



JOINT FAO/WHO FOOD STANDARDS PROGRAMME

CODEx ALIMENTARIUS COMMISSION

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FOOD SAFETY ASPECTS OF SOME NEW FOOD SOURCES AND PRODUCTION SYSTEMS AND EXPLORATION OF FUTURE LANDSCAPE OF THE SECTOR USING FORESIGHT

(Prepared by FAO)

Background

New food sources and production systems (NFPS) can play a critical role in the transformation of our agrifood systems by diversifying our current ways of producing food. NFPS is a fast-expanding, innovative sector that covers a range of areas ([FAO, 2022](#)¹). With promising potential, the NFPS sector is here to stay with certain products already on some supermarket shelves. However, as the term 'new' implies the sector will be subject to constant evolution and development, making it important for FAO to proactively take stock of the emerging areas and evaluate their associated opportunities and challenges. One of the key challenges is the identification of food safety hazards linked to various areas under NFPS, which underpins food safety risk assessments, and can subsequently guide the development of relevant standards and/or other management measures needed to propel the sector forward.

Food Safety Foresight Technical Meeting

Given this context and aiming to also build on the previous work of FAO in the area (FAO, 2022), the [Food Safety Foresight Programme](#)² of the Food Systems and Food Safety Division of FAO organized a [technical meeting](#)³ (13-17 November) to discuss the food safety aspects of *i*) plant-based food products; *ii*) new applications of precision fermentation; and *iii*) 3D food printing. These areas were chosen based on their current popularity, their relevance to food safety and the future potential for their growth.

The meeting was attended by 21 participants who came from different geographic regions and brought a wide range of expertise pertaining to the subject areas of the meeting. In addition to the food safety discussions around the three focus areas, foresight approaches were used at the meeting to illustrate the possible future landscape of NFPS. More specifically the meeting *i*) identified emerging innovations in the NFPS space; *ii*) described their

¹ FAO. 2022. Thinking about the future of food safety – A foresight report. Rome.

<https://www.fao.org/documents/card/en/c/cb8667en>

² FAO Food Safety and Quality website. 2023. Scientific advice – Foresight.

<https://www.fao.org/food-safety/scientific-advice/foresight/en/>

³ FAO Food Safety and Quality website. 2023. News - Experts look to the future for safety of new food production systems.

<https://www.fao.org/food-safety/news/news-details/en/c/1662307/>

opportunities and challenges (including the feasibility and impacts); and *iii*) broadly explored the various steps needed to optimize opportunities and circumvent the challenges identified.

Next steps

The full report capturing the deliberations at the meeting will be released in 2024 and FAO will keep the Codex membership informed on the release of the document. The [summary conclusions](#)⁴ of the meeting are published and also available in Annex I of this CRD.

It is hoped that the outcome of the meeting will encourage greater global discussions and collaborations pertaining to the food safety aspects of NFPS. Such discussions are vital to protect consumer health and ensure fair trade, while enabling innovations in the NFPS sector to achieve their full potential. FAO remains available for further technical support and engagement in this area.

⁴ Food Safety Foresight Technical Meeting on New Food Sources and Production Systems, FAO HQ, Rome, Italy: 13 – 17 November 2023. Summary and conclusions. <https://www.fao.org/3/cc8832en/cc8832en.pdf>

ANNEX I Summary conclusions

Conclusions and way forward

Overarching conclusions

- In general, the food safety hazards associated with the NFPS under consideration are similar to those linked with conventional foods. However, new production and processing technologies may introduce conditions that are unique to a particular NFPS and may require close attention from a food safety perspective.
- When conducting safety assessments on new food sources, the intended uses of final products should be a key consideration.
- Provisions contained in the Codex standards are applicable to new food sources and new production systems. Codex Alimentarius has developed and continuously works on standards for all types of foods, whether processed, semi-processed or raw. The standards include provisions on food hygiene, food additives, residues of pesticides and veterinary drugs, contaminants, labelling and presentation, methods of analysis and sampling, and import and export inspection and certification. However, there may be some unique food safety aspects and impacts of NFPS which may need further risk analysis and could lead to revision of existing standards and/or the drafting of new ones.
- The foresight exercise conducted at the meeting highlighted the importance of applying forward-thinking approaches to stay abreast of emerging areas with food safety implications, such as within the sector of NFPS.
 - Such foresight approaches promote strategic preparedness among the food safety community to not only proactively address challenges but also to optimize opportunities that such emerging areas may bring.

Plant-based food products⁵

- Food safety implications for plant-based food products depend on how the plants are grown, harvested, stored, transported, and processed to obtain the functional ingredients.
- While new plant-based food ingredients can provide sustainability benefits, new hazards may be introduced if food products are based on plants not traditionally used for food purposes, especially if the plant is a primary component, and increased exposure of consumers to known hazards may also occur.
 - Of concern is the potential for increased consumer exposure to toxins, agrochemicals, and heavy metals, due to the nature of plant production. Allergenicity resulting from the consumption of new proteins or increased consumption of proteins from plant-based sources may also require specific assessment.
- Consumers may perceive plant-based food products as microbiologically safer than their conventional animal-derived counterparts, and so may not appropriately handle the products to the same extent, including cooking and storage. This may lead to additional food safety risks which could be mitigated by proper labeling and consumer education.

Precision fermentation⁶

- Precision fermentation is not a new technology and has been used to produce various food ingredients for decades. Nonetheless, this field is rapidly evolving, and novel technologies and applications may introduce food safety challenges which require ongoing risk assessment from the food safety community.
- Safety considerations around new applications of precision fermentation include allergenic risks of proteins that either mimic existing allergens, are altered in a way that may be allergenic, or may not previously have been identified as allergens. Appropriate safety assessments, labelling and consumer messaging will continue to be important tools in addressing allergen risks.
- The variability in purification steps and varying target purity of final products may introduce food safety challenges.

⁵ For the purpose of this meeting, plant-derived products that generally mimic animal-derived foods such as meat, seafood, fish, eggs and dairy products are collectively called plant-based food products.

⁶ Precision fermentation does not have an internationally agreed definition and therefore the working definition has been set for the purpose of this meeting as the controlled cultivation of modified microbial cells to produce specific food products and ingredients.

- Moving from laboratory to industrial scale is required during the commercialization of precision fermentation produced ingredients. This scale-up may introduce challenges that are relevant to food safety, particularly when sourcing alternative raw materials for feedstock, ensuring strain stability, and developing scale-appropriate hazard control measures.
- Effective monitoring of precision fermentation manufacturing in line with established safety management guidelines is an important component in preventing contamination during manufacturing.

3D food printing⁷

- Although 3D food printing (3DFP) is a new food production method, most of the potential hazards associated with it are common to other food production processes and can be addressed by existing food safety risk assessments and appropriate hygiene protocols.
- 3DFP can be an enabling technology for other food innovations, which themselves may have food safety implications.
- As with other food processing equipment:
 - hygienic design principles should be used in the development process of the machine and associated consumables. This will help to prevent potential food safety issues.
 - consumer education around hygienic use of at-home 3D food printers is important to minimize potential food safety risks.

Data gaps and research needs

Plant-based food products

- Research on the safety of animal-derived food products may not always fully translate to plant-based food products which may need to be assessed further. For example, there is limited microbiological research specific to plant-based food products, such as on the types and sources of spores and the potential for pathogenic bacteria survival and growth, dependent upon packaging conditions and holding temperatures throughout the distribution chain.
- Gaps in allergenicity research include food safety risks from increasing exposure to plant-based proteins and potential for food allergies when plants not traditionally used are utilized in plant-based food products.
- There is research on mycotoxins in plant-based food products, but limited knowledge in the area of the presence of masked and emerging mycotoxins in these foods.
- Environmental contaminants, like per- and polyfluorinated substances (PFAS), residues of pharmaceutical or veterinary drugs, heavy metals, and/or micro- and nanoplastics, in plant-based food products may need further research.
- The toxicology of plant secondary metabolites (particularly of plants not traditionally used for food purposes) is an area where further research will be important.

Precision fermentation

- Lack of detection techniques for real-time, cost-effective appropriate monitoring of specific contaminants during precision fermentation remains an important gap.
- Additional research on allergenicity to inform safety assessment could be valuable in evaluating products produced via precision fermentation.

3D food printing

- There is limited information on the impact that some new post-printing methods, such as laser cooking, applied to provide structure stability to 3D printed foods, may have on food safety.
- Gap exists in our understanding of how consumers are likely to interact with 3D food printing devices intended for home use, related consumables, and their products, and how they will maintain required hygienic practices.

⁷ Additive manufacturing (AM) is a process of building three-dimensional objects from pre-programmed 3D digital models by adding materials in a layer-by-layer fashion using various techniques that allow a precise spatial arrangement. This process may include extrusion or 3D printing with food ingredients.