Food Industries Association of Queensland Inc.

FIAQ Food Safety Conference 2025
Pathogens finding new homes

Sofroni Eglezos

Date - 4th of June from 8:30am at the Colmslie Hotel
Time of your talk - 9:20am
Length of talk - 20 min with 5 min for Q&A

Brief: The subject that we have listed you for is "Pathogens finding new homes". This is looking at some of the new food systems that are being developed (cell culture and other plant based alternatives etc) and new outbreaks in existing products (E-coli in bottled water etc).

1.3 The Codex Alimentarius Commission adopted the revised Code of Practice (General Principles of Food Hygiene (CXC 1-1969) and its HACCP annex) in September 2020.

Which of the below is an adjusted or additional requirement to HACCP2003?

A. Cleaning and Disinfection procedures: Codification of the premise that *"the risk of microbial transfer from a contaminated surface to edible items is negligible when the duration of contact is no more than five seconds."*

B. Food Safety Culture: in Management Commitment to Food Safety. *"Fundamental to the successful functioning of any food hygiene system is the establishment and maintenance of a positive food safety culture acknowledging the importance of human behaviour in providing safe and suitable food."*

C. **GMO Food Safety:** Codification that food produced using gene technology defined as *"food which has been derived or developed from an organism which has been modified by gene technology"* is comparable to its conventional counterpart in relation to health risks and benefits.

D. **RACCP:** Religious Analysis Critical Control Points, a harmonisation of requirements for compliance to Halal and Kosher dietary laws which deal predominantly with allowed animals, the prohibition of blood, and the prohibition of mixing milk and meat. Additionally, alcohol is prohibited.

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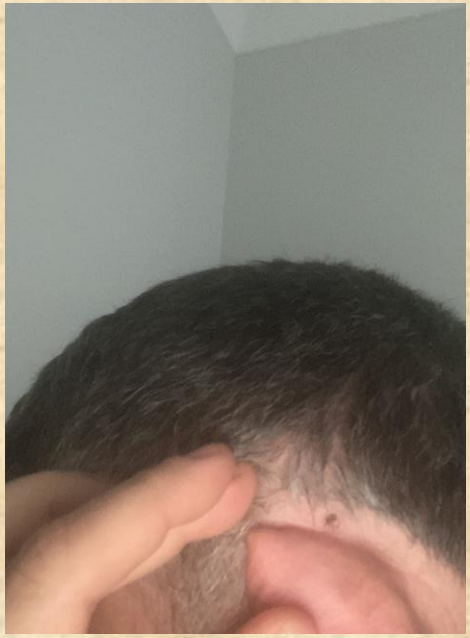
- **Food Microbiologist now Transitioning / value adding as a Food Safety Auditor.**
- **Great way to see beautiful people!**
- **Great way to see beautiful facilities!**
- **Great way to see our beautiful country!**

Meanwhile, while crabbing..



3.1 Which of the below is an allergic condition associated with tick bite?

A. Mammalian Meat Allergy
B. LESS COMMONLY Mammalian Milks and products Allergy
C. Tick Anaphylaxis
D. All three above
E. None of the three above
F. Only A and C

3.1 Which of the below is an allergic condition associated with tick bite? D. All of the above

https://allergyfacts.org.au/allergy-anaphylaxis/food-allergens/mammalian-meat-allergy

New Outbreaks in Existing Systems

- *Salmonella Newport in produce*
- *E.coli in bottled water (new-ish)*

Food microbial ecology

- **Food microbial ecology** is the study of the composition, structure, dynamics, and functional roles of microbial communities associated with food products and food production environments. It encompasses both beneficial and undesirable microorganisms, focusing on their interactions with each other, with food matrices, and with environmental factors throughout the farm-to-fork continuum.

    - Lets keep this in mind.

Economic loss

- Food contaminated by pathogenic and spoilage bacteria are a source of major economic impacts due to recall, loss of product, investigation to identify the source of contamination, costs of increased insurance and loss of consumer confidence in product and brand.

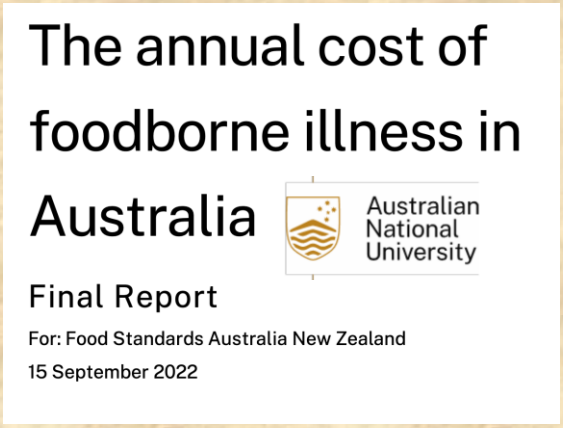


Table 1: Cases, cost per case, and total cost of illness for all foodborne pathogens, total gastroenteritis and priority pathogens.

Pathogen	Number of cases, n (90% UI)	Cost per case in AUD (90% UI)	Median costs in thousands of AUD (90% Uncertainty Intervals†)	
			Cost of initial illness	Cost of illness and sequelae
All foodborne pathogens	4,680,000 (2,640,000 – 7,540,000)	526 (431 – 688)	2,200,000 (1,410,000 – 3,440,000)	2,440,000 (1,650,000 – 3,680,000)
Total gastroenteritis	4,670,000 (2,620,000 – 7,520,000)	507 (417 – 660)	2,100,000 (1,310,000 – 3,340,000)	2,350,000 (1,550,000 – 3,590,000)
Campylobacter	264,000	1,390	179,000 (123,000 – 277,000)	365,000 (250,000 – 553,000)
Listeria monocytogenes	101 (50.5 – 151)	785,000 (482,000 – 1,590,000)	78,400 (58,600 – 103,000)	No sequelae
Non-typhoidal *Salmonella*	(34,300 – 109,000)	(1,640 – 3,360)	103,000 (78,800 – 135,000)	140,000 (102,000 – 201,000)
Norovirus	328,000 (89,600 – 671,000)	396 (328 – 545)	128,000 (42,500 – 262,000)	No sequelae
Shigella	1,930 (662 – 4,360)	1,740 (1,310 – 3,220)	2,310 (1,370 – 3,820)	3,410 (1,840 – 6,170)
Shiga-toxin producing *Escherichia coli* (STEC)	2,630 (1,140 – 5,760)	4,330 (2,210 – 10,000)	2,470 (1,190 – 5,020)	11,700 (7,260 – 18,300)
Other pathogenic *Escherichia coli*	312,000 (120,000 – 709,000)	422 (359 – 533)	133,000 (51,900 – 306,000)	No sequelae
Salmonella Typhi	28.6 (9.57 – 64.4)	15,100 (11,700 – 33,200)	468 (189 – 956)	No sequelae
Toxoplasma gondii	15,500 (6,130 – 27,500)	840 (588 – 1,640)	13,100 (8,120 – 19,500)	No sequelae
Yersinia enterocolitica	7,170 (3,960 – 12,600)	1,430 (986 – 2,270)	7,480 (4,430 – 12,300)	10,400 (6,150 – 17,100)

† Uncertainty intervals are provided by the model, which incorporates distributions for inputs, capturing variability and uncertainty in data.

FSANZ Definition of Foodborne Pathogens

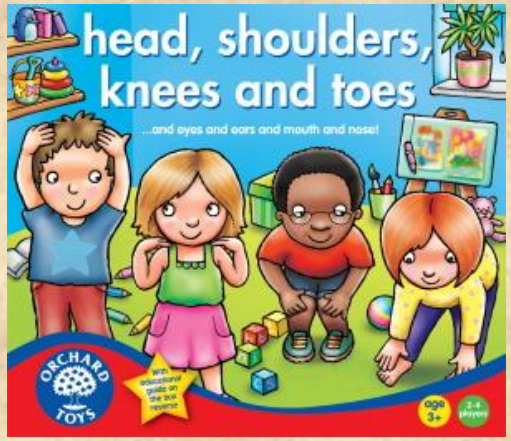
microorganisms—such as bacteria, viruses, parasites, and prions—that can cause illness when ingested through contaminated food. These pathogens are responsible for foodborne diseases, which are illnesses likely to be transmitted through consumption of contaminated food.

Salmonella found worldwide;

- Widespread occurrence in animals, especially in poultry and swine.
- Foods of animal origin and those subject to sewage pollution have been identified as transmitting these pathogens to humans and processing equipment.
  - **Foods involved include raw meats, poultry, eggs, milk and dairy products, fish, shrimp, frog legs, yeast, coconut, sauces and salad dressing, cake mixes, cream-filled desserts and toppings, dried gelatin, peanut butter, tree nuts, cocoa, and chocolate.**
- Environmental sources of the organism include water, soil, insects and factory surfaces. Cross contamination is produced by contaminated raw foods during processing; *Salmonella* can become established and multiply in both the environment and equipment of food-processing facilities.
  - **Infections not all a result of foodborne illness but may include zoonotic transmission etc.**

Salmonella symptoms

- Headache
- Fever
- Nausea
- Cramps
- Vomiting
- Diarrhoea



- Most people infected with salmonella develop diarrhoea, fever and abdominal cramps within 8 to 72 hours.
- The illness may lasts two to seven days.
- Most people recover without treatment – some may need hospitalization because of severe diarrhea.
- Typhoid fever (*Salmonella typhi*) more severe and protracted form of disease.

frontiers in Microbiology

Front Microbiol. 2018 May 18;9:877. doi: 10.3389/fmicb.2018.00877

Genome-Wide Comparative Functional Analyses Reveal Adaptations of *Salmonella* sv. Newport to a Plant Colonization Lifestyle

Marcos H de Moraes [1,*], Emanuel Becerra Soto [2,†], Isai Salas González [2,3,5,†], Prerak Desai [6,‡], Weiping Chu [6], Steffen Porwollik [6], Michael McClelland [6], Max Teplitski [1]

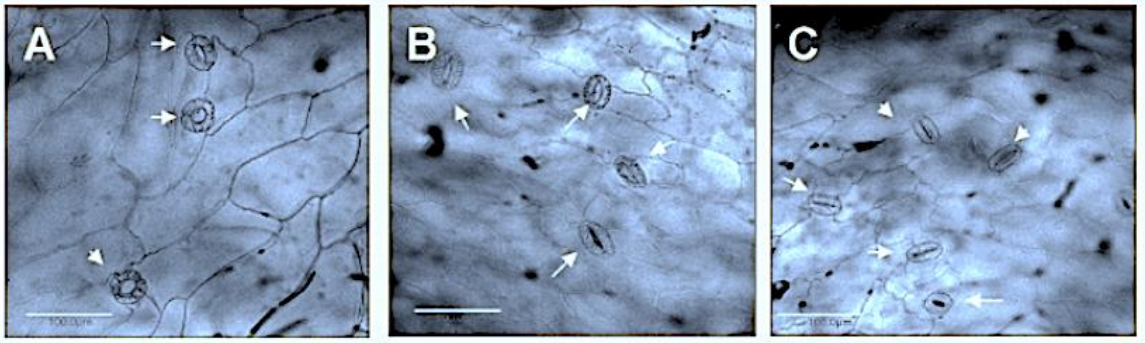
Salmonella Newport Adapting to Plant Hosts

- *Salmonella enterica* is a zoonotic pathogen traditionally linked to animal hosts and contaminated animal products. However, in recent years, **serovar Newport** has been repeatedly implicated in **large outbreaks** linked to **plant-based foods** — including **cucumbers, tomatoes, and leafy greens**.

- **2018–2020 outbreaks** in the U.S. linked to *Salmonella Newport* in:
  - **Cucumbers** (2018)
  - **Red onions** (2020 – caused over 1,100 cases across 47 US states
  - **Tomatoes and leafy greens** in earlier clusters
- These outbreaks suggest a **stable adaptation** of *S. Newport* to non-animal reservoirs.

The Adaptation: Pathogen Finding a New Home in Plants

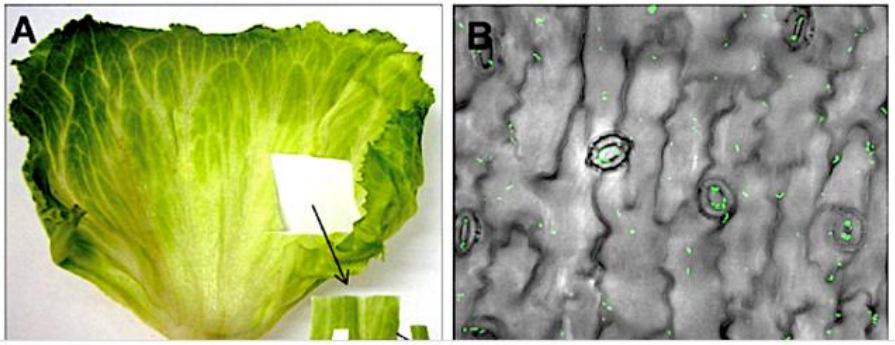
- *Salmonella Newport* has **adapted to survive and colonize plant surfaces**
- It can **attach to stomata and root structures**, using **adhesins and secretion systems** to invade plant cells.
- It tolerates **plant defense chemicals** and **low-nutrient, aerobic environments** on leaf surfaces and cut edges.
- Research shows the pathogen can **mimic plant hormone signalling**, enabling it to enter and persist in plant tissues.



Salmonella penetration through stomata

https://plantstomata.wordpress.com/2018/05/07/salmonella-penetration-through-stomata/

FIG. 3. Microscopic photomicrographs showing stomatal guard cells (white arrows) following 20 min of preconditioning at the following light intensities: 100 (A), 3 (B), and 0 (C) $\mu E\ m^{-2}\ s^{-1}$. Bars, 100 μm.



PATHOGEN Salmonella Newport - The Empire Strikes Back (New Strategies)

Food Safety Implications (Host Response):

- Washing alone often fails to remove internalized bacteria.
- Control strategies now focus on:

  Pre-harvest interventions (e.g., irrigation water quality, soil amendments)

  Genomic surveillance , WGS -to track persistence in plant supply chains

  Post-harvest controls including better cold chain management and anti-biofilm sanitation

International Journal of
Environmental Research and Public Health

MDPI

Article

A Community Waterborne *Salmonella* Bovismorbificans Outbreak in Greece

Lida Politi [1], Kassiani Mellou [2,*], Anthi Chrysostomou [3], Georgia Mandilara [4], Ioanna Spiliopoulou [5], Antonia Theofilou [6], Michalis Polemis [7], Kyriaki Tryfinopoulou [5] and Theologia Sideroglou [3]

Int. J. Environ. Res. Public Health **2024**, *21*(2), 167; https://doi.org/10.3390/ijerph21020167

Salmonella Bovismorbificans outbreak occurred in a small town in Southern Greece.
33 confirmed/probable/possible cases were identified, with **tap water** consumption as the only statistically significant risk factor (OR = 5.46).

Limited and inconsistent **water sampling and testing**
Absence of chlorination records and unclear maintenance practices complicated root cause analysis.

Inspection of the water supply system revealed that there was a plot used for grazing **sheep** in the catchment area close to the water intakes (15 m).

Western Pac Surveill Response J. 2012 Nov 13;3(4):20–24. doi: 10.5365/WPSAR.2012.3.4.009

An outbreak of acute gastroenteritis associated with contaminated bottled water in a university – Jiangxi, China, 2012

Ruiping Wang [a,b], Huijian Cheng [c,✉], Jun Zong [c], Ping Yu [c], Weijie Fu [c], Fuqiang Yang [c], Guoqing Shi [a], Guang Zeng [a]

417 cases – an attack rate (AR) of 4.7% (417/8781) for the university.

Escherichia coli O157 and ***Enterotoxigenic Escherichia coli (ETEC) O55:K19*** were isolated from two unopened bottled water specimens.

Enteropathogenic Escherichia coli (EPEC) O126:K71, EPEC O125:K70, EPEC O44:K74 and *ETEC O15:K17* were isolated from one faecal and three anal swabs, respectively. The ETEC O15:K17 from the faecal specimen was verified as heat labile toxin positive, with all other pathogenic bacteria testing negative for the toxin.

In recent years, bottled water has become more popular in China because of its lower price and because it can be drunk directly (without boiling).

International Journal of Environmental Research and Public Health

MDPI

Int J Environ Res Public Health. 2024 Aug 15;21(8):1074. doi: 10.3390/ijerph21081074

Consumption of Bottled Water and Chronic Diseases: A Nationwide Cross-Sectional Study

Jacopo Dolcini [1], Manuela Chiavarini [1,*], Giorgio Firmani [1,*], Elisa Ponzio [1], Marcello Mario D'Errico [1], Pamela Barbadoro [1]

Microplastics & Bottled Water

•Plastic pollution breaks into microplastics (<5 mm) and nanoplastics (<1 μm)
•These particles can enter human tissues, with unclear long-term effects
•1Lof bottled water contains ~240,000 plastic particles

Study Overview

•Italian national survey data (N = 45,597) analysed
•Used logistic regression to assess bottled water consumption and chronic disease risk
•Controlled for age, gender, education, and economic factors

Key Findings

•Bottled water use linked with higher odds of:

- **Hypertension (OR = 1.05),**
- **Ulcers (OR = 1.21)**
- **Diabetes (OR = 1.09)**
- **Kidney stones (OR = 1.17)**

•Results suggest need for **public awareness and preventive strategies**

Emerging Food Systems

- Plant-based alternatives (Listeria monocytogenes in Vegan Cheese)
- Cell-cultured Quail
- FMT
- Synthetic Food from Faecal Substrates
- Insect-based proteins
- Synthetic Food from Faecal Substrates - experimental

New Pathogen Risks

- Lack of historical data on novel substrates
- Contamination during fermentation or cell culture
- Unknown interactions with packaging and storage environments
- Case study: *Listeria in vegan cheese*

European Outbreak Linked to Vegan Cheese

The NEW ENGLAND JOURNAL of MEDICINE

CURRENT ISSUE SPECIALTIES TOPICS

CORRESPONDENCE

Outbreak of Listeriosis Associated with Consumption of Vegan Cheese

Published April 17, 2024 | N Engl J Med 2024;390:1439-1440 | DOI: 10.1056/NEJMc2400665 | VOL. 390 NO. 15

- 2022, a listeriosis outbreak in Europe
- including four pregnant women in France who gave birth prematurely, and cases were also reported in Belgium, Germany, and the Netherlands.
- Investigations revealed that the proliferation rate of *Listeria monocytogenes* was actually higher in vegan milk than in raw animal milk. This is attributed to the **physicochemical properties of plant-based milks, such as pH and water activity,** which can support the growth of *L. monocytogenes*.
- Made from **raw almond, cashew, or coconut milk**, these alternative semisoft cheese substitutes mimic dairy cheeses (e.g., Camembert, goat cheese, and blue cheese
- Promoted as being healthier to consume than dairy cheeses and free of zoonotic foodborne pathogens because they are plant-based. However, these products **did not undergo a kill step** such as pasteurization that could control contamination at the level of raw materials or from a contaminated production or postproduction environment.

Standard Quail

Cultured Quail

Approved Application A1269, permitting the use of cultured quail cells

Food Standards Australia New Zealand (FSANZ) has approved Application A1269, permitting the use of cultured quail cells as a novel food ingredient in Australia and New Zealand. This marks the first approval of a cell-cultured meat product in the region.

Key Points:

- **Applicant:** Vow Group Pty Ltd, an Australian biotechnology company, submitted the application to amend the Food Standards Code to allow the use of cultured quail cells derived from embryonic fibroblasts of Japanese quail (*Coturnix japonica*).
- **Safety Assessment:** FSANZ conducted a comprehensive evaluation, including chemical, nutritional, microbiological, and dietary exposure assessments, concluding that the product is safe for human consumption under the proposed conditions of use

Key Points: (cont'd)

- **Production Process:** The cultured quail cells are produced through cellular agriculture, involving the growth of animal cells in a controlled environment using a nutrient-rich medium, without the need to raise and slaughter animals.
- **Regulatory Conditions:** The approval includes specific conditions:
  - **Permitted Cell Line:** Only the cell line 221523-Fib-Quail is authorized for use.
  - **Product Form:** The cultured quail must not be sold as a standalone food for retail sale but can be used as an ingredient in other food products.
  - **Labelling Requirements:** Products must include terms like "cell-cultured" or "cell-cultivated" alongside the animal name and cannot use terms like "meat" or "poultry meat" unless directly accompanied by the required terminology.

The Risk Assessment

- Food Standards Australia New Zealand (FSANZ) conducted a comprehensive hazard and risk assessment for Application A1269, which proposed the use of cultured quail cells as a novel food ingredient. This assessment focused on three key areas: the cell line, the production process, and the harvested cells.

Cell Line Assessment:

- The cultured quail cells are derived from embryonic fibroblasts of Japanese quail (*Coturnix japonica*).
- FSANZ evaluated the genetic stability of the cell line and found it to be stable, with minimal microbiological hazards associated with cell line sourcing.

Production Process:

- The production involves expanding the cell line to a desired density in a controlled environment.
- FSANZ assessed the potential health risks associated with substances used in the production process and found no safety concerns at the estimated consumption levels.

Harvested Cells:

- The harvested cells are intended to be mixed with other ingredients to produce final food products.
- FSANZ concluded that the harvested cells are unlikely to pose a food allergenicity concern for the general population.
- Nutritional assessments indicated no risks from the consumption of the harvested cells, especially considering their likely infrequent consumption.
- Overall, FSANZ determined that the cultured quail cells are safe for human consumption under the proposed conditions of use. The assessment did not identify any toxicological, nutritional, or allergenicity concerns.

FSANZ Risk Assessment: Cultured Quail (Application A1269)

1. Cell Line Characterisation

- The quail cells are derived from **embryonic fibroblasts** of *Coturnix japonica*.
- The submitted data demonstrated **genetic stability** over multiple passages.
- No evidence of spontaneous immortalisation or transformation into abnormal growth patterns was found.
- The cell line was screened for **microbiological hazards** and contaminants such as bacteria, fungi, mycoplasma, and viruses. None were detected.

2. Production Process Evaluation

- The manufacturing process involves **in vitro culturing** of quail cells in a controlled bioreactor system, using a **serum-free, chemically defined medium**.
- Growth factors, cytokines, and nutrients are used to stimulate proliferation but are removed during downstream processing.
- FSANZ assessed the likelihood of any **residual chemicals** or **process-related contaminants** remaining in the final product and concluded that they were either:
  - Undetectable, or Present at levels far below any safety concern.

3. Compositional and Nutritional Analysis

- The harvested cultured quail cells were found to contain:
  - Comparable **macronutrient composition** (protein, fat) to conventional poultry meat.
  - Similar levels of **micronutrients**, including iron and B vitamins.
- The nutritional profile suggests that **consumption poses no nutritional disadvantage**.
- The food is **not expected to be a major contributor** to total dietary intake but rather a specialty or occasional-use ingredient.

FSANZ Risk Assessment: Cultured Quail (Application A1269)

4. Toxicological Risk Assessment

- No **novel toxins or harmful metabolites** were identified in the quail cell material.
- No use of genetic modification was involved in producing the cell line.
- There were no signals indicating **cytotoxicity, genotoxicity, or other toxic endpoints**.

5. Allergenicity Assessment

- A **bioinformatic comparison** of the quail cell proteome against known allergens was performed.
- While quail meat is not a major allergen, there are rare reports of **avian protein allergies** (e.g., "bird-egg syndrome").
- FSANZ concluded the **risk of allergenicity is low**, and equivalent to that of conventional quail meat.

6. Dietary Exposure Assessment

- Based on the proposed uses (as a food ingredient, not a standalone product), the estimated **dietary exposure is low**.
- No evidence was found suggesting **adverse effects from repeated or cumulative exposure**.

1. Cultured Cell Lines are a novel category, limited real-world, long-term data on its consumption performed
2. The risk assessment does **not include human clinical trials.**
4. Some elements of culture medium and downstream processing are **commercially confidential**.
5. Assumes Low and Controlled Use.

4.3.3 Microbiological criteria for cell-cultured food

Food safety criteria – standards

Cell-cultured quail is a new food with limited history of commercial food production or human consumption, with no assessed risk mitigation step and it readily supports microbial growth. FSANZ's conclusion is to include criteria for cell-cultured food in Schedule 27 for *Salmonella* spp. and *L. monocytogenes* (Table 1).

Table 1: Proposed mandatory food safety criteria for harvested cell biomass (Schedule 27)

Parameter tested	Proposed microbiological criteria[1]
Salmonella	n=5, c=0, m = not detected in 25g
Listeria monocytogenes	n=5, c=0, m = not detected in 25g

[1] n=number of sample units; c= number of sample units permitted to exceed m; m = the acceptable microbiological limit

L. monocytogenes and *Salmonella* spp. in food and the food production environment to be significant hazards for cell-cultured food, particularly during cell harvest and onwards through post-harvest processing; this is consistent for many food business producing potentially hazardous foods.

• There is limited history of use and thus evidence on the persistence of foodborne pathogens, viral or bacterial, in cell-cultured foods. No data could be found in literature on microbiological growth potential in or the stability of cell-cultured food. However by its very nature, a cell culture is designed for growing cells, including microbial cells.

• Microbiological data on the shelf-life of harvested cells (which is confidential commercial information) identified the biomass to be a potentially hazardous food; that is, it supported microbial growth.

• Microbiological specifications for cell-cultured food should be part of a food safety management system, with controls of hazards occurring at each relevant step.

• A treatment step has not been assessed as part of this application (i.e. cooking/further processing). FSANZ was unable to consider downstream risk mitigation. For instance, further processing and cooking would mitigate many of the microbiological risks with cell- cultured food.

The *Compendium of Microbiological Criteria for Food* recommends that food businesses implement a *L. monocytogenes* environmental monitoring program for presence of this food pathogen, to assist with managing this hazard in their processing environment.

Food hygiene criteria – guidance

- To support application of the processing standard and provide guidance on monitoring of process hygiene and control of cell-cultured food production, FSANZ will amend the *Compendium of Microbiological Criteria for Food* to include guideline limits as per Table 2.
- This information will be available to all cell culturing food businesses. T
- These limits take into account knowledge of effective hygiene monitoring and controls in other established food production systems, as well as the applicant's proposed microbiological specifications for the harvested cell biomass.
- These limits are established to support decision making about a food or process, with
- different consequences to those included in Schedule 27 if the limits are not met.

Table 2: FSANZ proposed process hygiene guideline limits for harvested cell biomass *(Compendium of microbiological criteria for food)*

Parameter tested	Proposed process hygiene guideline limit
Standard plate count	$<10^4$ (cfu/g)
Escherichia coli	<3 (MPN/g)
Enterobacteriaceae	<100 (cfu/g)
Yeasts and moulds	<10 (cfu/g)
Coagulase-positive staphylococci	<100(cfu/g)

Featured Article

"Cellular agriculture": current gaps between facts and claims regarding "cell-based meat"

Paul Wood,[†] Lieven Thorrez,[‡] Jean-François Hocquette,[ǂ] Declan Troy,[¥] and Mohammed Gagaoua[$]

[†]Monash University, Clayton, Victoria 3800, Australia
[‡]Tissue Engineering Lab, Department Development and Regeneration, KU Leuven Kulak, Kortrijk, Belgium
[ǂ]INRAE, University of Clermont Auvergne, Vetagro Sup, UMR Herbivores, Theix, 63122, Saint-Genès-Champanelle, France
[¥]Teagasc Food Research Centre, Ashtown, D15KN3K, Dublin, Ireland
[$]PEGASE, INRAE, Institut Agro, 35590 Saint-Gilles, France

April 2023, Vol. 13, No. 2

The economics of it just won't work – and it'll be terrible for the environment: Australia's leading expert on cell-based meat speaks out on latest study

05 June 2023

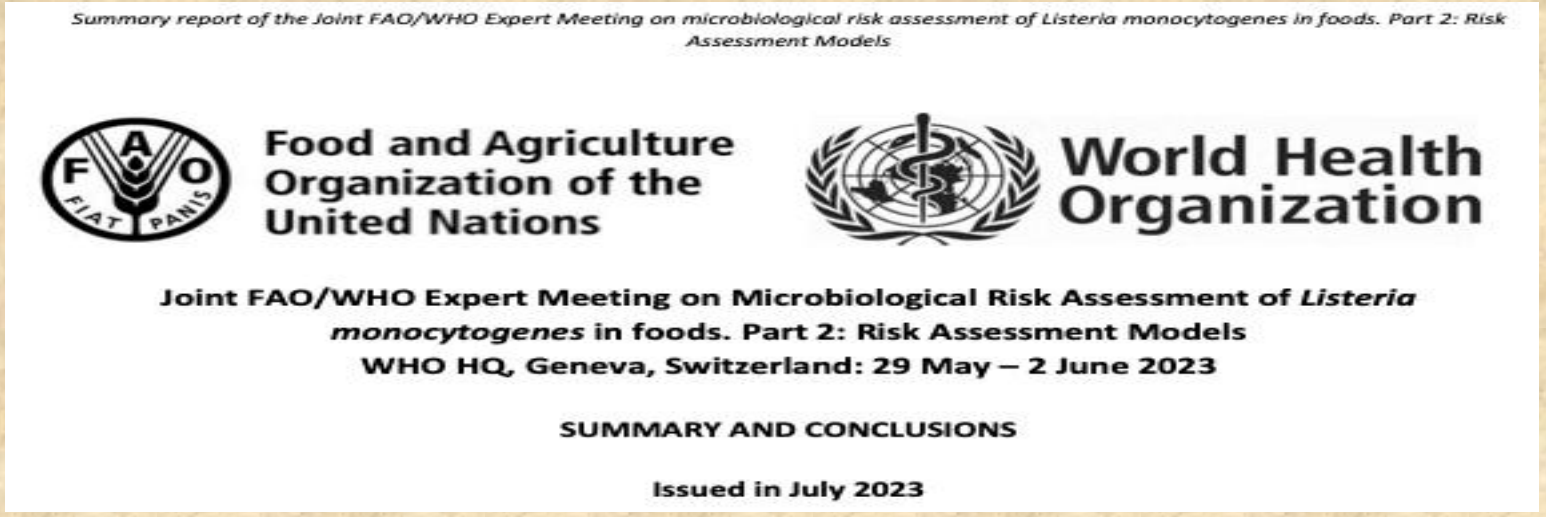
A fresh study on the environmental impacts of lab-grown meat has led an internationally recognised expert on the future of cell-based protein, Professor Paul Wood, AO, to confirm the economics of producing lab-grown meat at scale "just won't work" and will be less sustainable than traditional red meat production systems.

What Needs to Change?

- Proactive rather than reactive safety standards
- Risk assessments for alternative ingredients
- Cross-disciplinary collaboration (food science, microbiology, public health)
- Don’t forget the fundamentals

Consumer Perception

https://robalini.blogspot.com/2009/08/hungry-man-franken-food.html?utm_source=chatgpt.com



- https://cdn.who.int/media/docs/default-source/food-safety/jemra/jemra-listeria-part2-meeting-summary-and-conclusion.pdf

Conclusions from elaboration of the risk assessment models

Diced RTE cantaloupe

• The use of fit-for-purpose water in primary production was shown to reduce the risk.

• The use of an irrigation system that avoids the contact between water and the edible part of the crop also reduced the risk.

• Poor management of wash water increased the risk.

• Poor management of environmental hygiene during processing increased the risk.

• **Climate change** can considerably increase the risk as a result of its impact on different stages of the production-to-consumption chain, as tested in the model by assuming an increase of the prevalence of L. monocytogenes in soil, an increase of the quantity of soil transferred to produce (e.g. number of rainy weather days), a decrease of the agricultural water quality and an increase of storage temperature.

Faecal Microbiome Transplants

- **Clinically validated medical treatment** where screened, processed donor stool is transplanted into the gut of a recipient (usually via colonoscopy or capsules).
- Treats recurrent *Clostridioides (2016) difficile* infections, with very high success rates.
- Although not ingested as “food,” it technically involves **oral consumption of encapsulated faecal material** in some formulations.

1.4 The HACCP concept was first developed in the 1960s by X , working with Pilsbury, to ensure crumb- and pathogen-free food that had extensive shelf-life properties for space travel—the first pathogen monitoring and measurement requirement imposed on the food industry.

Who was X?

A. HACCP Alliance

B. KRAFT

C. IFS (International Food Standard)

D. ICMSF (International Commission on Microbiological Safety of Foods)

E. National Aeronautics and Space Administration (NASA)

F. Nestle

1.4 The HACCP concept was first developed in the 1960s by the U.S. National Aeronautics and Space Administration (**NASA**), working with X, to ensure crumb- and pathogen-free food that had extensive shelf-life properties for space travel—the first pathogen monitoring and measurement requirement imposed on the food industry.

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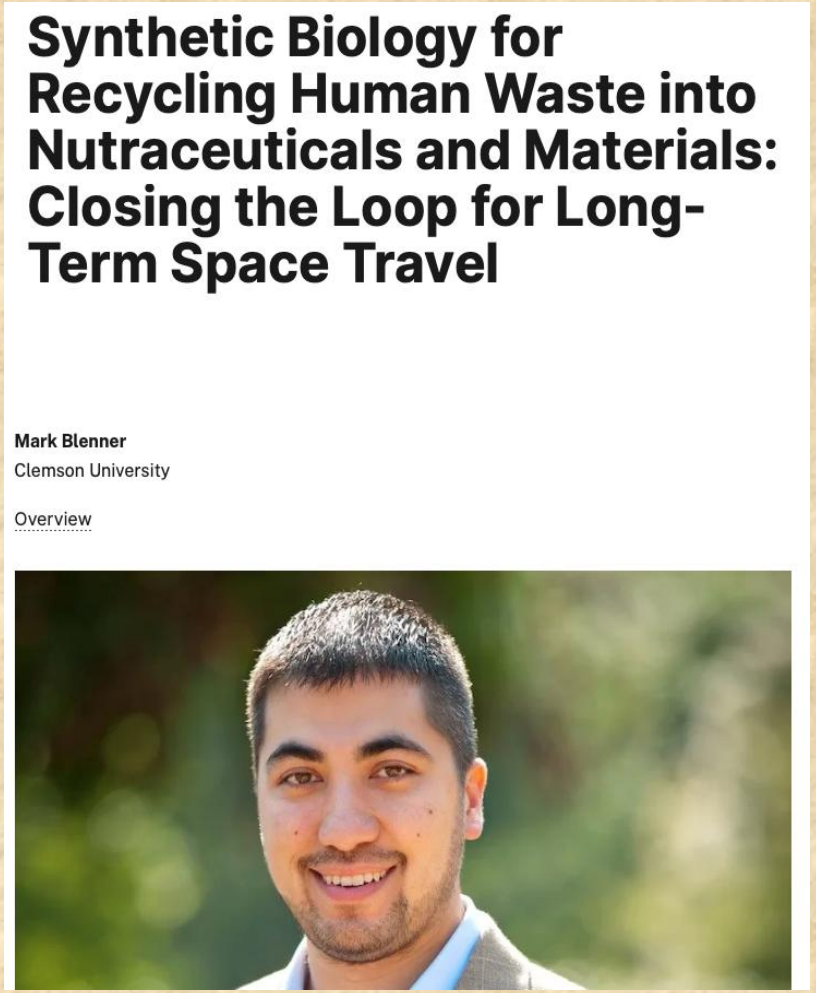
F. Nestle

https://www.google.com/search?client=safari&rls=en&q=pillsbury+company&ie=UTF-8&oe=UTF-8

Synthetic Food from Faecal Substrates - experimental

- Researchers have explored using **human or animal waste as a substrate** to grow **microbial protein** (e.g., single-cell protein from bacteria or fungi).
- NASA has funded research on using **human waste to grow edible microbial biomass** for long-term space missions.
- Engineering **yeast to utilize components of human waste** to produce nutritional compounds, including omega-3 fatty acids and proteins.
- This approach aims to close the loop in life support systems by recycling waste into valuable resources for astronauts.



https://www.nasa.gov/directorates/stmd/space-tech-research-grants/synthetic-biology-for-recycling-human-waste-into-nutraceuticals-and-materials-closing-the-loop-for-long-term-space-travel/?utm_source=chatgpt.com

Synthetic Food from Faecal Substrates (Experimental Biotechnology)

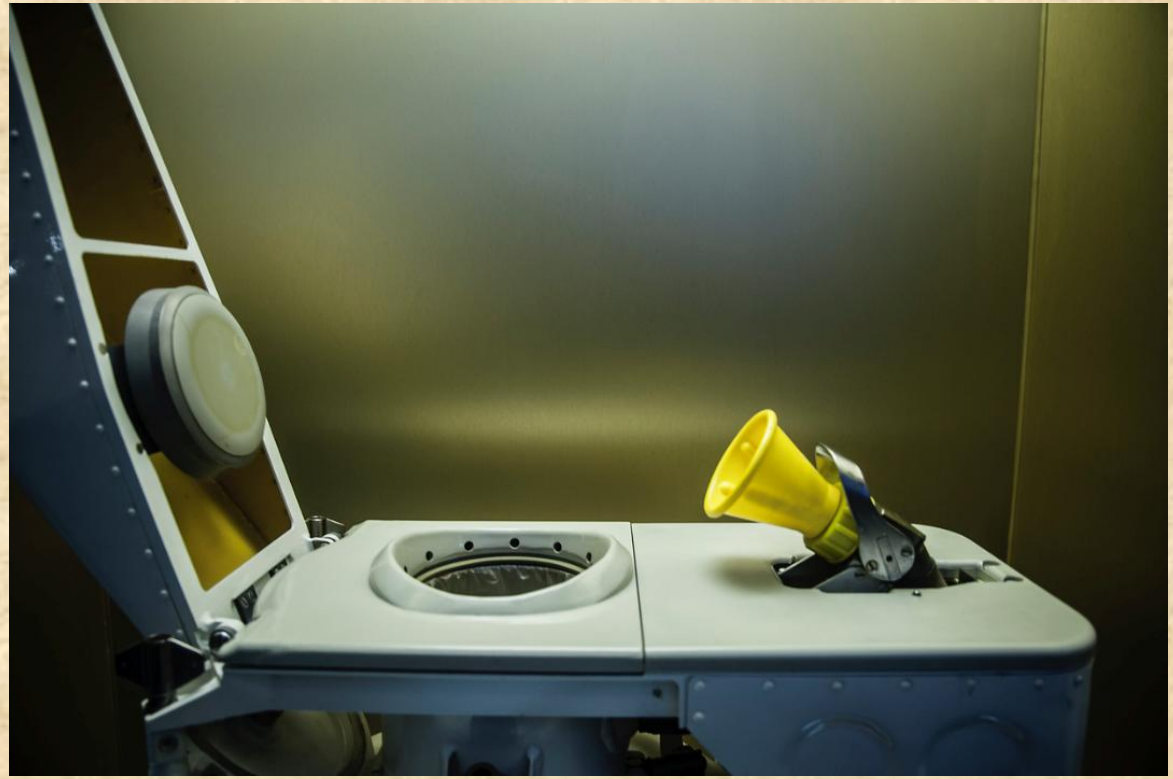
https://www.psu.edu/news/research/story/microbes-may-help-astronauts-transform-human-waste-food?utm_source=chatgpt.com

- Pennsylvania State University (NASA funded) demonstrated the feasibility of using microbial reactors to rapidly break down solid and liquid human waste, minimizing pathogen growth while producing edible microbial biomass.
- This research supports the potential for sustainable food production in space through waste recycling.

"Anaerobic digestion is something we use frequently on Earth for treating waste," "It's an efficient way of getting mass treated and recycled. What was novel about our work was taking the nutrients out of that stream and intentionally putting them into a microbial reactor to grow food."

Mark Blenner

Faeces as food - Synthetic Food from Faecal Substrates (Experimental Biotechnology)



This is an image of a **space toilet**, or **Zero-Gravity Waste Management System**, The **circular seat** is equipped with a suction mechanism to handle solid waste in microgravity.

•The **yellow funnel with hose** is used for urine collection, typically designed with separate funnels for male and female astronauts.

•The **containment and airflow system** ensures waste is directed into appropriate storage containers, using airflow rather than gravity.https://www.psu.edu/news/research/story/microbes-may-help-astronauts-transform-human-waste-food?utm_source=chatgpt.com

Synthetic Food from Faecal Substrates (Experimental Biotechnology)

Because pathogens are also a concern with growing microbes in an enclosed, humid space, the team studied ways to grow microbes in either an alkaline environment or a high-heat environment.

They raised the system's pH to 11 and were surprised to find a strain of the bacteria *Halomonas desiderata* that could thrive. The team found this bacteria to be 15 % protein and 7% fats. At 158F (70C), which kills most pathogens, they grew the edible *Thermus aquaticus*, which consisted of 61% protein and 16% fats.

Thermus aquaticus *is a thermophilic bacterium that has had a significant impact on modern food safety testing. What is it most famously known for?*

A. Being used to ferment ultra-spicy kimchi at volcanic temperatures

B. Providing a thermostable DNA polymerase used in PCR to detect foodborne pathogens

C. Enabling rapid amplification of vegan DNA in complex food matrices

D. Revolutionizing molecular diagnostics in food microbiology through LAMP amplification

Grand Prismatic Spring, Yellowstone National Park. Photo courtesy of the National Park Service.

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C. Enabling rapid amplification of vegan DNA in complex food matrices
D. Revolutionizing molecular diagnostics in food microbiology through thermal cycling compatibility
E. Supporting the development of reliable on-site testing for *Salmonella*, *Listeria*, and *E. coli* in food production environments

NB – Taq polymerase and PCR still widely used today (though there are High Fidelity Polymerases (eg Q5) qPCR / RT-qPCT, dPCR

ELSEVIER

Journal of Food Protection

Volume 88, Issue 7, 23 June 2025, 100528

General Interest

Testing Program Critical Control Points (TP-CCP): Characterizing and Optimizing Decision-making Power in Food Safety Testing

Joelle Mosso [1], Gustavo A. Reyes [1], Barbara Kowalcyk [2], De Ann Davis [1]

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https://doi.org/10.1016/j.jfp.2025.100528

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Highlights

- The TP-CCP framework focuses on the evaluation and optimization of testing programs.
- Framework includes sampling, testing, monitoring, and record-keeping principles.
- Establishes TP-CCP as a feedback loop for critical evaluation of testing programs.
- Enhances risk assessment with robust evaluation of microbiological methods.
- Proposes pilot testing for TP-CCP validation across diverse food industries.

TPCCP *tea-pa'-sip*

- Current frameworks lack a robust feedback loop for validating and monitoring testing systems.
- TPCCP Framework: A structured approach to evaluate and improve microbiological testing systems critical to food safety programs.
- Builds on the foundational principles of **HACCP** but applies them specifically to **testing systems** (e.g., sampling and microbiological testing), rather than production processes.
- Avoids false assurance from weak testing systems.

PRINCIPLE

1 IDENTIFY THE OBJECTIVE OF TESTING SYSTEM

- **A** Define responsible authority for program
- **B** Describe expected target prevalence (i.e., 0.5%)
- **C** Describe expected levels to be detected (i.e., 1 CFU/375g)
- **D** Describe expected contamination type (i.e., uniform, cluster, point-source)

2 IDENTIFY THE SAMPLING METHODOLOGY

- **A** Describe type of sampling to be used (random, stratified, aggregate, etc.)
- **B** Develop process to obtain samples
- **C** Ensure statistical capability to perform to needs

3 IDENTIFY THE TESTING METHODOLOGY

- **A** Review official validation for method choice
- **B** Review performance criteria to ensure method meets needs
- **C** Document official validation and extension
- **D** Document method conditions to be used
- **E** If no "like" matrix is on official validation, require full validation study

4 REVIEW LABORATORY AND SAMPLING ACTIVITIES

- **A** ISO 17025 accreditation requirements for suppliers
- **B** Perform supplier approval process to verify 17025 accreditation
- **C** Verify selected method will be performed per design criteria
- **D** Complete a review of the matrix verification/validation (as required)

5 DESIGN VERIFICATION AND MONITORING METHODS

- **A** Develop QC program to ensure the sampling program is executed per requirement
- **B** Monitor sampling plan performance and accuracy
- **C** Run blind "check" samples to monitor performance of method/lab combination
- **D** Complete annual review of program and "as-performed" values

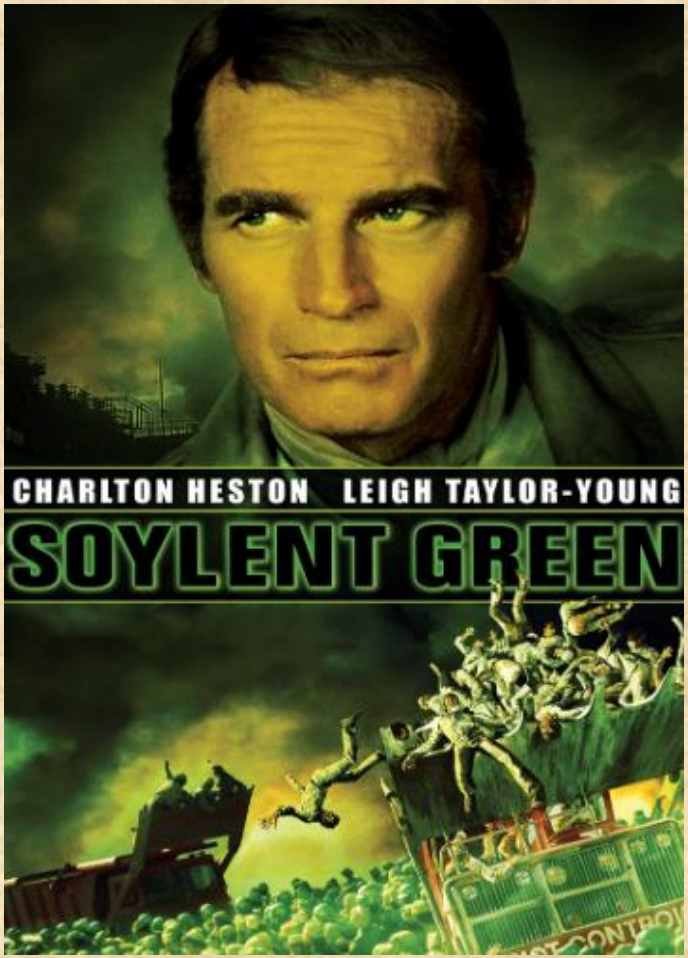
6 RECORD KEEPING AND DOCUMENTATION

- **A** Establish record keeping and documentation procedures
- **B** Incorporate plan in food safety plan records

Future Considerations

- Climate change and pathogen adaptation
- Emerging food systems require rethinking of food safety frameworks
- Antibiotic resistance in foodborne pathogens
- Consumer education and traceability
- TRCCP?

Soylent Green



Woman complained of forgetfulness and depression before doctors pulled out an 8cm roundworm normally found in pythons.

Abstract

We describe a case in Australia of human neural larva migrans caused by the ascarid *Ophidascaris robertsi*, for which Australian carpet pythons are definitive hosts. We made the diagnosis after a live nematode was removed from the brain of a 64-year-old woman who was immunosuppressed for a hypereosinophilic syndrome diagnosed 12 months earlier.

CDC Centers for Disease Control and Prevention
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EID Journal › Volume 29 › Number 9—September 2023 › Main Article

Volume 29, Number 9—September 2023

Dispatch

Human Neural Larva Migrans Caused by *Ophidascaris robertsi* Ascarid

Mehrab E Hossain, Karina J. Kennedy, Heather L. Wilson, David Spratt, Anson Koehler, Robin B. Gasser, A. Hawkins, Hari Priya Bandi, and Sanjaya N. Senanayake✉

Conclusions

The patient in this case resided near a lake area inhabited by carpet pythons.

Despite no direct snake contact, she often collected native vegetation, warrigal greens (*Tetragonia tetragonioides*), from around the lake to use in cooking.

We hypothesized that she inadvertently consumed *O. robertsi* eggs either directly from the vegetation or indirectly by contamination of her hands or kitchen equipment.

Source:

Hossain M, Kennedy KJ, Wilson HL, Spratt D, Koehler A, Gasser RB, et al. Human Neural Larva Migrans Caused by Ophidascaris robertsi Ascarid. Emerg Infect Dis. 2023;29(9):1900-1903. https://doi.org/10.3201/eid2909.230351

https://www.theguardian.com/australia-news/2023/aug/28/live-worm-living-womans-brain-australia-depression-forgetfulness

3.4 What unique coffee brewing method involves beans that have been eaten and excreted by a civet, a small mammal, before being collected, cleaned, and roasted?

A) Espresso Elegante
B) Mocha Madness
C) Kopi Luwak
D) Caturra Catapult

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Cat-butt coffee: A critical review | Boing Boing

Sofroni Eglezos

Food Microbiology Matters

View my profile on LinkedIn

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- Thank you for your attention.

Some services offered:

- Assessment of Microbiological Specifications
- Assessment of Laboratory Analysis, Sampling Plans, and Microorganism significance
- Project Challenge Studies to assess Pathogen Inhibition and Inactivation
- Industry-Specific Food Microbiology Training

Happy to take questions now, later,
or over a coffee!

What Has Augmented or Superseded Taq-PCR?

1. **High-Fidelity Polymerases**
- Examples: **Phusion, Q5, Pfu, PrimeSTAR**
- **Supersede Taq** when fidelity is critical

2. ⚡ **qPCR (Real-Time PCR)**
- Quantifies DNA **as it amplifies**, using fluorescent dyes or probes
- Now **standard** in diagnostics (e.g., COVID-19 testing), gene expression, microbial load estimation
- Still often uses Taq (or Taq-based enzymes) in modified form with hot-start or probe-based compatibility

3. RT-PCR & RT-qPCR
- Reverse transcription-PCR for **RNA-based targets** (e.g., virus detection, mRNA quantification)
- Also uses Taq (often in a master mix with a reverse transcriptase)

4. **Digital PCR (dPCR)**
- Ultra-sensitive, **quantitative**, and **partition-based** method
- Gaining ground in oncology, liquid biopsies, and rare mutation detection

5. Isothermal Amplification Technologies
- Examples: **LAMP**, **RPA**
- No need for thermal cycling
- Fast, portable, and ideal for **point-of-care diagnostics**