected dilutions. However, co-incubation with MGO or GO did not significantly improve cell viability compared with cells exposed to MGO or GO alone. Pre-incubation experiments suggested treatment-sequence-dependent differences, with modest improvements observed in selected conditions; however, these effects were inconsistent and did not demonstrate a robust cytoprotective response. Similarly, β-carotene pretreatment for 24 h before MGO or GO exposure did not restore cell viability to control levels. Under the experimental conditions employed, β-carotene did not exert a marked protective effect against MGO- or GO-induced cytotoxicity in Caco-2 cells. Nevertheless, the absence of a significant improvement in cell viability does not exclude a possible anti-dicarbonyl mechanism acting independently of acute cytoprotection.

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POSTER

Toxic Metal and Trace Element Levels in Bluefish (*Pomatomus saltatrix*) from the Black Sea: Influence of Cooking and Human Health Risk

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In recent years, increasing attention has been given to healthy and safe seafood consumption. Seafood is an important source of high-quality proteins, omega-3 long-chain polyunsaturated fatty acids (n-3 LC-PUFAs), vitamins, and essential minerals, providing important nutritional and health benefits, including cardiovascular protection.

Bluefish (*Pomatomus saltatrix*) is an important and widely consumed commercial species along the Bulgarian Black Sea coast. It is valued for its high nutritional content, including proteins, vitamins, and fatty acids, and is commonly consumed fresh or cooked. However, its ability to accumulate toxic elements highlights the need for continued food-safety assessment.

This study investigated the influence of common domestic cooking methods, including pan-frying, grilling, and controlled smoking, on the levels of toxic and essential elements (Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn) in Black Sea bluefish (*Pomatomus saltatrix*), a traditionally consumed marine species. In addition, the potential health risks and nutritional benefits associated with fish consumption were evaluated through carcinogenic and non-carcinogenic risk assessments, as well as benefit–risk ratio calculations based on trace element concentrations and n-3 LC-PUFA content in the cooked fish.

Sample Collection and Preparation:

Forty fresh bluefish samples were purchased from local fishermen upon arrival at Varna fishing port in November 2024. The fish had an average weight of 79.68 ± 4.73 g and length of 21.98 ± 5.31 cm. Samples were transported to the laboratory, washed with Milli-Q water, and randomly divided into four groups (n = 10): raw (control), pan-fried, grilled, and smoked.

Cooking Treatments:

Fish were dissected using a clean PTFE-coated stainless-steel knife, and the heads and viscera were removed. The edible portions were cut and homogenized. Cooking treatments were performed under controlled time and temperature conditions based on established literature and common culinary practices.

Element and Fatty Acid Analysis

Approximately 1 g of each sample was subjected to microwave-assisted acid digestion in closed Teflon vessels. Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn concentrations were determined using ICP-OES. Total lipids were extracted using the Bligh and Dyer method, and fatty acid methyl esters (FAMEs) were analyzed by GC-MS.

Analytical accuracy was verified using certified reference materials. Descriptive statistics and one-way ANOVA were performed using Microsoft Excel, with $p < 0.05$ considered statistically significant.

The concentrations of toxic elements in raw bluefish, including Cd (0.024 mg/kg w.w.), Ni (0.06 mg/kg w.w.), and Pb (0.14 mg/kg w.w.), were within the relevant safety limits. Cooking increased elemental concentrations, mainly due to moisture loss, with Cd ranging from 0.0029–0.039 mg/kg, Ni reaching 0.08 mg/kg, and Pb increasing to 0.25–0.30 mg/kg w.w. Grilling caused less water loss than pan-frying, resulting in lower metal concentrations. Despite these changes, essential elements such as Zn, Fe, and Cr remained at beneficial levels, while Cd and Pb stayed within safe limits, indicating no significant health risk to consumers.

The THQ and HI values for all elements remained within acceptable limits, indicating no significant health risk from bluefish consumption. TR values for carcinogenic metals also remained within acceptable limits (10^{-6}–10^{-4}). The benefits of PUFAs outweighed the potential risks from toxic elements. Both raw and cooked bluefish were considered safe for average consumers, although high-consumption groups may require further assessment. Cooking generally increased elemental concentrations, while Fe decreased after some treatments.

POSTER

Utilization of Desugarized Beet Molasses for the Development of Sustainable Culture Media Supporting Yeast Cultivation and Enumeration in Low Water Activity Foods

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The increasing demand for microbiological testing in food safety systems and emerging microbial food production processes requires sustainable and cost-effective culture media suitable for routine laboratory use. Desugarized beet molasses, a low-value by-product of the sugar industry, contains residual carbohydrates, minerals, nitrogen compounds, and growth-promoting factors that may support the growth of osmophilic yeasts and other industrially relevant microorganisms. This study investigates whether desugarized beet molasses can serve as a basis for an alternative ready-to-use microbiological medium for the cultivation and enumeration of yeasts in foods with water activity ≤ 0.95, while contributing to by-product valorization and circular bioeconomy principles. Three prototype ready-to-use culture media were developed using desugarized beet molasses originating from three different production seasons as the principal nutrient source. Formulations were optimized with respect to water activity, pH, agar concentration, and selective agents to favour osmophilic yeast growth while minimizing bacterial interference. Productivity and selectivity testing were performed according to ISO 21527-2:2008 using Saccharomyces cerevisiae ATCC 9763, Escherichia coli ATCC 10536, and Bacillus subtilis ATCC 6633, and compared with conventional DG18 agar. Validation was conducted according to ISO 16140-2:2016 using a comparative study design comprising relative trueness and accuracy profile assessments. The three prototype media were evaluated on food products with water activity ranging from 0.91 to 0.95, including hard cheeses, dry-cured meat products, and fermented sausages. Culture media formulated with desugarized beet molasses supported visible growth of target yeasts and demonstrated promising productivity compared with DG18 agar. Optimization of formulation parameters, including carbohydrate supplementation and selective agent concentration, further improved growth performance and selectivity. Validation studies demonstrated satisfactory relative trueness for all three prototype media. Relative trueness plots showed that results obtained with the alternative media were closely distributed around the identity line (X = Y) across the investigated concentration range, indicating good agreement with the reference DG18 method and negligible systematic bias. Accuracy profile assessment confirmed that

β-expectation tolerance intervals remained within the predefined acceptability limits of ± 0.5 log10 CFU/g, demonstrating compliance with ISO 16140-2:2016 performance criteria. Productivity testing yielded satisfactory results for all prototype media (PR > 0.50), while selectivity testing demonstrated complete inhibition of bacterial growth. The findings indicate that desugarized beet molasses is a promising sustainable raw material for the production of microbiological media intended for yeasts cultivation and enumeration in low water activity foods. Beyond routine food safety testing, the developed media may support cultivation, monitoring, and quality control of industrially relevant yeasts during microbial process development. The approach contributes to agro-industrial side-stream valorization and circular bioeconomy strategies while providing a cost-effective tool for microbiological process monitoring and quality assurance. Such characteristics are relevant to the development of sustainable microbial food systems and biotechnological applications.

Acknowledgement

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POSTER

Gas Supply Method as a Critical Factor in Modified Atmosphere Packaging: Implications for the Shelf Life and Microbiological Quality of Heat-Treated Chicken Products

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Abalioglu Lezita Gida Sanayi A.S.

This study comprehensively evaluated the effects of different modified atmosphere packaging (MAP) conditions and gas supply methods on the microbiological quality and shelf life of heat-treated chicken nuggets. To accelerate the detection of spoilage-associated microbial growth, samples were stored at 8°C for 29 days, a temperature deliberately selected outside the conventional 0–4°C storage range. Three industrial-scale application groups were established, each analyzed in triplicate: the current production line group, supplied by the existing gas system (30% CO_2, 70% N_2); Trial-1, representing a completely carbon dioxide-free atmosphere (100% N_2); and Trial-2, maintaining the same gas composition as the current group (30% CO_2, 70% N_2) but sourced from an independent external tank rather than the production line itself. Total plate count (TPC) and yeast-mold enumeration were performed on days 1, 10, 15, 25, and 29.

On day 1, all groups exhibited comparable initial microbial loads, ranging from 2.00 to 2.53 log CFU/g. Yeast and mold growth remained below the detection limit of <2 log CFU/g throughout the entire 29-day storage period across all groups, confirming effective suppression. Marked divergences in TPC values became apparent starting on day 15: the current production line group reached 7.70 log CFU/g, Trial-1 recorded 6.89 log CFU/g, and Trial-2, supplied via the separate external tank, displayed a comparatively more stable profile at 6.26 log CFU/g. By day 29, the current production line group concluded the storage trial at 7.36 log CFU/g, Trial-1 reached 7.92 log CFU/g, and Trial-2 exhibited the highest microbial load among all groups at 8.66 log CFU/g. These findings indicate that, even when gas composition is held constant, the method of gas supply together with the purity and stability of the delivery system exerts a significant influence on microbial proliferation throughout shelf life. The results underscore that in industrial-scale packaging operations, not only the gas ratio but also the continuity of the gas source and the integrity of the overall delivery system constitute critical determinants of food safety and shelf-life optimization.

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POSTER

Knowledge, Attitude and Behaviours of Food Safety Amongst Cooks Working in The Kitchens of A Public Institution' Social Facilities in Ankara

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Food handlers are undeniable component of food safety and hygiene at the food production process. The aim of this study is to determine the food safety knowledge, attitudes and behaviors of the food handlers. Research data were obtained through face-to-face interviews with 147 food handlers who constituted the study population, using a non-sample method. The questions were prepared by the researcher based on 66 questions derived from the literature and submitted to expert opinion for content and face validity. SPSS 10.0 package program was used for data analysis and descriptive statistics (Frequency, percentage, average and median etc.) were used while evaluating the data. The study found that 90.5% of participating food processors were competent in terms of knowledge, 99.3% in terms of attitude, and 100% in terms of behavior. This study shows that the length of service as a food handlers and the education level of the food handlers had a positive effect on food safety knowledge scores; no smoking had a positive effect on food safety attitude scores; and receiving food safety training from different disciplines had a positive effect on food safety knowledge, attitude and behavior scores. Furthermore, whether the marital status of the food handlers or they have received culinary education or they follow food safety news from written and visual media or they consider the food safety education they receive to be sufficient do not have an effect on their food safety knowledge, attitudes and behaviors. The importance of human factor should continue to be investigated by using public health metrics which are Knowledge, Attitude and Practices (KAP) for providing safe food.

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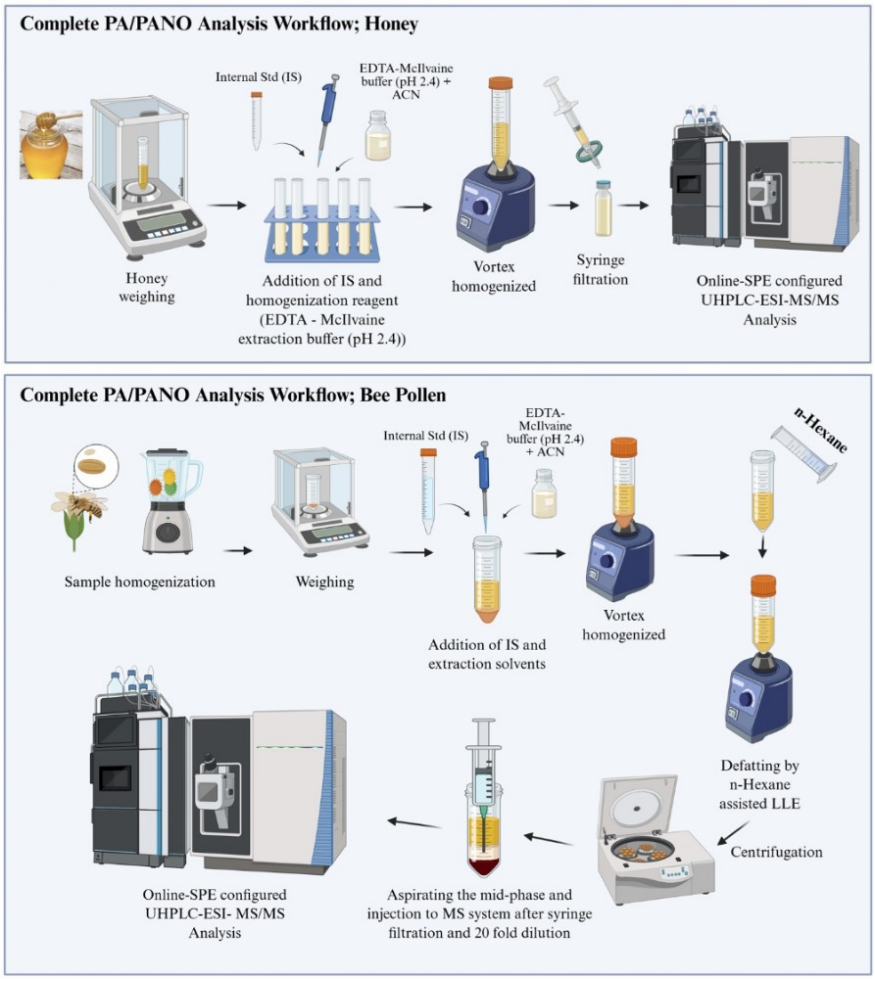
POSTER

Unveiling the Pyrrolizidine Alkaloid Residues in Honey and Bee Pollen Samples by Employing Novel Online-SPE Configured LC-MS Analysis

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Pyrrolizidine alkaloids (PAs) and N-Oxide forms (PANOs) are one of the harmful metabolite subclass of plants. This research reports the actual residue profiles for honey and bee pollen samples by introducing a straightforward method for the quantitation of 28 PAs/PANOs. We aimed to quantify 28 PAs/ PANOs using a novel online-SPE-UHPLC-MS/MS methodology. An online-SPE was optimized for the first time as an alternative automated pretreatment instead of the traditional acidified extraction followed by offline-SPE. A fully automated online-SPE strategy allowed us to integrate the effortless dilute & shoot technique without matrix suppression and led us to gain increased sensitivity. Samples were palynologically classified, 15 bee pollen and 19 color-distributed bee pollens were supplied to clarify the main contamination source. Next, validated method was applied to pre-classified honeys (n=29) and pollens. PAs in pollen samples were extracted using ACN and McIlvaine buffer and defatted with hexane. Aqueous phase was used for analysis. Dilute & shoot preparation was conducted for honeys. Separation was performed on UHPLC and C18-trap cartridge was the extractive stationary phase. Altis TQMS was operated in +ESI with dynamic MRM. Commission Regulation 2020/2040 amended Regulation 1881/2006 as regards maximum levels of PAs/PANOs in foodstuffs. New MRL was set as 500 µg/kg for pollen-based foods. Thus, undesirable concentrations should be monitored meticulously by using sensitive methodologies. Validation results showed that all parameters for both matrices are consistence with the Eurochem guideline requirements. Recovery ranged from 93.1 to 98.6%. The intra and inter-day RSDs% ranged from 2.9 to 7.6% and from 10.8 to 15.8%, respectively. Observed LOQs (0.25 µg/kg) were below the minimum requirements. R2 was consistently above 0.99. Real sample analysis indicated that total PA/PANO concentrations in honey ranged between 0.28 to 177.38 µg/kg and in pollen ranged from 10.9 µg/kg to 14.543 mg/kg. Erucifolin, Europine, Lycopsamine, Intermedine, Europine N-oxide, Retrorsine, Seneciphylline, Heliotrine, Seneciphylline N-oxide, Echimidine, Senecivernine, Senecionine, Lasiocarpine were the most frequent in honeys and Europine with 21.87 µg/kg was the highest residual concentration. Monocrotaline, Erucifoline, Intermedine, Europine, Lycopsamine, Europine N-oxide, Intermedine N-oxide, Lycopsamine N-oxide, Retrorsine, Seneciphylline, Heliotrine,

Seneciphylline N-oxide, Heliotrine N-oxide, Senecivernine, Senecionine, Senecivernine N-oxide, Senecionine N-oxide, Echimidine N-oxide, Echimidine, and Senkerkine were dominantly quantified in bee pollens. Seneciphylline, Senecivernine, Senecionine Echimidine and N-oxide forms are the most prevalent and 4,317 ug/kg was the highest concentration for Echimidine. The data does not suggest that bee pollen composition has significant effect on PA concentration in honey. 86% of the honey and all pollen samples were contaminated with PAs/PANOs and the sum of the 28 PAs/PANOs was higher than 500 µg/kg in 21.2 % of the pollen samples means these samples exceeded the EU MRL limits. In regards to food safety, implementation of the strict QC mindset and adapting innovative methodologies are needed to prevent human exposure to PAs in bee products. Automated online-SPE strategy allowed us to integrate fast and effortless pretreatment combined with accurate and sensitive PA monitoring.



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POSTER

The OCTN1 Paradox: The Machinery Behind Ergothioneine Bioavailability

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Ergothioneine (EGT) is a sulfur-containing histidine-derived betaine that mammals cannot biosynthesize and must obtain from the diet, where it is concentrated in mushrooms and present at lower levels in beans, offal, and cereals. Among dietary antioxidants it is chemically distinctive: at physiological pH it exists predominantly as the stable thione tautomer, conferring a high redox potential, pronounced resistance to autoxidation, a metal chelator, and thermal stability sufficient to survive cooking that degrades most bioactives. Its physiological handling is equally notable. The transporter historically designated OCTN1 (SLC22A4), presumed to translocate organic cations it transports only negligibly, was identified as a high-affinity, sodium-coupled ergothioneine transporter, prompting the proposed functional renaming to ETT. Cells lacking this carrier fail to accumulate EGT, and the transporter mediates both avid cellular uptake and active renal reabsorption, selectively enriching tissues subject to oxidative stress. This constitutes the paradox central to this review: the evolutionary conservation of a dedicated, energetically coupled uptake-and-retention system for a non-synthesizable compound signals physiological indispensability, yet EGT remains formally unclassified as a nutrient, without an established requirement, reference intake, or defined deficiency state. Retention behavior implies the organism cannot afford EGT loss; nutritional taxonomy holds that it is not required.

For food technology, this repositions EGT as a supply-and-delivery challenge rather than an absorption one, since enrichment is governed upstream by production route. Two dominate. Extraction from mushroom biomass and fungal by-products yields a natural-source ingredient but is constrained by low and variable native content, species- and substrate-dependence, and costly purification. Microbial fermentation, employing native fungi or engineered bacterial systems, delivers scalable, high-purity L-EGT decoupled from harvest variability and underpins the regulatory-approved synthetic ingredient. The routes diverge in cost, scalability, purity, and clean-label positioning but converge on a shared premise: because OCTN1/ETT-mediated uptake is avid and retention active, EGT supplied by either route is efficiently absorbed and conserved rather than rapidly cleared, so fortification is not lost at the absorption step. Combined with EGT's processing stability, this locates the rate-limiting constraint on population EGT status not in human

bioavailability nor thermal degradation, but in consistent, economical production and formulation at physiologically meaningful doses.

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POSTER

Impact of Raw Material Variability on Moisture Sorption Behaviour, Quality and Safety of Freeze-Dried Fruit Ingredients

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Variability among commercially available freeze-dried fruit ingredients may significantly influence moisture sorption behaviour, product stability, and ultimately food safety. While previous studies have primarily focused on drying processes or the storage stability of freeze-dried fruits, limited attention has been given to how supplier-related raw material variability influences moisture sorption resistance and subsequent product performance. This study hypothesised that structural differences among freeze-dried strawberry ingredients obtained from different suppliers would result in distinct water activity dynamics, textural stability, and end-product performance.

Freeze-dried strawberry samples obtained from three commercial suppliers (Samples A, B, and C) were characterised for moisture content (infrared moisture analyser), water activity (aw meter), and textural properties using Texture Profile Analysis (TPA). All analyses were performed in triplicate ($n = 3$). Moisture sorption behaviour was evaluated under both real-time and accelerated storage conditions on Days 0, 3, and 7. Samples were assessed both as raw ingredients and within a model bar matrix formulated under standardised conditions, where the raw material source was the only independent variable. Statistical differences among suppliers were analysed using one-way analysis of variance (ANOVA) followed by Tukey's Honestly Significant Difference (HSD) test ($p < 0.05$).

Initial characterisation revealed significant differences in moisture content, water activity, and textural behaviour among suppliers ($p < 0.05$). Sample A (1.33% moisture) exhibited a compact and crisp structure with the highest mechanical resistance, whereas Sample C (3.56% moisture) displayed a more porous structure, higher initial water activity, and lower structural integrity. Sample B (2.14% moisture) exhibited intermediate physicochemical characteristics, while its initial hardness was statistically comparable to Sample A despite differences in moisture content and water activity. During storage, water activity increased and hardness decreased in all samples. Water activity increased to a significantly greater extent under accelerated storage conditions when data were pooled across suppliers and sampling times ($p = 0.024$), whereas the corresponding reduction in hardness was not statistically significant ($p = 0.194$). By Day 7, Sample C exhibited the greatest increase in water activity (approximately 1.6-fold) together with pronounced textural degradation, whereas

Sample A showed the highest resistance to moisture uptake and retained its structural integrity throughout storage. Notably, although Sample B met conventional initial quality criteria, it exhibited the greatest proportional loss in hardness under real-time storage and remained among the most affected samples under accelerated conditions, demonstrating that satisfactory initial physicochemical properties alone do not reliably predict storage performance. Across both raw ingredient and model bar systems, compact structures exhibited smaller increases in water activity and better textural stability, whereas porous structures showed accelerated moisture uptake and more pronounced quality deterioration. These findings indicate that moisture sorption resistance is a more reliable predictor of storage stability than conventional initial moisture content, water activity, or hardness measurements alone.

Overall, raw material variability among suppliers significantly affected moisture sorption behaviour, structural integrity, and storage stability of freeze-dried strawberry ingredients. The findings support incorporating moisture sorption resistance into supplier qualification protocols and raw material specifications to improve product consistency, reduce batch-to-batch variability, enhance storage stability, and ultimately strengthen food safety in industrial applications involving freeze-dried fruit ingredients and snack bar production.

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POSTER

Quantitative Analysis of Cannabinoids in Hemp Seed and Hemp Seed Oil by Liquid Chromatography-Tandem Mass Spectometry (LC/MSMS)

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Hemp, botanically known as *Cannabis sativa,* is an annual crop that contains therapeutic compounds called "cannabinoids". Hemp seed products are popular due to the health-promoting properties. Although seeds are virtually free of cannabinoids, they can be contaminated by cannabinoid-containing parts of plant during harvest. Therefore, cannabinoids in hemp seed products should be monitored.

A quantitative liquid chromatography-tandem mass spectrometry (LC-MS/MS) method that is reliable, spesific, sensitive and accurate for analysis of nine cannabinoids in hemp seed and hemp seed oil was optimized and validated in our laboratory. A two-step solvent extraction and further dilution with methanol:water (80:20) was applied to samples. An Acquity ultra performance liquid chromatography system combined with Xevo TQ triple quadrupole system (Waters, Milford, MA) was used. Chromatographic separation was achieved on a Waters Acquity UPLC BEH C18 column (1,7 µm, 2,1 x 100 mm) by gradient elution with mobile phases 5 mM ammonium formate in water (A) and acetonitrile (B) both containing % 0,1 formic acid. Total run time is 10 min. The column temperature was 50 ° C, injection volume was 10 µL and the flow rate was 0,2 mL/min. Mass spectrometric analysis was carried out by using electrospray ionisation (ESI) in both positive and negative mode, with multiple reaction monitoring (MRM) of two ion transitions for each cannabinoid. Desolvation gas temperature was 300 °C, desolvation gas flow was 600 L/hr, capillary voltage was 3,5 kV and cone gas flow was 80 L/hr.

The method was validated for selectivity, sensitivity, limit of quantification (LOQ), linearity, recovery, precision and robustness, with linseed and sunflower oil as blank materials spiked at three concentrations. Selectivity of the method was evaluated by observing potential interferences between the analytes and impurities in sample extracts. Two spesific MRM ion transitions, ion ratios, retention times and peak shapes were evaluated in order to ensure the selective analysis of each analyte. The use of IL-IS of 4 major analytes enhances the selectivity. The calibration range was 0,2-100 ng/ml; corresponding to 0,1-50 mg/kg in sample with 500 fold dilution. Linearity of calibration curves were evaluated by checking residuals ≤ 20 % and $R^2 \geq 0{,}99$. Limit of quantification (LOQ) for each analyte

was determined as 0,25 mg/kg in both seed and oil matrices, so the sensitivity of the method is much lower than required according to Turkish Food Codex, The average recoveries of analytes were between 80,2-110 %, with repeatability percent relative standard deviation (% RSD) 0,84- 11,4 % and within-lab reproducibility % RSD 3,04- 10,62 %. The robustness of the method was evaluated by Youden Test by altering 7 analytical parameters.

The method is suitable both for routine analysis of major cannabinoids in hemp seed and oil to check the compliance to Turkish Food Codex and for determination of major and minor cannabinoid profile of samples. The relatively shorter run time (10 min) compared to existing methods and confirmation of the results with LC-MS/MS technique in the same run make the method well-applicable to routine analysis. The method has been used in our laboratory for import, official control and special request samples.

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POSTER

Detection and Classification of Foreign Materials in Vacuum-Packaged Kashar Cheese Production Lines Using Artificial Intelligence-Assisted Imaging Technology

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Physical contamination remains a significant food safety concern in vacuum-packaged dairy products, particularly during slicing, packaging, and sealing operations. Conventional inspection systems may show limited performance in detecting low-density contaminants such as plastic fragments and packaging film residues. This study hypothesizes that an artificial intelligence-assisted imaging system integrated into the production line may improve real-time foreign material detection and contribute to digitalized food safety control practices in Kashar cheese production.

The study was designed on a vacuum-packaged Kashar cheese production line by integrating an imaging inspection station onto the output conveyor of the vacuum packaging unit. The inspection system consisted of a 12 MP industrial RGB camera, homogeneous LED linear illumination, a GPU-supported industrial computer, an IP67 hygienic stainless-steel enclosure, and a PLC-connected pneumatic rejection mechanism. A total of 4,500 vacuum-packaged cheese samples were included in the dataset, comprising 3,800 compliant products and 700 samples containing intentionally introduced foreign materials. The foreign materials were intentionally placed only on the surface of the cheese before vacuum packaging in order to simulate visible contamination scenarios encountered during industrial production. No contaminants were embedded within the cheese matrix.

All images were manually annotated and divided into training, validation, and test datasets at ratios of 70%, 15%, and 15%, respectively. A convolutional neural network (CNN)-based object detection model using a Yolo architecture was employed for real-time classification and detection. The model was trained for 120 epochs using the Adam optimizer and cross-entropy loss function. Data augmentation techniques including rotation, contrast adjustment, and blur simulation were applied. System performance was evaluated using accuracy, precision, recall, and false positive rate metrics.

The artificial intelligence-assisted imaging system demonstrated high performance in the detection and classification of foreign materials on the production line. The model achieved an overall detection accuracy of 98.7%, with precision and recall values of 97.9% and 99.1%, respectively. The false positive rate was measured at 1.9%. The average processing time was calculated as 0.18 seconds per product, enabling continuous real-time inspection without interrupting production flow.

The system showed improved detection capability for contaminants that are difficult to identify using conventional metal detectors, particularly low-density plastic particles and packaging film residues. Approximately 96% of these contaminants were successfully detected during testing conditions. The model also identified surface color anomalies potentially associated with thermal processing deviations, supporting early corrective interventions during production.

Compared with manual inspection procedures, the proposed approach may reduce operator dependency and improve inspection consistency. Continuous digital recording and automated reporting functions also contributed to enhanced traceability. The system may support the establishment of a digital Critical Control Point (dCCP) within HACCP-based food safety management systems.

The proposed artificial intelligence-assisted inspection system demonstrated potential for improving foreign material detection and supporting digital food safety management in vacuum-packaged Kashar cheese production. Real-time monitoring, automated rejection mechanisms, and traceability functions may contribute to preventive HACCP applications and sustainable food safety practices in dairy manufacturing environments.

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POSTER

Production of Galactooligosaccharides (GOS) from Milk Lactose and Evaluation of Shelf-Life Stability in UHT Milk

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This study hypothesized that lactose naturally present in milk could be converted into galactooligosaccharides (GOS) at pilot scale using β-galactosidase and that the resulting GOS would remain at levels sufficient for prebiotic fiber labeling under appropriate UHT processing conditions during storage. It was also anticipated that the developed process would provide a value-added prebiotic ingredient produced from milk lactose.

A commercial β-galactosidase enzyme preparation, Nurica™, was used for GOS production. The enzyme was added to a 1.5% fat UHT milk system at a concentration of 0.32%, and the samples were incubated for 12, 18, and 24 hours. The optimum incubation period was selected based on sensory evaluation.

Following enzymatic conversion, the products were processed using direct and indirect UHT systems at 141 °C, 145 °C, and 150 °C. Product stability, caramelization, and color changes after heat treatment were compared. GOS analyses were carried out at TÜBİTAK laboratories using the HPAEC-PAD method. Both total GOS content and fractions with a degree of polymerization (DP) ≥3 were analyzed separately. The results were interpreted according to EFSA criteria and the labeling requirements of the Turkish Food Codex.

Shelf-life stability was evaluated over 90 days under ambient storage conditions by monitoring GOS content, soluble dietary fiber, enzyme activity, and sensory properties, including taste, texture, and color.

Among the incubation periods tested, 18 hours provided the most favorable balance between sensory quality and GOS production. Only limited conversion occurred after 12 hours, whereas extending the incubation to 24 hours did not result in a meaningful increase in GOS formation.

In the UHT trials, the direct processing system preserved product stability, while caramelization occurred in the indirect system, particularly at 145 °C and 150 °C. This adversely affected the color and taste of the product. Consequently, the direct UHT system was selected for subsequent process applications.

HPAEC-PAD analysis showed that total GOS content ranged from 3.54 to 4.28 g/100 mL. The DP≥3 fraction, considered functionally important by EFSA, ranged from 2.45 to 3.16 g/100 mL. Both values exceeded the Turkish Food Codex labeling threshold of 1.25 g/200 mL.

During the 90-day storage period, GOS content gradually decreased; however, the remaining amount was still sufficient to support the prebiotic fiber claim. Soluble dietary fiber remained within the required labeling limits, and acceptable sensory characteristics were maintained throughout storage. By the end of the study, a 1.5% fat UHT milk containing GOS that fulfilled the requirements for prebiotic fiber labeling over a 90-day shelf life had been successfully produced.

The results demonstrate that GOS production from milk lactose can be successfully integrated into dairy processing. The developed method enabled the production of a GOS-containing UHT milk while maintaining the GOS and soluble dietary fiber levels required for prebiotic fiber labeling during the 90-day shelf life. In addition, acceptable sensory quality was preserved throughout storage, confirming the technological feasibility of the process.

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POSTER

Next Generation β-fructofuranosidase Analysis to Identify Inverted Sugar Syrups Usage in Honey Adulteration: Detection of Foreign Invertases Through Targeted Proteomic Acquisition

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Economically motivated honey adulteration is a major global issue, particularly due to the widespread use of inverted sugar syrups (ISSs) as adulterants. ISSs are commonly produced through enzymatic or acid-catalyzed inversion of sucrose and can closely mimic the physicochemical properties of authentic honey, making their detection highly challenging. Conventional authenticity tests are often insufficient, especially when syrups are heat-treated or highly processed. In this study, a novel targeted microproteomic approach was developed to detect ISS adulteration through the identification of foreign invertase enzymes originating from microbial sources.

For method development and real sample analysis, invertase formulations (n =12), authentic honey samples (n =35), and ISS samples (n =15) were collected. Razor peptides of honeybee α-glucosidase were selected from the literature for SRM-based targeted bottom-up microproteomic analysis, while signature peptides of microbial invertases from *Candida utilis*, *Aspergillus oryzae*, *Aspergillus niger*, and *Saccharomyces cerevisiae* were empirically determined. Samples were dissolved in water, and proteins were isolated and purified using optimized centrifugal ultrafiltration. The resulting protein fractions were subjected to tryptic digestion after the DTT reduction, and IAA alkylation steps.Proteomic validations were first performed by employing LC-Orbitrap system. The MS/MS spectras were searched through Sequest HT against the related databases from the UniProt/Swiss-Prot using an in-house Proteome Discoverer workflow. Unique peptides were also generated by in-silico digestion using the Expasy PeptideMass tool for theoretical and experimental comparisons. The information of filtered peptides was transferred to the UHPLC-SRM-MS method using Skyline interface. Water-ACN gradient was applied on CSH C18 column. C18-E cartridge and an optimized online-SPE protocol were used for peptide cleanup and enrichment. The traditional β-fructofuranosidase (BFF) analysis was also performed in comparison using in-house HPLC-RID method.

The results demonstrated that no foreign invertase-specific peptides were detected in authentic honey samples, confirming the reliability of the selected peptides for fraud assessment. Most ISS samples

were found to contain invertases derived predominantly from *Aspergillus oryzae* and *Saccharomyces cerevisiae*, whereas invertases from *Candida utilis* and *Aspergillus niger* were not detected. Some ISS samples lacked detectable foreign invertases, and their low pH values suggested acid-catalyzed inversion. It should be noted that these enzymes might be encountered through contamination. Hence, microbial culturing techniques should also be used in confirmation. Signature peptides of honeybee α-glucosidase were successfully used as authenticity markers, while low peptide intensities were associated with dilution caused by syrup addition. Comparative analyses revealed major limitations of the conventional BFF assay, particularly for pasteurized syrups containing denatured enzymes. In contrast, the developed UHPLC-SRM-MS method successfully detected both native and denatured invertases, demonstrating superior sensitivity and reliability. Real sample analysis indicated ISS adulteration in 15% of the analyzed honey samples.

This study presents the first targeted proteomic approach for the comprehensive and qualitative detection of foreign invertases in honey to elucidate ISS adulteration. The findings emphasize the importance of expanding authenticity assessment strategies and implementing them globally for more reliable detection and prevention of honey fraud.

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POSTER

Hurdle Technology Integration in Non-Heat-Treated Clean-Label Functional Snack Design: An R&D and Risk Analysis Approach

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Ensuring food safety in non-heat-treated, clean-label functional snacks remains a significant challenge, as conventional preservation strategies largely rely on thermal processing and synthetic additives. This study aimed to evaluate whether a formulation-based multi-barrier system - comprising low water activity (aw), controlled raw material specifications, and matrix-based moisture management (referred to as Hurdle Technology) - could maintain microbial stability and shelf-life stability in a clean-label functional snack produced without thermal processing or synthetic preservatives.

A cold-pressed, plant protein- and fruit-based model functional snack was used in this study. No synthetic preservatives were included in the formulation and no thermal processing step was applied during production. Water activity, textural changes, and oxidative stability were monitored under different storage conditions. Microbial stability was assessed through monitoring of naturally occurring yeast and mould populations over a 90-day shelf-life simulation; no pathogen challenge studies were performed. Microbiological risk levels of raw materials, particularly nut- and fruit powder-based ingredients, were additionally assessed using Failure Mode and Effects Analysis (FMEA). Lipid oxidation was monitored via peroxide value under accelerated storage conditions. Data were evaluated using descriptive statistics and correlation analyses.

Stabilising water activity within the 0.58–0.62 range was identified as critical for limiting yeast and mould development. Samples stored within this range showed limited yeast and mould growth throughout the 90-day shelf-life simulation. When water activity exceeded 0.65, increased free moisture mobility and localised structural deterioration were observed, particularly in regions containing hygroscopic ingredients.

FMEA results indicated that raw materials with high initial microbial load represent a priority risk factor, even at low water activity values, highlighting the importance of supplier control and incoming quality specifications as critical control strategies at the R&D stage.

Texture analyses demonstrated that the water-holding capacity of protein isolates contributed to matrix stability by limiting free moisture migration. The moisture-retaining effect of natural fruit sugars was associated with an approximately 20% reduction in hardness increase during storage. Accelerated oxidation analyses suggested that natural tocopherol content partially delayed lipid oxidation, although oxidative stability was also found to be influenced by packaging barrier properties.

Unlike previous studies that typically address water activity control, raw material risk assessment, or oxidative stability in isolation, this work integrates these elements into a single formulation-level Hurdle Technology framework applicable at the R&D stage. These findings suggest that microbial stability in non-heat-treated clean-label snacks can be supported through combined water activity control and raw material risk management. As the present findings are based on naturally occurring microflora rather than pathogen challenge testing, further studies incorporating targeted pathogen challenge trials are warranted to confirm microbiological safety. Water activity control and raw material specifications should nonetheless be regarded as critical parameters at the R&D stage, providing a scalable framework for the development of microbiologically stable clean-label functional snacks.

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POSTER

Development of Cheese-Based Snack Products by Freeze-Drying Technology and Extension of Shelf Life

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Cheese is highly susceptible to microbiological spoilage due to its high moisture content and water activity. Reducing the water activity of cheese through freeze-drying may extend shelf life while preserving product structure and sensory properties. This method is expected to be effective in developing safe and stable cheese-based snack products.

In this study, freeze-dried cheese-based snack products were developed using four different cheese varieties: full-fat white cheese, reduced-fat white cheese, full-fat Kashar cheese, and reduced-fat Kashar cheese. Cheese samples were cut into 2 × 2 × 2 cm cubes and frozen at −20°C for 24 h. The frozen samples were subsequently freeze-dried in a laboratory freeze dryer (Labconco Co., FreeZone 2.5 Plus, Kansas City, MO, USA) at −84°C under an absolute pressure of 0.02 mbar for 30 h. Following freeze-drying, the sensory and textural properties

The products were packaged under modified atmosphere packaging (MAP) conditions and stored at room temperature. During storage, monthly microbiological analyses were performed, including total mesophilic aerobic bacteria, yeast and mold, and coliform counts using standard microbiological methods. In addition, water activity (aw) values were measured throughout storage, and their relationship with microbiological stability was evaluated.

Freeze-drying significantly reduced the water activity of all cheese samples. This reduction positively affected microbiological stability by limiting microbial growth throughout the storage period. According to the sensory evaluation, the snack produced from reduced-fat Kashar cheese received the highest scores for texture, crispness, aroma, and overall acceptability compared with the other cheese varieties. The freeze-drying process largely preserved the structural integrity of the cheese samples while preventing undesirable quality changes, such as textural deterioration and caramelization, which may occur during conventional high-temperature drying processes.

Monthly microbiological analyses of the MAP-packaged products demonstrated that total mesophilic aerobic bacteria and yeast-mold counts remained within acceptable limits throughout storage. The products were safely stored at room temperature for approximately six months. While conventional cheese products generally have a shelf life of approximately 3–4 months under normal conditions, freeze-drying successfully extended product stability without compromising quality attributes.

These findings demonstrate that freeze-drying provides significant advantages for cheese-based snack products in terms of food safety. In particular, the reduction in water activity effectively minimized microbiological risks, enhanced product safety, and prolonged shelf life.

In conclusion, freeze-drying reduced the water activity of cheese products, thereby limiting microbial growth and improving product safety. Together with the preservation of product structure and quality, the extended shelf life indicates that freeze-drying is a feasible and sustainable technology for the production of safe cheese-based snack products.

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POSTER

Preliminary Screening of Syrup Adulteration in Grape Molasses by 1H-NMR and Machine Learning

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The syrup adulteration in grape molasses (Pekmez) may cause measurable changes in characteristic 1H-NMR spectral regions, particularly within sugar-related and anomeric regions. These spectral changes may be useful for preliminary adulteration screening using an explainable machine learning approach.

Because grape molasses naturally contains a complex carbohydrate composition, even small additions of external syrup sources may alter the spectral fingerprint profile observed in characteristic sugar-related ppm regions.

In this study, 1H-NMR spectra obtained from authentic grape molasses samples and laboratory-prepared adulterated samples were evaluated. Spectra were preprocessed using smoothing, normalization, and water suppression procedures. Spectral regions between 1.1–1.5 ppm, 2.0–3.0 ppm, 3.0–4.5 ppm, and 4.5–5.5 ppm were mainly investigated.

An explainable feature engineering approach was applied by calculating regional signal areas, peak distribution features, peak density parameters, and marker-based ratios. In particular, the 2.03–2.13 ppm, 2.85–3.05 ppm, and 4.95–5.25 ppm regions were evaluated as possible marker regions. A bagging-based ensemble machine learning model was used for classification. Model performance was evaluated using repeated hold-out validation, ROC-AUC analysis, permutation testing, and spectral region comparison analyses.

Additionally, PCA and t-SNE analyses were used to visualize clustering behaviour and spectral separation trends between authentic and syrup-adulterated sample groups.

The developed 1H-NMR-based screening pipeline showed promising results for distinguishing authentic grape molasses samples from syrup-adulterated samples. Repeated validation experiments suggested that the proposed workflow may provide reproducible classification performance for preliminary screening purposes. Permutation testing showed that model performance decreased to near-random levels after class labels were shuffled, suggesting that the model learned meaningful spectral relationships rather than random patterns. ROC-AUC analysis demonstrated strong

discrimination performance throughout repeated validation experiments, while dimensionality reduction analyses showed partial clustering behaviour between authentic and adulterated groups. Spectral difference analysis indicated that the strongest separation was mainly observed within the 3.0–4.5 ppm sugar fingerprint region. In addition, the 2.85–3.05 ppm and 2.03–2.13 ppm regions appeared to be useful candidate marker regions.

When previously unseen samples were evaluated, several samples showed suspicious or syrup-like classification behaviour. However, some authentic samples outside the training distribution also showed intermediate-risk behaviour. These findings suggest that authentic sample diversity is an important factor affecting model generalization performance.

The preliminary findings suggest that an explainable 1H-NMR and machine learning-based approach may provide a useful screening tool for detecting adulteration of grape molasses with syrup. However, larger and more diverse authentic sample datasets with different geographical origins, production conditions, and seasonal variations are still needed to improve model robustness and generalization performance.

The combined use of spectral visualization and machine learning validation made the workflow easier to understand. Instead of working only as an automatic classification system, the approach also helped visualize which spectral regions contributed most to the separation between authentic and syrup-adulterated samples, especially within sugar-related regions.

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POSTER

Monitoring of Multi-class Veterinary Drug Residues in Honey Utilizing 'Direct-Connect 2D RP-WCX' Multidimensional Separation and UPLC-ESI-MS/MS Detection

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Multi-class quantification of antibiotic residues in honey is essential to reduce total costs and instrument downtime for laboratories. Herein, using a UHPLC-ESI-MS/MS configuration coupled with Direct-Connect 2D RP-WCX multidimensional separation and a dilute-and-shoot pretreatment, we defined a rapid, inexpensive, and sensitive method as a novel analytical workflow.

For method development and validation, authentic honeys of diverse botanical origins including monofloral blossom (n=4), pine (n=3), and chestnut (n=3) were classified via melissopalynological analysis. The method facilitates simultaneous quantification of antibiotics across seven classes (macrolides, tetracyclines, sulfonamides, amphenicols, fluoroquinolones, nitroimidazoles, and aminoglycosides) within a 14 min runtime. To address inherent challenges of antibiotic analysis in honey, several approaches were implemented. Sulfonamides were monitored individually at neutral pH as both free and N-linked glycated forms, utilizing an optimized homogenization buffer to bypass acid hydrolysis. Maintaining a neutral pH ensured the stability of macrolides and their metabolites, eliminating the requirement to monitor degradation products of erythromycin and tylosin. Furthermore, the recovery of tetracyclines and fluoroquinolones was enhanced by incorporating a chelating agent into the homogenization buffer. While all antibiotics except aminoglycosides were retained using the reversed phase column, highly polar aminoglycosides were successfully retained using the Weak Cation Exchange cartridge, enabling simultaneous analysis on a single platform. Finally, S/N ratios for amphenicols and nitroimidazoles were improved through scheduled MS acquisition, optimized via concave gradient elution and superficially porous particle column chromatography.

Therapeutics for preventing apiary diseases lead to significant residue accumulation in honey. Direct-connect 2D liquid chromatography connects two different separation columns (RP & WCX) in series to achieve increased separation power without complex switching valves or a second LC pump. This unique configuration facilitates a straightforward dilute-and-shoot approach that mitigates matrix

suppression and enables large-volume injection (50 µL) for enhanced sensitivity. An isotope dilution strategy, utilizing deuterated internal standards, compensated for matrix effects across diverse botanical origins to ensure accurate quantification via area normalization. The methodology was validated in terms of specificity, linearity, sensitivity, precision, accuracy, robustness, and ruggedness in accordance with European Commission Decision 2002/657/EC. Validation results showed that RSDs were below 20% for intraday and interday precisions. Mean recoveries ranged between 80% and 110%. CCα and CCβ were in the ranges of 0.1–0.5 µg/kg and 0.5–2 µg/kg, respectively satisfying the current legislation levels. The correlation coefficient values were consistently greater than 0.99. The proposed approach was successfully applied to market honey samples of different botanical origins (n=60) and approximately 20% contained residues exceeding the established CCβ values. Real sample analysis demonstrated the importance of antibiotic analysis for public health and food safety.

Accomplished comprehensive real sample analysis thanks to novel Direct-Connect 2D RP-WCX UHPLC-MS/MS method reflected the growing antibiotic residue problem in honey accurately, practically and sensitively. Furthermore, the proposed method serves as a benchmark methodological framework for laboratories, facilitating the standardized and efficient determination of multi-class antibiotics in complex matrices.

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POSTER

Risk Assessment Of Mineral Oil Hydrocarbons In Dairy Products

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Mineral oil hydrocarbons (MOHs), including mineral oil saturated hydrocarbons (MOSH) and mineral oil aromatic hydrocarbons (MOAH), have emerged as significant chemical contaminants in dairy products due to their potential adverse health effects and widespread occurrence within food processing and packaging systems. This review study presents a comprehensive risk assessment of MOH contamination in dairy products by integrating current scientific literature with analytical findings obtained from commercially produced dairy products. The assessment evaluates possible contamination sources, exposure pathways, analytical detection methods, and associated toxicological risks. Potential contamination routes were identified throughout the dairy supply chain, including lubricants used in processing equipment, migration from packaging materials, environmental contamination, and transportation processes.

As part of the study, a total of 60 dairy product samples representing different product categories, including raw milk, UHT milk, yogurt, cheese, butter, milk powders, and dairy desserts, were analyzed for the presence of MOSH and MOAH using online liquid chromatography–gas chromatography coupled with flame ionization detection (LC-GC-FID). The risk characterization was conducted by comparing estimated dietary exposure levels with toxicological reference values established by international authorities.

Results of the conducted analyses indicated that MOSH and MOAH contamination was not detected in any of the evaluated dairy product samples, suggesting that current production practices, packaging materials, raw material control, and contamination prevention measures were effective in minimizing mineral oil hydrocarbon risks. Although MOSH fractions primarily raise concerns regarding bioaccumulation in human tissues, MOAH fractions containing three or more aromatic rings may exhibit genotoxic and carcinogenic properties. The literature review further highlights that packaging migration and inadequate food-grade lubricant management remain critical contributors to contamination incidents in dairy manufacturing environments.

The findings emphasize the necessity for robust preventive control measures, including stricter supplier verification programs, enhanced food-grade lubricant monitoring, optimized packaging

selection, and implementation of targeted analytical surveillance within food safety management systems. Furthermore, integrating MOH risk evaluation into Hazard Analysis and Critical Control Point (HACCP) and Food Safety Culture frameworks can significantly improve contamination prevention strategies in the dairy industry.

The results demonstrate that a comprehensive risk assessment conducted throughout the entire dairy supply chain facilitated the identification and mitigation of potential MOH contamination risks at the earliest stages. By systematically evaluating potential contamination sources and implementing appropriate preventive measures, contamination was effectively controlled before reaching the final product. The effectiveness of this risk-based approach was verified by the absence of detectable MOSH and MOAH in 60 finished dairy products analyzed within the scope of this study.

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POSTER

Electrooxidation Treatment of Wastewater From The Soft Drink Industry

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High water consumption in soft drink production and the generation of organically loaded wastewater constitute an important environmental sustainability issue. This study hypothesizes that electrooxidation can effectively remove chemical oxygen demand (COD) from soft drink industry wastewater when process conditions are optimized.

The aim of the study was to determine the process conditions affecting COD removal efficiency and to identify the optimum operating range. Response surface methodology (RSM) was used as the experimental approach, and the results were evaluated using Design Expert software. A central composite design was applied to the electrooxidation process, and 17 experimental runs were conducted using three independent variables: initial pH, current, and electrolysis time. The individual effects of these variables and their combined interactions on COD removal were evaluated through modelling. The wastewater characteristics were interpreted by considering its high organic load and suspended solids content. In the experimental evaluation, removal efficiency and treatment cost based on electricity consumption were assessed together. During optimization, both COD removal efficiency and treatment cost were considered. Thus, an integrated data set was obtained to evaluate laboratory-scale performance and potential industrial applicability.

The wastewater from the soft drink industry was characterized by high COD and suspended solids content. Organic substances mainly originating from sugar, together with nutrients such as nitrogen and phosphorus, were considered to increase the COD value. Therefore, conventional treatment methods may be insufficient for the removal of high macro-organic pollution. Electrooxidation results showed that initial pH, current, and electrolysis time had significant effects on COD removal. The evaluation of experimental data using RSM indicated agreement between the model outputs and experimental results. The highest COD removal efficiency was 94.58%, obtained at an initial pH of 4, a current of 1.75 A, and an electrolysis time of 8.92 hours. When low cost and high COD removal were targeted together, the optimum conditions were determined as an initial pH of 6.19, a current of 0.80 A, and an electrolysis time of 10 hours. Under these conditions, 67.35% COD removal was achieved, and the treatment cost was calculated as 2.98 $/m^3$. Increasing electrolysis time improved

removal efficiency but also increased the cost. This finding shows that process parameters should be evaluated together for efficient and economical treatment performance.

This study demonstrates that electrooxidation can be an effective alternative treatment approach for COD removal from soft drink industry wastewater. The systematic evaluation of process variables using RSM enabled the determination of suitable conditions in terms of both treatment efficiency and cost. The findings indicate that higher removal efficiency can be achieved under more acidic pH and higher current conditions; however, optimum process selection should also include cost, energy consumption, and process continuity. Electrooxidation may provide environmental benefits as a supportive or alternative process to conventional treatment methods, especially for wastewater with high organic load. Therefore, it can be considered an innovative and applicable method for sustainable wastewater management.

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POSTER

Production of Value-Added Bioactive Fibers from Beverage Industry Diatomite Filtration Wastes via Microbial Fermentation: A Circular Biorefinery Approach

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When evaluating food waste, filter aids that are generally not subjected to recovery pose a significant environmental challenge. Diatomite (kieselguhr), a natural mineral of biological origin, is composed of fossilized siliceous shells of microscopic algae known as "diatoms". Subjected to calcination, this material is widely used in the beverage industry for sugar syrup filtration to maintain filter cake porosity and achieve the desired clarification. However, a high-organic-load "diatomite mud" waste emerges post-process, which often remains unutilized.

In this study, an integrated biorefinery model was established to recover the mentioned waste for the production of value-added products. In the initial stage, the waste sludge was centrifuged at 5000 rpm for 15 minutes, separating into an inorganic silica-containing pellet and a supernatant with a high organic load. Chemical analyses revealed that the supernatant contained sugar syrup at a concentration of 60 °Brix. Comprehensive microbiological analyses (Total Viable Count at 22 °C and 37 °C, *E. coli*/Coliform, and Yeasts) of the raw diatomite sand, pellet, and supernatant fractions were completed. While the microbial load in the raw material and pellet was zero (0), total viable counts and yeast growth were observed in the supernatant, identified as *Sphingomonas paucimobilis*, *Staphylococcus vitulinus*, and *Candida pelliculosa*. To pave the way for controlled biotechnological processes, this contaminated supernatant was sterilized at 121 °C for 15 minutes.

The sterile supernatant was diluted to ~5 °Brix (pH 4.5–5.5) without additional mineral supplementation to create a suitable bio-matrix. Submerged batch fermentations will be initiated using *Saccharomyces cerevisiae* alongside halotolerant microalgae/cyanobacteria strains *(Dunaliella sp., Halothece sp.*) at 28 °C and 150 rpm for 72 h to convert free carbon into bioactive polysaccharides. Post-fermentation, cell-wall β-glucans will be isolated via microwave-assisted extraction (400 W, 5 min, 60 °C), while exopolysaccharide (EPS) fractions will be recovered through cold ethanol precipitation (1:3 v/v at 4 °C, 24 h) followed by lyophilization.

To comprehensively characterize the extracted exopolysaccharides (EPS), their purity, molecular weight, and structural features will be determined using colorimetric composition assays, FTIR spectroscopy, and HPLC/GC-MS monomer profiling analysis. Additionally, thermal stability (TGA/DSC) and techno-functional properties—including rheological behavior, water/oil binding capacity, and antioxidant potential—will be evaluated to assess their industrial application prospects. The produced polysaccharide fractions aim to function as "clean label" nutraceutical valorized fibers exhibiting immunomodulatory properties in beverage formulations. Consequently, this research demonstrates the in-situ biological synthesis of fibers from waste sugars, presenting an innovative alternative to obtaining fibers from lignocellulosic sources through chemical methods and pioneering a sustainable, zero-waste circular bioeconomy model for the beverage sector.

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POSTER

Evaluation of Phenolic Content, Antimicrobial Activity, and Sensory Acceptance Tests of Functional Lozenges Enriched with Honey, Propolis, and Botanical Ingredients

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Honey and propolis contain various naturally occurring bioactive compounds, including phenolic substances, and have attracted increasing interest as functional food ingredients. Their incorporation into lozenge formulations may provide an alternative approach for developing products with natural functional properties. This study aimed to develop honey- and propolis-enriched lozenges and to evaluate their total phenolic content, antibacterial activity, sensory acceptance, and stability during shelf life in comparison with commercially available honey- and propolis-containing lozenges.

Two different lozenge formulations containing higher levels of honey and propolis than comparable commercial products were developed. Elderberry extract, recognized for its antioxidant potential and richness in bioactive compounds, was incorporated into one formulation, while radish extract, traditionally associated with expectorant and throat-soothing effects, was incorporated into the other. Various plant extracts and essential oils were additionally included to support the functional characteristics of the formulations and to provide a diverse combination of natural ingredients. Total phenolic content was determined using a spectrophotometric method and expressed as gallic acid equivalents (GAE). Antibacterial activity against *Staphylococcus aureus* and *Streptococcus pyogenes* was evaluated using the disk diffusion method. Sensory acceptance was assessed and compared with commercial honey- and propolis-containing lozenges. The stability of total phenolic content and antibacterial activity was evaluated over a two-year shelf-life period. Statistical analyses were performed to determine differences between the tested products and changes during storage.

Both developed formulations exhibited measurable total phenolic content. The mean total phenolic content was 10408 ± 21.9 mg GAE/kg for the elderberry-containing formulation and 9771 ± 21.3 mg GAE/kg for the radish-containing formulation. Antibacterial activity was observed against both test microorganisms. The mean inhibition zones against *S. aureus* were 14.0 ± 0.28 mm for the elderberry-containing lozenges and 14.4 ± 0.26 mm for the radish-containing lozenges, while those against *S. pyogenes* were 15.0 ± 0.22 mm and 16.5 ± 0.24 mm, respectively. No antibacterial activity was detected in the commercial products under the conditions of the study. Statistically significant

differences were observed between the developed and commercial products in terms of total phenolic content and antibacterial activity ($p < 0.05$). During the two-year shelf-life period, neither total phenolic content nor antibacterial activity showed a statistically significant change ($p > 0.05$), indicating that the evaluated functional properties were maintained under the tested storage conditions. These findings demonstrate that the developed formulations were able to retain their measurable phenolic and antibacterial characteristics throughout the specified storage period.

The developed honey- and propolis-based lozenges exhibited measurable phenolic content and antibacterial activity and maintained these properties throughout the two-year shelf-life period under the tested storage conditions. These findings support the potential of honey, propolis, and selected botanical ingredients for the development of functional lozenge products. However, the study was limited by the relatively small number of commercially available honey- and propolis-containing products included for comparison.

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POSTER

Product Design of Acidified Brine-Free Pickled Gherkins

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In line with changing consumer expectations in the food industry, the demand for preservative-free, minimally processed, convenient-to-consume products presented with innovative packaging technologies is steadily increasing. In this context, alternative product concepts developed for pickle and acidified food categories, beyond traditional brine-based systems, have gained significant importance. However, ensuring microbiological stability, maintaining product safety throughout shelf life, and determining appropriate process–packaging combinations remain critical technical requirements for brine-free and preservative-free products.

In this study, the effects of modified atmosphere packaging (MAP), pasteurization applications, and the acidified food approach on product safety, microbiological stability, and shelf life of preservative-free brine-free pickled gherkins were evaluated. Within the scope of the study, a 56 g net weight brine-free pickled gherkin product was developed. No chemical preservatives were used in the formulation; natural rowanberry extract and acidity regulators were incorporated to support product stability. The products were filled into doypack packages under MAP conditions and subsequently subjected to pasteurization. Commercial conventionally brined gherkin products obtained from different suppliers were used as benchmark reference samples, and the developed product was comparatively evaluated in terms of sensory attributes, texture, color, physicochemical properties, and shelf-life stability. Achieving the targeted equilibrium pH during processing was considered one of the critical process parameters to ensure sustainable product safety.

Shelf-life evaluation was carried out through accelerated shelf-life studies based on temperature-dependent changes in critical quality attributes, including color degradation and flavor changes associated with the oxidation of phenolic compounds, texture (firmness and crispness), syneresis, equilibrium pH, and microbiological quality (total yeast and mold count).In this context, the Q10 temperature coefficient approach and the Arrhenius equation were jointly utilized to evaluate temperature-dependent quality change kinetics. Reaction rates were determined using quality change data obtained at different storage temperatures, and the effect of temperature increase on deterioration reactions was quantitatively demonstrated. While shelf-life predictions under different storage conditions were estimated using calculated Q10 values, the Arrhenius approach was employed to

kinetically model the thermal sensitivity and temperature-dependent deterioration behavior of the product. Thus, shelf-life estimation was supported through a predictive modeling approach together with experimental storage data.

The findings demonstrated that MAP effectively reduced oxidative changes and suppressed microbiological growth by limiting oxygen availability. When combined with pasteurization, the process ensured sustainable microbiological safety and acceptable product quality throughout 150 days of accelerated shelf-life testing and 18 months (approximately 540 days) of real-time storage under appropriate process control conditions.

This study presents an innovative approach by comprehensively integrating a brine-free snack-type pickle concept, preservative-free formulation, MAP-supported doypack packaging technology, acidified food approach, and Q10–Arrhenius-based shelf-life modeling. The findings are expected to contribute to food safety-oriented new product development studies, the scientific validation of shelf-life prediction, and industrial packaging optimization applications.

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POSTER

Good Practice Examples in Food Safety by Sector

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Good Practice Examples in Food Safety by Sector Food safety is of critical importance in modern food systems in terms of protecting consumer health, ensuring the sustainability of production processes, and maintaining quality standards in international trade. The globalization of the food supply chain and the increasing volume of production necessitate the systematic management of food safety risks. In this context, HACCP, ISO 22000 food safety management systems, traceability practices, environmental monitoring programs, digital control mechanisms, and sustainable production approaches constitute the foundation of sector-specific good practices. The HACCP system is a risk management approach that enables the analysis of biological, chemical, and physical hazards in food production and the identification of critical control points. The literature reports that HACCP applications reduce risks, ensure standardization in production processes, and strengthen quality assurance systems. HACCP systems integrated with the ISO 22000 standard make it possible to manage food safety not only during the production stage but throughout the entire supply chain.

Traceability systems ensure that all processes, from raw materials to final products, are recorded. Thus, product recalls can be carried out in cases of nonconformity. Today, these systems are supported by blockchain technologies, IoT sensors, and data analytics, creating a more transparent and reliable structure. Environmental monitoring practices enable the early detection of microbiological risks in production environments. Regular monitoring of surfaces, equipment, and air quality helps identify sources of contamination. ATP tests, swab analyses, and microbiological monitoring programs are among the commonly used methods for hygiene verification. In recent years, digitalization and artificial intelligence applications in food safety have gained increasing importance. Digital HACCP systems enable the prediction of risks in advance through real-time data monitoring, automated alarm mechanisms, and big data analytics. Blockchain-based solutions enhance transparency in the supply chain by preserving data integrity. The sustainability approach has become an integral part of modern food safety systems. Energy efficiency, water conservation, waste management, and environmentally friendly sanitation practices reduce environmental impacts and optimize production processes. The "Green HACCP" approach is discussed in the literature as a holistic model integrating food safety and sustainability.

Nevertheless, several research gaps remain in the literature. The practical applicability of artificial intelligence-supported food safety systems, the cost-effectiveness of digital traceability systems in SMEs, the control of biofilm formation, and the effects of sustainable packaging technologies have not been sufficiently investigated. Furthermore, issues related to data security, system integration, and standardization represent areas requiring further research in the future.

In conclusion, sector-specific good practice examples in food safety constitute a holistic framework centered on HACCP, ISO 22000, traceability systems, environmental monitoring, digitalization, and sustainability. These practices reduce risks in production processes while increasing consumer confidence. In the future, food safety systems are expected to evolve into more digitalized, predictable, and sustainable structures.

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POSTER

Behind the Label of Donkey Milk: PCR for Authenticity and Food Safety

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Donkey milk has gained increasing scientific and commercial interest due to its favorable nutritional profile, hypoallergenic properties, antimicrobial potential and expanding use in infant nutrition and functional food products. However, its high market value and limited production volume make it highly susceptible to economically motivated adulteration with cheaper milk from other species, such as cow, goat, and sheep. Such practices pose significant challenges to food authenticity, traceability, consumer trust, and food safety, particularly in relation to accurate labeling and the protection of sensitive consumer groups.

Molecular DNA-based methods targeting mitochondrial markers (cytochrome b, 12S rRNA, and COI) offer greater specificity and thermal robustness for dairy species identification than protein-based assays. However, the compiled data reveal distinct hierarchical variations in their analytical performance. While conventional and touchdown PCR formats serve as cost-effective screening tools for major adulterations with a limit of detection (LOD) of approximately 1% (v/v), they often fail to amplify heavily degraded DNA in processed products. In contrast, advanced assays demonstrate superior applicability to thermally treated matrices; for instance, a single-target TaqMan assay successfully detects 2% cow milk even after autoclave treatment (121 °C, 15 min). At the same time, multiplex real-time PCR (qPCR) and digital PCR (dPCR), which typically rely on short amplicons for compatibility with degraded template DNA, achieve detection limits as low as 0.1%. Double-tube TaqMan multiplex systems display particularly strong analytical performance, simultaneously identifying multiple species with the precision required for routine regulatory monitoring of complex, processed dairy matrices. Reported studies confirm that PCR-based methods, particularly multiplex real-time PCR, can reliably identify donkey milk in complex, thermally processed mixtures, supporting their application in routine food control and regulatory monitoring.

The authenticity of donkey milk is particularly relevant in emerging dairy sectors, including Serbia, where niche production systems are developing. Recent market analyses estimate the global donkey milk market at approximately USD 35-40 million in 2025, with projected growth to over USD 70 million by 2034 and an annual growth rate of around 8-9%. Europe currently represents the leading market, accounting for more than 35% of global production and commercialization. In this context,

molecular traceability systems can strengthen product integrity, support sustainable market development, and enhance consumer confidence in high-value dairy products.

This compilation critically synthesizes current PCR-based molecular approaches for donkey milk authentication, with particular emphasis on their analytical robustness, regulatory relevance, and pivotal role in strengthening food authenticity, traceability, and food safety assurance within modern dairy systems.

Open areas in food safety research:

- Lack of standardized PCR protocols for donkey milk authentication in processed dairy products.
- Limited harmonization of molecular methods for routine regulatory control.
- Need for rapid, sensitive, and field-applicable assays for milk species verification.
- Insufficient quantitative tools for detecting low-level adulteration in mixed dairy matrices.
- Limited data on undeclared allergenic substitution with cow, goat, or sheep milk.
- Need for stronger molecular traceability systems to support consumer trust and high-value dairy markets.

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POSTER

Evaluation of Bactofugation for the Removal of *Clostridioides difficile* Spores from Milk

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Bactofugation is widely used in the dairy industry to reduce bacterial contamination and remove bacterial spores from milk. Considering the potential presence and high resistance of *Clostridioides difficile* spores in dairy environments, this study hypothesized that bactofugation conditions could contribute to reducing *C. difficile* spore contamination in milk.

Pasteurized milk samples were inoculated with approximately 10^8 spores/mL of four different *Clostridioides difficile* strains (ATCC 700057, ATCC 43593, ATCC 1870, and ATCC 9689). To evaluate the effectiveness of bactofugation conditions, inoculated milk samples were subjected to centrifugation treatments at different centrifugal forces and durations. The applied conditions were 4,000 ×g for 10 min, 10,000 ×g for 15 min, and 12,000 ×g for 10 and 15 min. After centrifugation, the supernatant fractions were collected, and decimal dilutions were prepared. Appropriate dilutions were plated on Brain Heart Infusion Supplemented (BHIS) agar and incubated anaerobically at 37°C for 48 h. Following incubation, colonies were counted, and results were expressed as log CFU/mL.

All analyses were performed in duplicate, and results were presented as mean ± standard error. The reduction efficiency of different centrifugation conditions was determined by comparing initial and post-treatment spore concentrations.

The results demonstrated that bactofugation conditions had limited effects on the removal of *C. difficile* spores from milk. Initial spore populations of the tested strains ranged between 7.32 and 7.76 log CFU/mL. After centrifugation treatments, reductions in spore concentrations were observed; however, none of the applied conditions achieved a reduction of ≥1 log CFU/mL. For *C. difficile* ATCC 700057, the initial population of 7.32 log CFU/mL decreased to 6.90, 6.64, 6.57, and 6.43 log CFU/mL following centrifugation at 4,000 ×g for 10 min, 10,000 ×g for 15 min, and 12,000 ×g for 10 and 15 min, respectively. Similar limited reductions were obtained for ATCC 43593, ATCC 1870, and ATCC 9689 strains.

Although increasing centrifugal force and treatment duration slightly enhanced spore reduction, the effectiveness remained insufficient for complete spore removal. Additionally, higher centrifugal forces caused visible separation of milk fat, indicating possible negative effects on milk homogeneity. While bactofugation is considered an effective technology for decreasing microbial load and removing certain bacterial spores in dairy processing, these findings suggest that *C. difficile* spores may not be efficiently eliminated using bactofugation alone. Therefore, relying solely on bactofugation may be inadequate for controlling *C. difficile* spore contamination in milk, and combined preservation approaches may be required to improve microbial safety in dairy products.

This study demonstrated that bactofugation conditions alone were insufficient for effective removal of *C. difficile* spores from milk. The findings provide important insights for dairy safety by emphasizing the need for additional or combined processing strategies to control resistant bacterial spores in dairy production.

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POSTER

Textural Properties of Chicken Pâté with Partial Substitution of Chicken Meat by Crayfish Meat During Refrigerated Storage

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Invasive crayfish (*Faxonius limosus*), an underutilized species with meat rich in protein and essential nutrients, may serve as a functional substitute for chicken meat in pâté formulations. The aim of this study was to evaluate the effect of partial substitution of chicken meat with fresh crayfish meat on the textural properties (firmness) of chicken pâté during refrigerated storage.

Four pâté formulations were prepared: a control (C) containing no crayfish meat, and three experimental formulations in which chicken meat was substituted with fresh crayfish meat at levels of 15% (F1), 30% (F2), and 45% (F3). Chicken meat was cooked before incorporation into the pâté formulation, while crayfish meat was incorporated in its fresh (raw) state. Samples were stored under refrigerated conditions and analyzed at four time points: days 0, 15, 30, and 45. Firmness was measured in Newtons (N) using a TA.XT Plus Texture Analyzer (Stable Micro Systems, Godalming, UK) by penetration test. A cylindrical Delrin probe (P/0.5; 5 mm diameter) was used in distance mode with a penetration distance of 8 mm and a strain of 10%. Instrument settings were as follows: pre-test speed 1.50 mm/s, test speed 1.50 mm/s, post-test speed 10.00 mm/s, and trigger force 10 g. Each sample was measured in five replicates and force-distance curves were recorded to determine firmness. Data were analyzed using two-way analysis of variance (ANOVA) with formulation and storage duration as independent factors, along with their interaction. Post-hoc comparison of means was performed using Tukey's test at a significance level of $p \leq 0.05$.

Storage duration and formulation, as well as their interaction, had a statistically significant effect on pâté firmness ($p \leq 0.05$). At day 0, firmness increased progressively with higher substitution levels, ranging from 0.63 N in the control to 1.27 N in F3. This trend was maintained throughout the entire storage period, reaching values of 0.76 N, 1.02 N, 1.45 N, and 1.54 N for C, F1, F2, and F3 at day 45, respectively. All formulations showed a significant increase in firmness over storage time ($p \leq 0.05$), with F2 exhibiting the most pronounced progression (1.10 N → 1.45 N), while F3 showed significant changes between days 0 and 30, stabilizing thereafter. The significant interaction between

storage duration and formulation indicated that the rate of firmness change over time differed among formulations, suggesting that higher crayfish meat content not only increases initial firmness but also modifies the kinetics of textural changes during refrigerated storage. The higher firmness observed with increasing crayfish meat substitution may be attributed to differences in the protein functionality of fresh crayfish meat and pre-cooked chicken meat. Since chicken meat was pre-cooked prior to formulation, its myofibrillar proteins (primarily myosin and actin) had already undergone thermal denaturation, limiting their capacity to contribute to gel network formation during subsequent heat processing. In contrast, fresh crayfish meat introduced native, non-denatured proteins into the formulation. During thermal processing of the pâté, these proteins underwent gelation for the first time, forming a denser and more cohesive protein matrix. This mechanism is consistent with findings that crustacean proteins retain their gelling capacity even after cooking, a property linked to the unfolding and re-aggregation of thermally treated proteins. Furthermore, firmness in meat products is well-established to increase progressively with the thermal denaturation of myofibrillar proteins, particularly myosin (40–60°C) and actin (66–73°C). The dose-dependent increase in firmness across formulations suggests that crayfish meat proteins contributed to the structuring of the final product.

The incorporation of fresh crayfish meat as a partial substitute for pre-cooked chicken meat significantly increased pâté firmness through enhanced protein gelation during thermal processing. The observed textural stability, particularly at higher substitution levels, suggests the potential of crayfish meat as an ingredient for improving the textural properties of pâté during refrigerated storage.

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POSTER

Is the Use of AI in Broiler Meat Inspection to be Established? - Are We Ready

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Food safety is a key challenge for global food security. In this context, artificial intelligence (AI) offers immense potential for innovation in terms of early risk identification, the automation of quality assurance, and the optimization of traceability. This review aims to assess the current state of the art and provide practical information regarding food safety and industrial approaches to AI implementation. The following section evaluates the technical maturity and regulatory frameworks relevant to practical application

Particularly in the poultry slaughter sector, modern computer vision systems are capable of handling extremely high line speeds processing carcasses, shackles, and sets of viscera per minute while simultaneously addressing the acute shortage of skilled personnel. Visual meat inspection often remains non-efficient, especially in the herds with higher pathological findings, where frequently broilers with different pathologies remain undetected and enter the food safety chain, showing a low sensitivity of the methods used. Automated video systems showed within the industry as key to increasing efficiency; European hygiene regulations continue to require that every carcass undergo comprehensive validation by a human inspector.

This poster examines the status of AI systems for the post-mortem inspection of broilers in terms of their readiness for practical application and regulatory approval. It highlights the technological capabilities as well as the operational and legal obstacles that currently stand in the way of widespread, fully automated implementation.

The legal requirements of the new EU AI Act and Regulation (EU) 2017/625 are reflected here. The poster highlights the balance between benefits for companies and acceptance by the authorities. AI detections were digitally recorded and statistically compared with actual, manually recorded findings from the official veterinarians present.

From a technical standpoint: Yes. AI systems can already consistently detect surface anomalies and quality defects at full line speed with a high sensitivity. Visual overlays demonstrably relieve the strain on the human eye. From regulatory and operational standpoints: No. Furthermore, the lack of

standardized image databases for rare diseases and the cleaning conditions in slaughterhouses limit fully autonomous deployment [5].

The official veterinarian must make any decision beyond this scope; the Final, legally binding decision remains their prerogative within the framework of existing regulatory authority. This poster illustrates practical approaches for how facility operators and regulatory authorities can jointly shape this transition within regulatory "living labs."

Artificial intelligence significantly boosts efficiency in poultry meat inspection by acting, purely AI-based decision-making is not yet feasible from a regulatory standpoint, therefore, a hybrid model incorporating final human validation is recommended.

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POSTER

Domestic Balkan Donkey Milk as a Bioactive Dairy Matrix with *In Vitro* Inhibitory Activity Against Multidrug-resistant Enterobacterales

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Antimicrobial resistance (AMR) is a growing One Health challenge affecting both human and animal health. Donkey milk has been proposed as a natural dairy matrix with potential antimicrobial properties. This study tested the potential of Domestic Balkan donkey milk to inhibit the *in vitro* growth of clinically relevant multidrug-resistant Enterobacterales. The *in vitro* antimicrobial activity of raw donkey milk (RDM) and pasteurized donkey milk (PDM) was investigated using ten clinically relevant ESBL- and carbapenemase-producing Enterobacterales isolates recovered from human clinical specimens. Bacterial suspensions adjusted to the 0.5 McFarland standard were serially diluted, and appropriate dilutions were used to inoculate milk samples, resulting in an initial concentration of approximately 10^2 CFU/mL. Raw bulk milk was obtained from healthy Domestic Balkan donkeys, and one portion was subjected to low-temperature long-time pasteurization at 63 °C for 30 min. Nutrient broth (NB) and pasteurized cow milk (CM) served as control matrices. Non-inoculated raw and pasteurized donkey milk samples served as negative controls and were plated throughout the 8 h incubation period at 37 °C. No growth of Enterobacteriaceae was detected in the negative controls after 8 h of incubation. Bacterial growth kinetics were monitored during 8 h of incubation at 37 °C by enumeration on Violet Red Bile Glucose agar. Three independent antimicrobial assays were performed for each selected bacterial strain. Data were analyzed using two-way ANOVA followed by Tukey's post hoc test, with significance set at $p < 0.05$. Both RDM and PDM reduced bacterial proliferation compared with NB and CM controls. However, the magnitude of inhibition differed among isolates, indicating strain-dependent susceptibility. The strongest inhibitory effect was observed against the OXA-48-producing *Klebsiella pneumoniae* A4 isolate. After 8 h of incubation, bacterial counts remained at 1.70 log CFU/mL in RDM and 2.60 log CFU/mL in PDM, whereas its growth reached 6.25 log CFU/mL in NB and 5.52 log CFU/mL in CM. A comparable pattern was observed for the CTX-M-producing *Escherichia coli* A1 isolate, which

reached only 1.90 log CFU/mL in RDM and 2.62 log CFU/mL in PDM after 8 h, compared with 6.22 log CFU/mL in NB. Moderate inhibitory activity was recorded for *Providencia stuartii* F4 and *Proteus mirabilis* F9. After 8 h, counts of *P. stuartii* F4 remained at approximately 3.30 log CFU/mL in both donkey milk matrices, while growth in NB reached 4.95 log CFU/mL. Similarly, *P. mirabilis* F9 reached 3.28–3.35 log CFU/mL in donkey milk compared with 5.31 log CFU/mL in NB. In contrast, NDM-producing isolates exhibited weaker responses. Nevertheless, even for *E. coli* F8, bacterial counts after 8 h remained markedly lower in RDM (3.30 log CFU/mL) and PDM (3.60 log CFU/mL) than in NB (7.04 log CFU/mL). No consistent association was observed between AMR phenotype and susceptibility to donkey milk. The variable responses among highly resistant isolates suggest that strain-specific characteristics, rather than the detected resistance mechanisms alone, may influence susceptibility to the inhibitory effects of donkey milk. These findings demonstrate the potential of Domestic Balkan donkey milk to suppress the growth of clinically relevant antimicrobial-resistant Enterobacterales and support further investigation of its bioactive antimicrobial properties within a One Health research framework.

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POSTER

From Risk Prevention to Resource Efficiency: The Emerging Role of Membrane Technologies in Dairy Food Safety

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Ensuring food safety while meeting sustainability goals has become one of the most significant challenges facing the global dairy industry. Increasing consumer expectations, strict regulatory requirements, and the increasing complexity of food supply chains require innovative technologies that can minimize food safety risks while reducing environmental impact. Among emerging processing solutions, membrane technologies have gained considerable attention due to their ability to simultaneously support microbial safety, process efficiency and sustainable production.

Foodborne pathogens and spoilage microorganisms remain major concerns in dairy products because milk provides an ideal growth medium for microbial contamination. Traditional thermal treatments are highly effective for pathogen inactivation. However, they may affect nutritional and sensorial quality and typically require significant energy inputs. Membrane processes (Microfiltration-MF, Ultrafiltration-UF, Nanofiltration-NF, and Reverse Osmosis-RO) are non-thermal separation methods that separate milk components based on their molecular weight or particle size, and do not require phase change.

Numerous studies have demonstrated the quantitative benefits of membrane technologies for dairy food safety, particularly in reducing the microbiological load and preserving product purity with bacteria and spore removal, extended shelf life (ESL) milk production, somatic cell removal, pathogen retention, preservation of bioactive components. Microfiltration using ceramic membranes with pore sizes approximately 1.4 µm can achieve 3–6 log reductions in total bacterial counts while removing more than 99% of bacterial spores and somatic cells. In extended shelf-life (ESL) milk production, the combination of microfiltration and mild pasteurization has been shown to increase refrigerated shelf life from 10–15 days to 30–45 days, while maintaining higher sensory and nutritional quality compared with conventional high-heat treatments. Lower microbial loads decrease the attachment of spoilage and pathogenic microorganisms to processing surfaces, reducing biofilm formation and improving cleaning efficiency. Combined with fouling monitoring and optimized cleaning-in-place (CIP) strategies, membrane-based processing can reduce the chemical consumption by 15–30% while improving hygienic design and sanitation performance.

From a food safety perspective, membrane processes support the principles of preventive risk management such as Hazard Analysis and Critical Control Point (HACCP) systems. The sustainability benefits of membrane technologies further strengthen food safety outcomes. RO based water recovery and reuse systems recover 50–90% of process water for reuse and reduce pressure on freshwater resources while supporting hygienic process water management. The recovery of proteins and nutrients from dairy by-products contributes to circular economy objectives and reduces waste generation without compromising safety standards. Ultrafiltration enables recovery of more than **90%** of valuable whey proteins that would otherwise be lost. Compared with conventional evaporation processes, membrane concentration requires **30–70% less energy,** contributing to lower greenhouse gas emissions and supporting circular bioeconomy strategies.These integrated benefits demonstrate that sustainability and food safety should be viewed not as competing priorities but as complementary objectives supported by advanced processing technologies. Real-time sensor systems, digital process monitoring, and AI-based predictive models enable early detection of fouling, process deviations, and sanitation failures. Such tools support risk-based decision-making, optimize cleaning-in-place (CIP) procedures, and contribute to continuous verification of food safety controls.

In conclusion, membrane technologies represent a promising approach for addressing current and future food safety challenges in dairy processing. Beyond their traditional role in separation and concentration, they function as preventive food safety tools that reduce microbial risks, improve process control, support traceability, and enhance resource efficiency. Membrane technologies maximize food safety in the dairy industry while enabling the development of high-nutritional-value and sustainable products. As the dairy industry moves toward more sustainable and resilient production systems, membrane technologies are expected to play an increasingly important role in delivering safe, high-quality, and environmentally responsible dairy products.

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POSTER

Determination of Trace Amounts of PFAS in Risky Food Matrices by LC-MS/MS: Method Validation and Assessment of Regulatory Compliance

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Perfluoroalkylated and polyfluoroalkylated substances (PFAS) are a range of synthetic chemical compounds consisting of a hydrophobic alkyl chain of varying size (typically between 4 and 16 carbons), containing one or more carbon atoms that are partially or completely fluorinated, i.e., where hydrogen atoms have been replaced by fluorine atoms, and a final hydrophilic group. The partially fluorinated form of the hydrophobic chain is called polyfluoroalkyl substances; while those where the entire chain is fluorinated except for the H atoms are called perfluoroalkyl substances. Polyfluoroalkyl substances can be converted to perfluoroalkyl substances under suitable conditions (e.g., through environmental degradation). These are considered environmental pollutants, and studies have linked them to various types of cancer, developmental toxicity, and immunotoxicity. Food categories such as fish, meat, fruits and fruit products, and eggs and egg products have been identified as the primary sources of PFAS exposure in humans. Among PFAS, the group consisting of perfluoro-1-octanesulfonate (PFOS), perfluoro-n-octanoic acid (PFOA), perfluoro-n-nonanoic acid (PFNA), and perfluorohexanesulfonate (PFHxS) is considered to have a higher risk of causing developmental effects and having adverse effects on serum cholesterol, liver, immune system, and birth weight in humans. Furthermore, IARC (International Agency for Cancer Research) has classified PFOA as a carcinogen for humans (Group 1). And PFOS has been assessed as possibly carcinogenic for humans (Group 2B). (4) Therefore, the European Food Safety Authority (EFSA) has determined the weekly tolerable intake (TWI) for the 4 PFAS (PFOA, PFNA, PFHxS and PFOS) frequently detected in serum as 4.4 ng/kg body weight per week.

In this study, an LC-MS/MS method with 4 analytes was developed and validated to monitor a wide variety of per- and polyfluoroalkyl substances (PFAS) at ng/kg levels in four different food matrices (offal, poultry, lamb, fish (sea bass), eggs). The analytical approach in the study was; The method is based on acetonitrile:water extraction followed by solid-phase extraction for purification, and then quantitative analysis of the extracted analytes by isotope dilution (55 compounds) or standard addition

(2 compounds) mass spectrometry. Validation criteria were determined in accordance with the PFAS analysis guideline document published by the European Union Halogenated Persistent Organic Pollutants Reference Laboratory. For the four recently regulated compounds (PFOS, PFOA, PFNA, PFHxS), the minimum quantification limits (LOQ) were calculated based on the standard deviations of the 4 product matrix and determined as 0.010 µg/kg. Reproducibility data were statistically evaluated and conformity checks were performed. No deviations were detected. Overall validation data showed the robustness of the method for most compounds and that the obtained LOQs are sufficiently low to ensure compliance with Commission Regulation 2022/2388 of the EU and also to support the future collection of data on presence in food at the ng/kg level.

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POSTER

Fermentation Ability of Antibiotic-Resistant Lactic Acid Bacteria in The Presence of Different Antimicrobial Substance Concentrations

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Lactic acid bacteria (LAB) are a diverse group of Gram-positive microorganisms widely used as starter cultures in fermented dairy products due to their ability to improve food safety, enhance sensory properties, extend shelf life, and provide probiotic health benefits. However, the emergence of antibiotic-resistant LAB has raised concerns because these bacteria may act as reservoirs of antimicrobial resistance genes potentially be transferred to pathogenic microorganisms through the food chain and can alter fermentation performance secondary to changes in bacterial physiology or metabolism associated with the resistance mechanism.

This study aimed to investigate the genetic diversity and antibiotic resistance profiles of LAB isolated from raw milk and fermented dairy products and to evaluate the impact of antibiotic stress on milk fermentation using electronic nose and electronic tongue technologies.

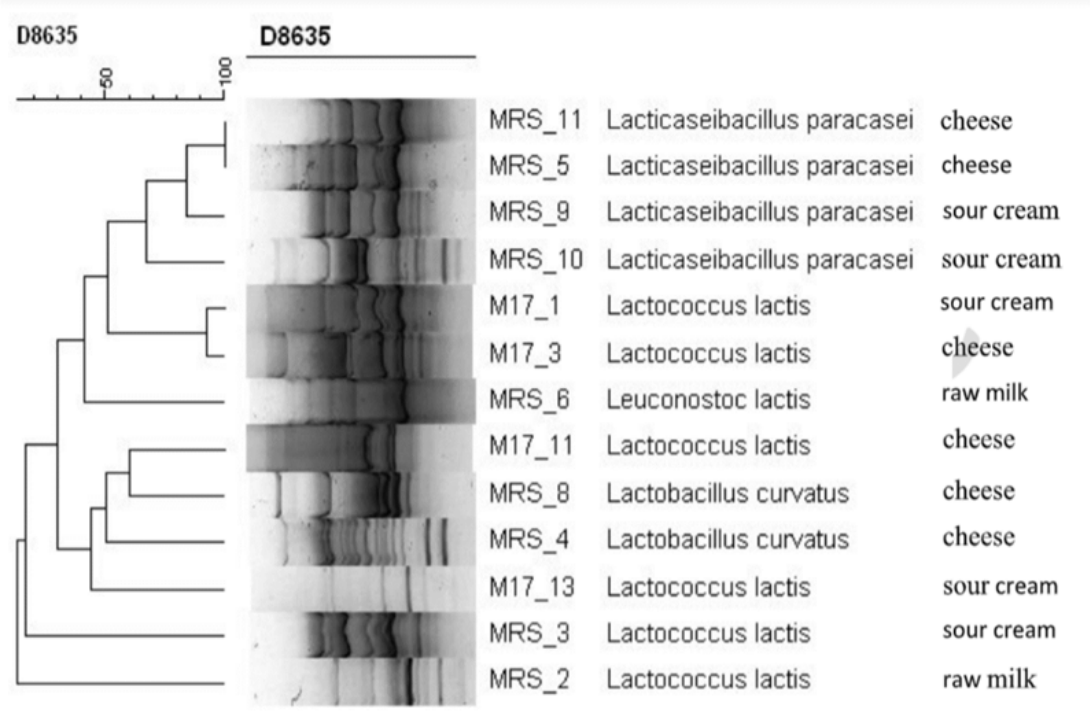
LAB were isolated from raw milk, cheese, cottage cheese, yoghurt, and sour cream commercially available in Hungary using M17 and MRS media. The isolates were identified by MALDI-TOF MS, while their genetic diversity was assessed using RAPD-PCR. Antimicrobial susceptibility was determined by the Kirby–Bauer disk diffusion method against twelve antibiotics: ampicillin, tetracycline, kanamycin, erythromycin, azithromycin, streptomycin, ciprofloxacin, vancomycin, aztreonam, chloramphenicol, clindamycin, and gentamicin. A multidrug-resistant LAB strain was subsequently used to ferment milk containing different concentrations of ciprofloxacin, and fermentation changes were monitored using an electronic nose and electronic tongue.

A total of thirteen LAB isolates were recovered from raw milk and fermented dairy products and identified as *Lactococcus lactis*, *Lactobacillus curvatus*, and *Lacticaseibacillus paracasei*. RAPD-PCR fingerprinting revealed considerable genetic diversity among the isolates, grouping them into four major clusters and twelve distinct branches irrespective of their dairy product origin. Primer D8635 generated highly polymorphic fingerprints, with only two *Lacticaseibacillus paracasei* isolates recovered from cheese showing 100% genetic similarity. Several isolates exhibited multidrug resistance, with growth unaffected by aztreonam, ciprofloxacin, kanamycin, and

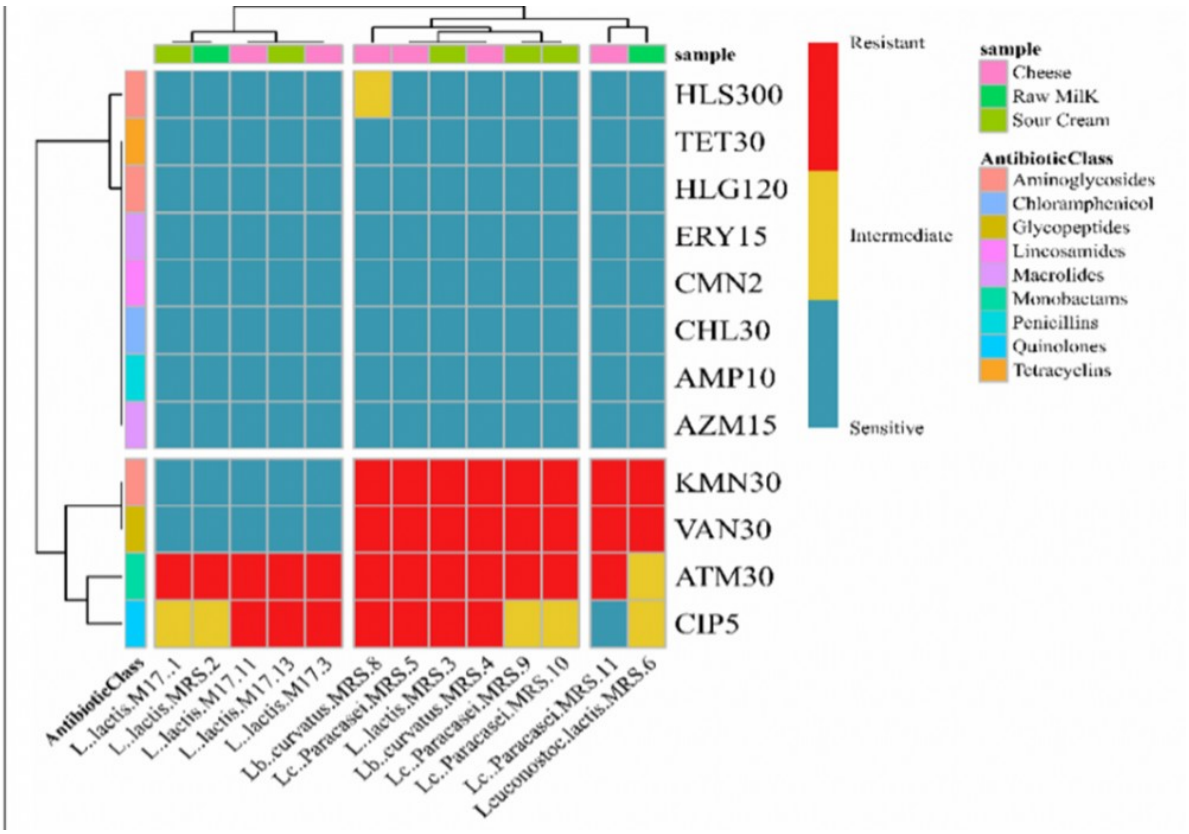
vancomycin. Electronic nose and electronic tongue analyses clearly differentiated fermentations performed in the presence and absence of ciprofloxacin (agent to which resistant exist), indicating measurable changes in the fermentation profile under antibiotic stress.

LAB isolated from raw milk and fermented dairy products exhibited substantial genetic diversity and multidrug resistance, highlighting their potential role as reservoirs of antimicrobial resistance within the dairy chain. Furthermore, electronic nose and electronic tongue technologies proved to be effective tools for monitoring antibiotic-induced alterations during milk fermentation.

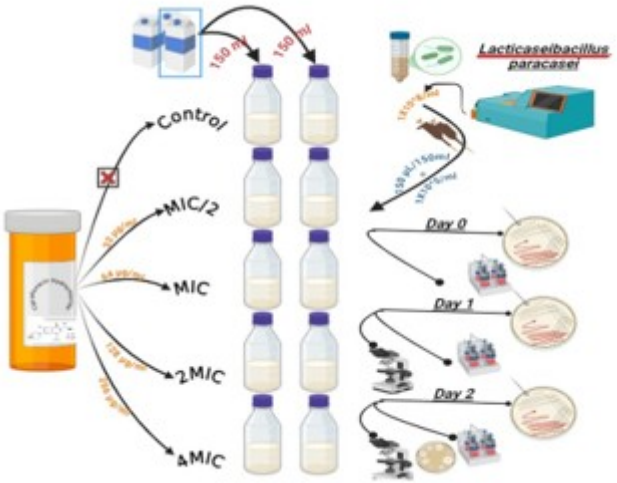
RAPD-PCR for LAB



The phenotypic resistance for all 13 LAB strains.



workflow diagram



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POSTER

Physics-Informed Machine Learning in Food Systems: Interpretable Modeling of Bioactive Stability

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Retaining bioactive compounds such as polyphenols, carotenoids, and thiol antioxidants through processing and storage is a central challenge in functional-food and food-quality engineering. Their degradation follows coupled thermal, oxidative, and matrix-dependent kinetics that established models capture only partially. Purely mechanistic approaches such as Arrhenius and first-order kinetics impose fixed functional forms and miss formulation-dependent behavior, while purely data-driven machine learning needs large datasets, extrapolates poorly beyond training conditions, and offers little physical interpretability — a serious limitation when predictions inform food quality and safety. This review examines physics-informed machine learning (PIML) and related hybrid strategies as a route past this impasse for bioactive stability, a problem not yet consolidated despite growing physics-informed activity in food transport and thermal processing. It surveys methods that embed kinetic and thermodynamic knowledge into learning: physics-constrained loss functions, Gaussian-process surrogates of kinetic parameters, Bayesian optimization for formulation and process design, and explainable methods such as SHAP for interpreting formulation–process–stability interactions. The central argument is that hybrid models suit bioactive degradation because they stay physically consistent, need fewer experiments than black-box learning, and reveal the drivers of retention rather than hiding them — properties that matter when results guide shelf-life, fortification, and safety decisions. Applications to encapsulation and spray-dried delivery systems, where core and wall composition govern stability, illustrate the approach and link it to functional-food development. The review positions interpretable, data-efficient hybrid modeling as a practical alternative to both rigid mechanistic models and opaque deep learning for the food industry.

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Evaluation of the Effects of Bacteriophage and Bacteriocin Applications on *Listeria monocytogenes* in Chicken Products

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Listeria monocytogenes is one of the most important foodborne pathogens associated with ready-to-eat and heat-and-serve chicken products because it can survive and proliferate following post-processing contamination. This study evaluated the effectiveness of the commercial bacteriophage **PhageGuard Listex™ (PGL)** (Micreos Food Safety, Wageningen, The Netherlands) and the commercial nisin preparation **Astro Nisin** (Calza Clemente S.r.l., Italy) in reducing *L. monocytogenes* during refrigerated storage while preserving product quality.

Commercially produced heat-and-serve marinated chicken wings were used as experimental material. After cooking, product surfaces were artificially inoculated with approximately 3.60 log CFU/g of *L. monocytogenes* to simulate post-processing contamination. A 1% commercial bacteriophage preparation and a 2% commercial bacteriocin preparation were separately applied by spraying according to the manufacturer's recommendations. Inoculated samples without antimicrobial treatment served as the control. Samples were packaged under modified atmosphere (%70 N; %30 CO_2) and stored at 0–8°C for 10 days. Microbiological analyses were performed on days 0, 3, 5, 7, and 10. Total aerobic plate count (TPC), yeast and mold, *Listeria spp.*, and *L. monocytogenes* populations were determined using standard culture-based methods. Instrumental color (L*, a*, b*) was measured using a Konica Minolta CR-400 colorimeter. The experiment consisted of two independent production trials with parallel analyses. Data were analyzed by one-way ANOVA, and differences were considered significant at $p < 0.05$.

The initial inoculum contained approximately 4.48 log CFU/g *Listeria spp.* and 3.60 log CFU/g *L. monocytogenes*. Both treatments significantly reduced Listeria populations during storage, although their effectiveness differed. The 1% bacteriophage treatment gradually reduced *L. monocytogenes* to approximately 2.40–2.45 log CFU/g on day 7, with counts remaining around 2.50 log CFU/g on day 10. *Listeria spp.* also declined to approximately 3.48 log CFU/g by the end of storage.

The 2% bacteriocin treatment demonstrated greater antimicrobial activity. *L. monocytogenes* populations decreased to 1.00–1.48 log CFU/g by day 3 and remained between 2.04

and 2.11 log CFU/g on day 10. Likewise, *Listeria spp.* counts decreased to 2.00–2.18 log CFU/g on day 7 and remained significantly lower than the initial contamination level throughout storage ($p < 0.05$). Total aerobic plate counts were consistently lower in bacteriocin-treated samples than in bacteriophage-treated samples, whereas yeast and mold remained below the detection limit (<100 CFU/g) throughout storage. Neither treatment significantly affected instrumental color parameters ($p > 0.05$), indicating that product appearance was maintained.

Both bacteriophage and bacteriocin effectively reduced Listeria populations while preserving product quality. However, the stronger inhibitory effect of bacteriocin suggests that it is a more effective post-processing intervention for improving microbiological safety and reducing the risk of *L. monocytogenes* contamination in ready-to-eat chicken products. These findings support the industrial application of biological antimicrobial strategies to enhance food safety and extend microbiological stability.

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POSTER

Biogas Plants as an Integral Component of Food Safety Management: An Integrated Approach from Environmental Hygiene to Safe Food Production

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Food safety is generally evaluated within the scope of production processes and final product controls. However, the foundation of safe food production relies on biosecurity practices, environmental hygiene, and sustainable resource management that begin at the farm level. In the dairy industry, inadequate management of organic waste generated during livestock production may lead to environmental contamination, pollution of natural resources, and adverse impacts on the sustainability of production systems. Therefore, effective organic waste management should be considered not only from the perspective of environmental sustainability but also as an integral component of food safety management systems. Within this context, biogas plants have emerged as integrated systems that enable the controlled treatment of organic waste, generate renewable energy, and facilitate the reintegration of by-products into the production cycle.

This study proposes an evaluation of the contribution of biogas plants to food safety management within the framework of the Circular Economy and the One Health approach. The One Health concept emphasizes the interdependence of human, animal, and environmental health, highlighting that food safety should be addressed through a holistic risk management approach beginning at the farm level. From this perspective, biogas plants should not be regarded solely as facilities for organic waste disposal or renewable energy generation, but also as infrastructures that strengthen environmental hygiene, improve resource efficiency, and support sustainable production systems.

The reutilization of digestate obtained through anaerobic fermentation represents one of the most significant outputs of biogas systems within the circular economy. Transforming organic waste into value-added agricultural inputs offers important opportunities for reducing the consumption of natural resources and improving resource efficiency throughout the production chain. In this context, the TÜBİTAK 1505 University–Industry Cooperation Project entitled **"Determination of the Potential Use of Biogas Plant-Derived Digestate as a Growing Medium for Seedling and Sapling Production and Its Effectiveness in Suppressing Bacterial Diseases,"** conducted in collaboration with **Ege University,** investigates the potential use of digestate as an alternative to peat as well as its effectiveness in suppressing bacterial diseases in tomato seedlings and pear saplings. Furthermore,

the suitability of digestate for seedling and sapling cultivation is being scientifically evaluated through assessments of plant growth, root and shoot development. The project aims to reduce dependence on imported peat, develop biological alternatives to chemical disease control, and convert biogas by-products into value-added agricultural resources.

Such research on the safe and value-added utilization of digestate demonstrates that biogas plants are not merely energy production facilities but also integrated systems that support safe agricultural production, strengthen environmental sustainability, and contribute to the early stages of the food safety chain. The development of safe growing media and the promotion of plant health can be regarded as preventive approaches that reduce risks at the beginning of the food production chain, thereby supporting safe food production.

In conclusion, biogas plants are strategic systems that integrate environmental hygiene, effective organic waste management, the principles of the circular economy, sustainable agricultural production, and the One Health approach. Considering that food safety is not limited to controls implemented in food processing facilities but depends on the effective management of environmental and biological risks originating at the farm level, biogas plants should be recognized as important tools for food safety management extending from environmental hygiene to safe food production. This study aims to increase awareness of the role of biogas plants within the food safety perspective and to contribute to the development of sustainable food systems.

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POSTER

Sustainable Healthy Nutrition: Health Star Rating Profile of Dairy Products

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The increasing trend among consumers toward sustainable healthy nutrition necessitates comprehensive nutrient profiling analyses in the dairy sector as well (Jones et al., 2019). Dairy products concurrently contain essential positive components such as calcium and protein, alongside nutrients of concern that require limitation, such as saturated fat and sodium (Al-Mazaideh et al., 2022). The hypothesis of this study is that the nutritional risks posed by negative components requiring limitation can be algorithmically counterbalanced by positive nutritional elements.

Various front-of-pack labeling (FOPL) and nutrient profiling methods, such as Traffic Lights, Nutri-Score, Keyhole, HSR, and Warning Labels, are utilized in the food industry. Among these methods, the Health Star Rating (HSR) system was selected as the primary methodology of this research, as it evaluates both negative components to be limited and health-promoting positive elements through an algorithm, thereby providing an objective and balanced mapping. In this research, the nutritional compositions of a total of 104 dairy products were examined across 4 main categories (Non-Fermented Products, Fermented Products, White Cheeses, and Yellow Cheeses) representing a national market portfolio. Based on the energy and nutrient data of each product, final scores were determined by calculating components to be limited, such as energy, saturated fat, total sugar, and sodium, together with positive components representing protein, dietary fiber, and calcium/fruit ratios according to a standardized matrix. All obtained data were processed through the Health Star Rating Calculator system, utilizing a globally recognized, official, and up-to-date algorithmic infrastructure (Commonwealth of Australia,2025). The final scores, ranging from 0.5 to 5.0 stars, and the categorical arithmetic means for each main category and product sub-group were calculated in strict accordance with published standard procedures without any modifications to generate the profile map (Food Standards Australia-New Zealand [FSANZ],2026).

Consequently, the calculations revealed that while the HSR scores of the 104 examined products demonstrated significant variances on an individual product basis, they exhibited notable similarities across the broader product categories. When the categorical overall arithmetic means were evaluated, the Non-Fermented Products Category—which encompasses the UHT milk group, pasteurized milk, clotted cream (kaymak), butter, powdered products, dairy desserts, and cream—averaged 3.0 stars,

primarily due to the predominant impact of high saturated fatty acids and added sugars in the dessert group. Conversely, the Fermented Products Category, including ayran, yogurt varieties, and kefir, achieved an average of 4.0 stars owing to its high protein content and lower sodium/sugar load. The most striking objective data regarding consumer health and safety emerged within the cheese groups. Despite containing high amounts of sodium (salt) and saturated fat due to their manufacturing technologies, the White Cheese Group products reached an average of 4.0 stars because of the high density of natural protein and calcium within the food matrix. Similarly, the Yellow Cheese Group products were found to rank at a high score level with an average of 4.0 stars. These objective findings demonstrate that the intrinsic calcium and protein content of dairy products provides a tangible algorithmic power to offset the negative components that require limitation (Al-Mazaideh et al., 2022).This study provides a comprehensive mapping that analyzes the nutritional quality of a dairy product portfolio in accordance with international standards.

The results obtained based on official Health Star Rating System criteria demonstrate that the nutritional quality of fermented foods and cheese groups is robustly supported by their high calcium and protein content. Conversely, within the non-fermented group, the findings indicate that functional reformulation strategies focusing on salt, fat, and sugar reduction could be developed in the future, particularly for high-fat items (cream, butter, clotted cream, etc.) and sugar-sweetened products (desserts). These findings will guide future R&D innovation processes and labeling objectives to the extent permitted by current food regulations.

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POSTER

Antioxidant Applications In Mayonnaise Production: Evaluation Of Oxidative Stability And Sensory Quality During Shelf Life

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Mayonnaise is one of the most-widely consumed oil-in-water emulsion products and contains a high proportion of unsaturated lipids, making it highly susceptible to oxidative deterioration during storage. Lipid oxidation negatively affects the physicochemical, sensory, and nutritional quality of mayonnaise by causing rancidity, off-flavor formation, discoloration, and reduction of shelf-life. This study'll investigate how to improve shelf-life stability in the final product by identifying mayonnaise recipes with different fat contents and compositions that can be used in conjunction with EDTA, a commonly used compound in the industry, and thus maintaining oxidative stability for a longer period.

In mayonnaise, interfacial oxidation is of great concern due to the fact that a very large area of the oil is exposed to an aqueous phase and existence of air bubbles introduced into the emulsion through a blending process.

Antioxidants may act through variety of mechanisms, including free-radical deactivation, pro-oxidants suppression, and control of oxidation substrates (Kishk&Elsheshetawy, 2013). There are two hypotheses describing the efficiency of antioxidants in emulsion: the cut-off effect and the polar-paradox theory. According to the second theory, non-polar antioxidants tend to be located in the interfacial region, whereas polar antioxidants have a tendency to accumulate in the water-phase. Therefore, lipophilic/amphiphilic antioxidants should be desired to protect mayonnaise from oxidation.

In recent years, extending the shelf-life stability of low-fat/light, and spice-rich mayonnaise, increasingly preferred by consumers, has become a significant focus in food research and product development. These mayonnaise formulations are more susceptible to oxidative and physicochemical degradation due to their modified compositions and reduced fat content. Therefore, improving oxidative stability while maintaining desirable sensory and textural properties is considered essential for ensuring product quality and consumer acceptance.

The purpose of this study was to investigate the effects of tocopherol, rosemary-extract and mixture of BHT+BHA on oxidative stability of mayonnaise during storage. Their effiency was also compared with EDTA and control group. During the primary oxidation stage, tocopherol was more efficient than mixture of BHT+BHA, in the secondary oxidation phase, tocopherol and rosemary extract performed similarly but showed superior performance compared to other antioxidants. An accelerated shelf-life test design was developed to analyse the level of oxidation in samples using sensory evaluations. Each sample included in the experimental design was evaluated by expert panelists at 7-day intervals. According to the values of variance table based on the results of 21-days accelerated shelf-life test, no significant difference was found in the oxidative level of samples containing tocopherol and rosemary-extract ($p>0.05$). At the end of storage, the sensory quality of mayonnaise products containing tocopherol+EDTA and rosemary extract+EDTA increased by 1/3 over their shelf life.

Based on the overall results, tocopherol and rosemary-extract can be recommended as to ensure that sensory quality is maintained for as long as possible throughout the product's shelf-life. However, a more detailed assessment is needed regarding the preservation of organoleptic-properties in low-fat/light mayonnaise, spice-based emulsified sauces, and vegan mayonnaise formulations.

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POSTER

Integrated Sensor, Model, and Vision-Based Cooking Assistance for Risk Reduction in Domestic Food Preparation

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Household cooking risks can be reduced when appliance control systems combine thermal sensing, energy-based temperature estimation, and temporal image analysis. We hypothesized that three complementary functions NoBurnt, Ready2Cook, and CamOven; could detect hazardous cooking states, improve pan-temperature control, and support consistent doneness assessment without materially increasing consumers workload.

Three embedded cooking-assistance functions were developed and evaluated. NoBurnt monitored a cooktop temperature signal using adaptive low-pass and high-pass filtering, temperature-rise features, and derivative thresholds; warning and automatic power-off logic were assessed with ten cookware types on three hobs.

Ready2Cook estimated pan temperature from the hob NTC signal and accumulated energy using a second-order regression model with interaction terms. Its experimental design comprised six pans, two hobs, and three operating modes, totalling 72 runs; a +10 °C calibration offset was applied before validation. Performance was compared with manual operation using relative temperature error and overshoot.

Camera Oven combined an in-cavity camera, a user-interface workflow, and a convolutional neural network long short-term memory architecture to analyse temporal appearance changes. Image sequences were collected for five foods during 150 development runs, followed by a ten-user home-use evaluation. Descriptive statistics, regression goodness-of-fit, prediction standard error, threshold compliance, and relative error reduction were used for analysis. Camera outputs were interpreted as visual doneness support, not as direct evidence of microbiological lethality.

NoBurnt completed 30 cookware–hob validation combinations, all below the 180 s intervention criterion; the longest observed response was approximately 150 s. These findings indicate that a common sensing-and-control principle can respond across cookware with substantially different thermal characteristics while retaining a defined safety response window. For Ready2Cook, the pan-temperature regression achieved a predicted R^2 of 90.30% with a prediction standard error of 22.80

°C. In the controlled comparison, relative temperature error decreased from 11.6% under manual control to 6.0% with Ready2Cook, corresponding to a 48% relative reduction. Temperature overshoot decreased from 14.3% to 12.7%. The cooking-image comparison also showed more uniform pancake development under automated control than during the matched manual sequence, supporting the relevance of tighter pan-temperature regulation to burn prevention and repeatability. The Sensitivity: Internal / Non-Personal Data Sensitivity: Internal / Non-Personal Data Camera Oven dataset captured time-dependent visual changes in salmon, small pastry, fresh pizza, and other target foods across the cooking cycle. The implemented CNN–LSTM pipeline connected image acquisition, temporal feature extraction, stage estimation, and user-facing feedback in an end-to-end prototype. The 150 run development dataset and subsequent ten-user evaluation demonstrated the practical feasibility of embedding vision-assisted doneness guidance in a domestic oven interface. However, numerical classification metrics and core-temperature validation remain necessary before visual stage estimates can be associated with pathogen inactivation. Taken together, the three functions address different points in the cooking-risk chain: NoBurnt limits unattended overheating, Ready2Cook reduces control error and overshoot at the cooktop, and Camera Oven supports timely user decisions in the oven. The combined approach therefore translates appliance sensor data into preventive actions rather than relying solely on user observation.

Sensor fusion and embedded intelligence can extend food-safety prevention from passive warnings to active control and decision support. The results support further validation across food loads and usage conditions, while confirming that vision-based doneness estimation should complement, not replace, core-temperature or microbiological verification when safety is claimed.

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POSTER

The Role of Sociocultural Factors and Psychological Safety in Embedding Food Safety Culture

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Food safety culture concerns the shared values, beliefs and norms that shape everyday practices related to safe food production. Technical infrastructure, written procedures and training are important components, but employees' interpretations of rules, perceptions of risk and responses to deviations also require attention. Social and cultural contexts, workplace relationships and management practices may influence how food safety expectations are understood and adopted. This narrative review aims to discuss the role of sociocultural factors and psychological safety in embedding food safety culture and to identify practical implications for food businesses.

The conceptual framework draws on selected publications addressing food safety culture and climate, national and organisational culture, workers' social conditions and the psychosocial dimensions of food safety behaviour. These publications are considered together to explore potential connections between attitudes towards authority, team norms, communication, management support, working conditions, motivation and risk reporting. The work is not designed as a systematic review or meta-analysis. Psychological safety is considered a shared belief that interpersonal risks, such as asking questions, acknowledging mistakes or raising concerns, can be taken without humiliation or punishment. It is distinguished from employee stress, general job satisfaction and technical food safety knowledge.

The selected literature indicates that food safety behaviour should be considered within its organisational and social context, alongside individual knowledge. Cultural values and relationships with authority may shape employees' willingness to question instructions or communicate concerns to supervisors. Informal team norms are also relevant to understanding how written procedures translate into everyday practices. However, national or regional cultural characteristics should not be used to make deterministic assumptions about individual employees. Different teams and management levels within the same organisation may have distinct experiences and norms.

Psychological safety provides a useful framework for examining whether employees feel able to raise food safety concerns promptly. Management responses to feedback and mistakes, together with opportunities for employee participation, are discussed within this framework. Nevertheless,

perceived freedom to speak up should not be equated with actual reporting behaviour or improved food safety performance. Workload, time pressure, resource constraints, job stress and motivation also warrant consideration when examining the maintenance of safe practices. Psychological safety should therefore be considered alongside adequate resources, clear responsibilities and consistent management practices.

Practical implications include training adapted to employees' language and learning needs, accessible reporting channels, visible feedback on reported concerns and leadership behaviours that support open communication. Learning from mistakes should be encouraged without weakening accountability for food safety responsibilities. An increase in reporting should not automatically be interpreted as deteriorating safety performance; the nature of reports, organisational responses and recurrence of problems should also be considered.

In conclusion, embedding food safety culture calls for consideration of sociocultural contexts and employees' interpersonal experiences alongside technical management systems. Direct relationships between psychological safety and food safety outcomes require further investigation across production settings. Future studies should measure cultural factors, psychological safety and observed behaviour separately, and complement self-reported perceptions with workplace observations and operational performance indicators. Such research could help identify context-sensitive approaches that support employee participation while maintaining clear food safety expectations.

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POSTER

Investigation of the Effect of Processing Time on Color Stability in UHT Milk Desserts: Evaluation of ΔE Values

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In dairy desserts produced using UHT (Ultra-High Temperature) technology, the holding time in aseptic tanks after heat treatment and before filling is an important process parameter that may affect final product quality. Prolonged holding under the prevailing temperature conditions may lead to undesirable color changes associated with processes such as Maillard reactions and potential changes in colorants. Monitoring these changes is important for maintaining the visual quality of the products and improving the production process. This study aimed to investigate the effect of different tank holding times on the color stability of vanilla, strawberry, and banana UHT dairy desserts. Color measurements were performed using the L* (lightness), a* (redness–greenness), and b* (yellowness–blueness) parameters in the CIELAB color space. Color changes were compared using ΔE values, which represent the total color difference. Milovanovic et al. (2020) discussed the use of the CIELAB color space and the ΔE metric for evaluating color properties in milk and dairy products. Accordingly, $\Delta E \leq 3$ was defined as an operational evaluation criterion for this study. Process optimization aimed to identify tank holding times that meet this criterion to help maintain product color quality.

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Pesticides and Their Place in Food Safety

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Pesticides are substances used to prevent, destroy, repel, or control pests. They include; **Insecticides**, **Herbicides, Fungicides**, **Rodenticides**, **Nematicides** and **Plant growth regulators**. Pesticides can contribute to food security by protecting crops from pests and diseases. Without effective pest management, agricultural production may be reduced and food quality may deteriorate. Nevertheless, pesticides must be selected and applied carefully because misuse can lead to unnecessary exposure and environmental contamination.

What Are Pesticide Residues?

Pesticide residues are small amounts of pesticides or their breakdown products that may remain in or on food after treatment. Residues can result from; Incorrect application rates, Harvesting too soon after treatment, Use of unauthorised pesticides, Contaminated soil or water, Poor storage and handling practices.

Health Risks

The presence of a residue does not automatically mean that food is unsafe. Risk depends on the pesticide's toxicity, the residue concentration, and the amount and duration of exposure.

Risk is generally higher for agricultural workers and vulnerable groups such as children and pregnant people. Risks can be reduced with Good Agricultural Practices, Integrated Pest Management, Food Handling by Consumers.

High or repeated exposure may cause:

- Skin and eye irritation
- Headache, nausea, or dizziness
- Breathing difficulties
- Neurological effects
- Reproductive or developmental effects in some cases

Maximum Residue Limits

A **Maximum Residue Limit (MRL)** is the highest legally permitted concentration of a pesticide residue in or on food when the pesticide is used correctly. MRLs are established using:

- Toxicological studies
- Approved application methods
- Dietary exposure data
- Pre-harvest intervals
- Food-consumption patterns

Food exceeding an MRL does not automatically indicate an immediate health effect; the substance and exposure must be assessed.

Traceability and Testing

As Döhler, one of our agricultural partners Konfrut sources strawberries directly from the field. These raw materials go through multiple processing stages, **from IQF to FD strawberries**.

In 2023, we launched a **fully digital traceability** system to monitor pesticide residues throughout every stage - from the field to the final product. Powered by **blockchain technology**, this system allows us to track each batch, identify contamination sources, and take immediate risk management actions.

Conclusion

Pesticides remain important tools for protecting agricultural production, but their use must be science-based, controlled, and proportionate to the pest problem. Food safety depends on the correct selection and application of pesticides, observance of pre-harvest intervals, reliable monitoring, laboratory testing, and effective regulatory oversight. Protecting consumers, workers, and the environment requires responsible pesticide management at every stage of the food chain.

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POSTER

AI-Driven Product Genealogy and Integrated Digital Traceability for Food Safety Management in Food Supply Chains

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This study proposes an AI-driven digital framework to address fragmented information, limited traceability, and documentation challenges across food supply chains. The framework is built around a product-genealogy-based relational data architecture that connects raw materials, suppliers, product specifications, production processes, processing events, batches, lots, and shipments. By recording relationships and transformations, including lot splitting and merging, the architecture is designed to support both backward and forward traceability from raw material origin to the final product and its distribution. Product and lot records are linked to digital evidence, including technical specifications, certificates, laboratory analysis reports, quality records, and food safety documentation. The framework distinguishes statutory regulatory obligations from buyer-defined requirements. Corporate buyers can define and communicate their own product specifications, technical conditions, quality criteria, and organisation-specific documentation requests, while suppliers can submit, maintain, and update the corresponding product information and supporting evidence within the same digital environment. The conceptual architecture is informed by established food traceability principles, including Article 18 of Regulation (EC) No 178/2002 and the Codex Alimentarius traceability guidelines (CAC/GL 60-2006). An integrated artificial intelligence (AI) layer is proposed to extend the framework beyond record storage. Its functions include monitoring relevant regulatory developments, identifying potentially affected requirements and records, notifying relevant stakeholders, and supporting the preparation and organisation of documentation. AI-assisted document analysis is intended to classify submitted files, extract key information, review validity dates, and flag missing, expired, or inconsistent evidence. The layer also supports matching documents to regulatory or buyer-defined requirements and providing suppliers with tailored guidance and training resources. Risk indicators and suggested follow-up actions may be generated to assist decision-making; however, regulatory interpretation, verification of authenticity, and final compliance decisions remain subject to competent human review.

The proposed framework integrates product genealogy, digital evidence management, regulatory intelligence, and buyer-supplier collaboration within a common information structure. Its central contribution is to connect the physical movement and transformation of food products with the requirements and documentary evidence needed to demonstrate traceability and food safety management. This approach is intended to reduce fragmentation between independently maintained records, improve the accessibility and controlled reuse of supplier evidence, and provide a more consistent overview of product, lot, and supplier status. For corporate buyers, the framework offers a structured means of communicating requirements and reviewing supplier-provided information; for suppliers, it provides a shared environment for understanding requests, maintaining records, and receiving practical guidance. AI-assisted workflows are expected to reduce repetitive manual activities, simplify document preparation and retrieval, minimise administrative workload, and enable more efficient use of human and operational resources. These capabilities may be particularly valuable to small and medium-sized food businesses that face resource constraints when responding to multiple customer requirements and maintaining current documentation. In addition, linking product genealogy with regulatory and buyer-specific requirements may strengthen supply chain transparency and support more informed risk-based oversight. The framework is presented as a conceptual system architecture rather than a fully validated operational product, and no measured performance improvements are claimed at this stage. Further work should include prototype implementation, assessment with representative food businesses, and evaluation of data quality, interoperability, document-analysis accuracy, usability, and the time and resource implications of the proposed workflows. Such validation will be necessary to determine the framework's practical effectiveness and its contribution to more integrated food safety and traceability management.

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