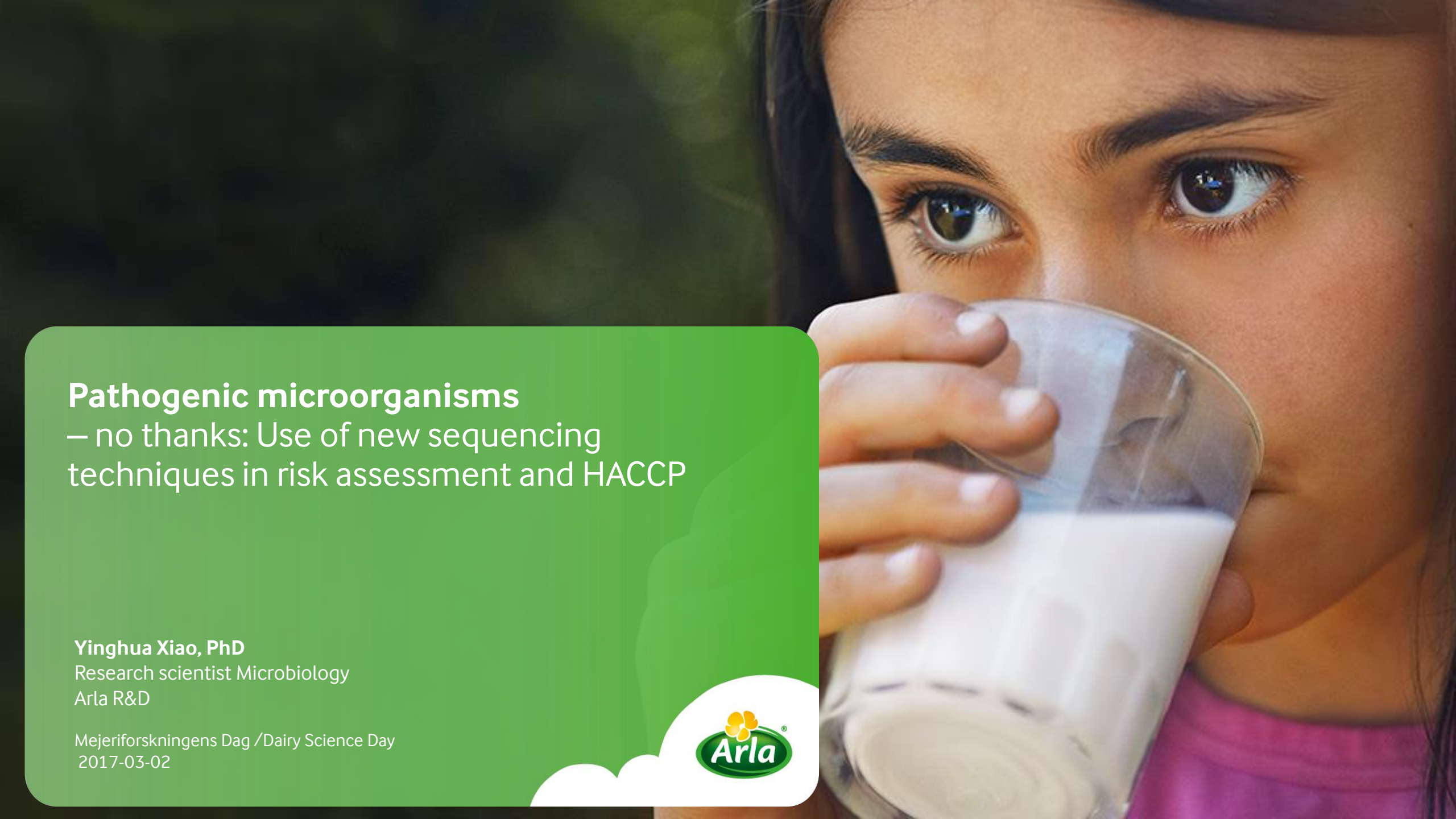


Pathogenic microorganisms – no thanks: Use of new sequencing techniques in risk assessment and HACCP

Yinghua Xiao, PhD
Research scientist Microbiology
Arla R&D

Mejeriforskningens Dag /Dairy Science Day
2017-03-02

"A food business operator has **primary legal responsibility** for ensuring **food safety**"

– Regulation (EC) No 178/2002 General Food Law

Our vision

Creating the future of dairy to bring **health** and inspiration to the world, naturally

Arla is participating

ILSI

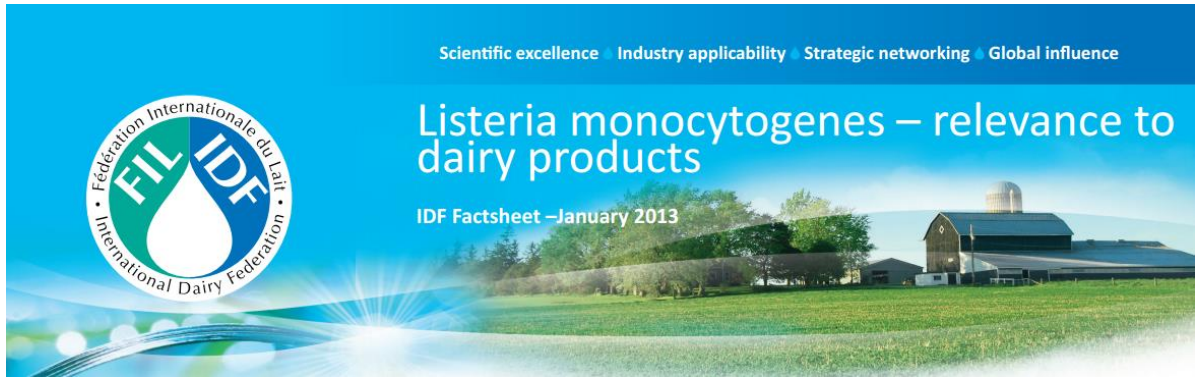
Microbiological Food Safety Task Force
Expert group "The Use of NGS:
Translation into practice"

http://ilsi.eu/task-forces/food-safety/microbiological-food-safety/

Nestlé, Unilever, Danone, Fuji Oil, Mérieux, PepsiCo, Mars, Mondelēz, **Arla**

FAO, FDA, CDC, TNO, **DTU**, U. Nantes, U. Malaya, Münster U.H., Tokyo U.

Whole genome sequencing (WGS) applications in *Listeria monocytogenes* risk management



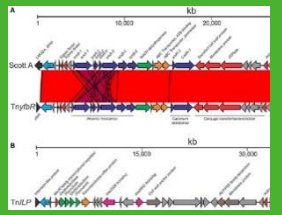
https://www.fil-idf.org/wp-content/uploads/2016/04/Factsheet-SCMH-Listeria-Monocytogenes.pdf

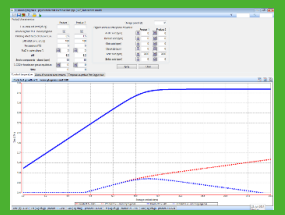
Facts about Listeria monocytogenes

- Causing listeriosis, >90% hospitalization, 20% death rate
- Sensitive groups: young, old, pregnant, immunodeficient (YOPI)
- Dairy products can become contaminated at many stages along the food chain
- A particular concern where the product can support the growth of the organism

Genomic and phenotypic characterization and their applications in risk assessment

- Product isolates
- Growth potential
- Virulence or persistence
- **Product matrices**
- **Predictive modeling**



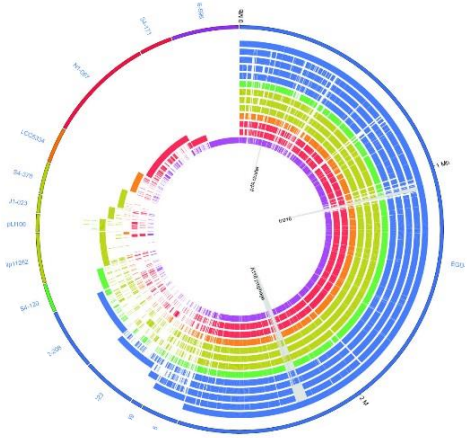


Pathogen Source Tracking

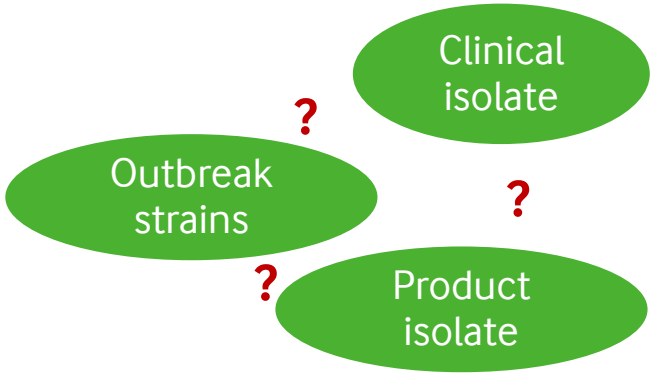
WGS applications in risk management: pathogen source tracking

Following a food safety incident, tracking contamination resource/reservoir of the causative pathogenic isolate(s) becomes one of the main tasks for microbiologists.

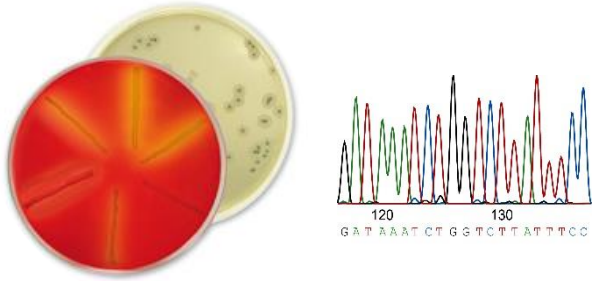
- Farm-to-Fork milk chain
- Dairy companies in Global supply chain
- Outbreaks and historical events



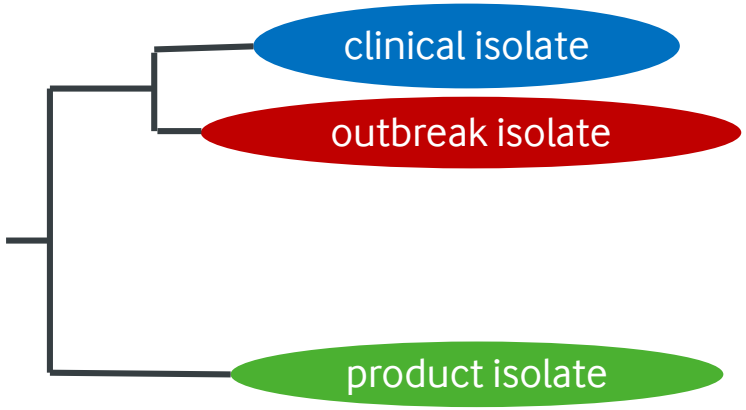
Whole genome alignment



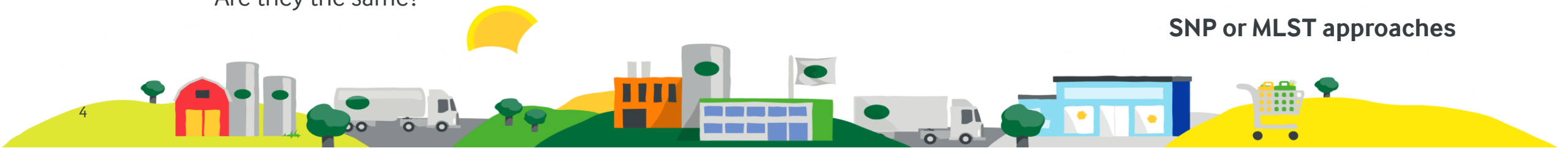
Are they the same?



Current identification techniques can only reach genus or species level



SNP or MLST approaches



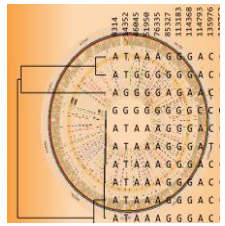
Commercial pipelines and collaborations

Purified colony → Cultivation and DNA isolation → Sample preparation & shipment → Sequencing → Data analysis pipeline → Result interpretation → Food safety management

- **in a few days**
- **3.000** DKK/isolate

- Standardized sample preparation
- Local or nearby sequencing facility
- Data analysis pipeline and databases are available in house
- Result interpretation is verified

BioNumerics APPLIED MATHS Manage. Analyze. Discover.



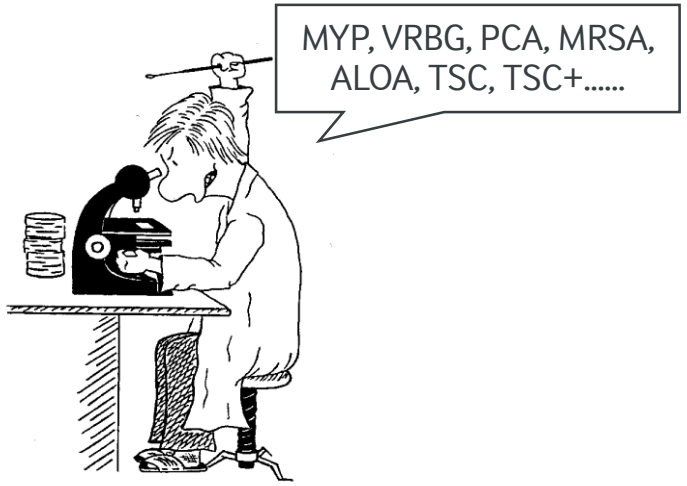
Genome analysis module

Partners needed

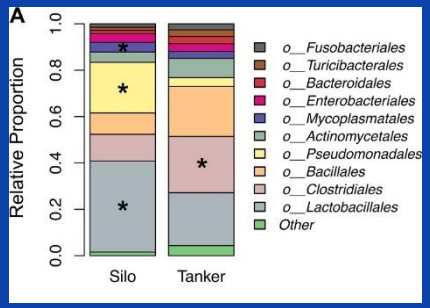
Cultivation-independent investigation

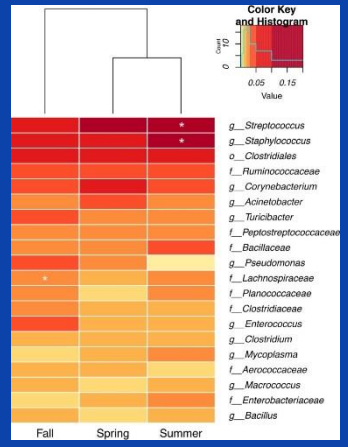
From its humble beginnings as simple meat extract to the advanced science of diagnostic media, the agar plate has always been the workhorse of the microbiologist.

- History of the agar plate[1]

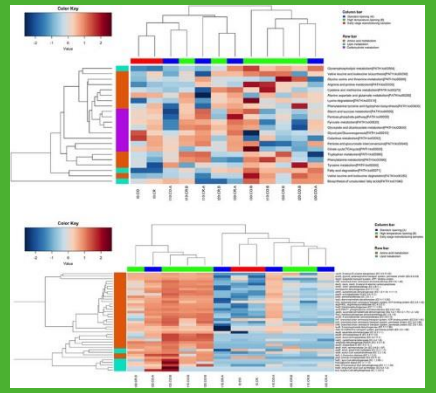


Core and seasonal **Microbiota** of raw bovine **milk** in **tanker trucks** and **silos**[2]





Metatranscriptomics reveals temperature-driven functional changes in microbiome impacting **cheese maturation** rate[3]



[1] http://www.labnews.co.uk/features/history-of-the-agar-plate-01-11-2005/
[2] Kable ME, et al. (2016) mBio 7.
[3] De Filippis F, et al (2016). Scientific Reports 6: 21871.

Mapping microbial contamination sources inside the plant

Mapping microbial contamination sources inside the brewery as presented in Bokulich et al. . Increasing color intensity of each surface indicates an increasing relative degree of microbial contamination from that source type.

Bokulich NA, et al. (2015) Mapping microbial ecosystems and spoilage-gene flow in breweries highlights patterns of contamination and resistance. eLife 4: e04634.

Discussion

Can information from NGS be used within an industrial setting to intelligently optimize our assessment of microbial risks and verification of our HACCP plans?

- Food safety management
  - risk assessment
  - pathogen source tracking
  - crisis management
  - control strategy
- HACCP plans
- Routine analysis
- Specification management
- Quality constancy
- Fermentation and culture

Contact information

Dr. Yinghua Xiao

Genomics applications in food safety and quality
+45 87465035
yinghua.xiao@arlafoods.com

Dr. Sander Sieuwerts

Genomics applications in fermentation and fast detection
+45 8746 6703
sander.sieuwerts@arlafoods.com

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