The Role of Microbial Genomics in Feed Quality

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Which technologies to improve the delivery and the personalisation of animal nutrition?

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Agenda

1. Livestock production and public health concerns
2. Probiotics & EFSA
3. Efficacy of probiotics: Microbiome Analysis
4. Other alternatives to improve performance: FMT?

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1. Livestock production - feed – public health

Feed conversion ratio & Infection resistance

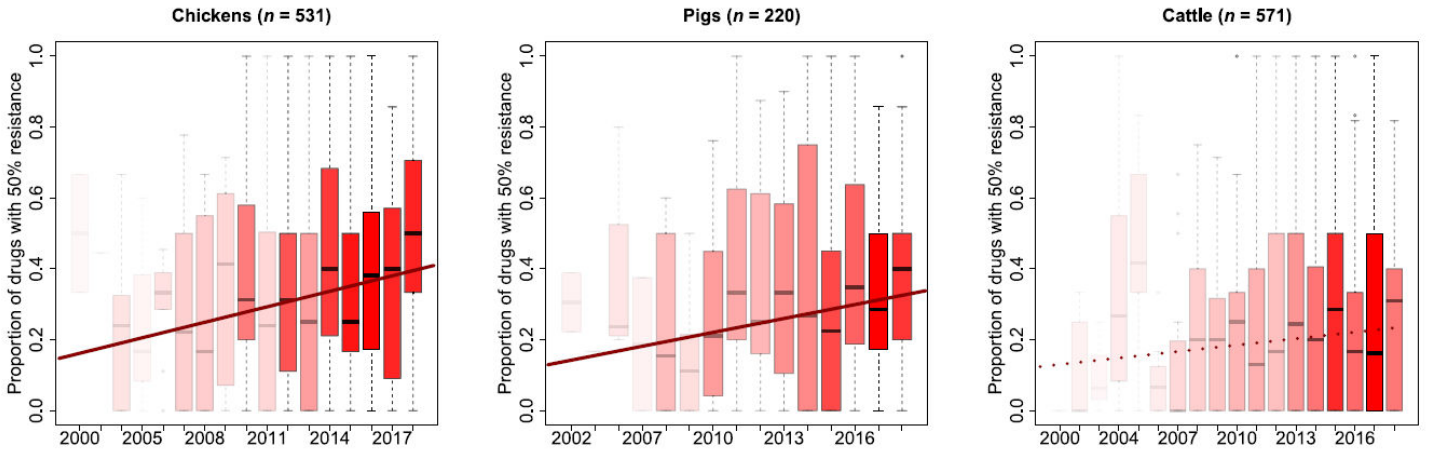
VERSUS

Feed additives

- Antimicrobial (AM) use = AM resistance to common pathogens:

E. coli, Campylobacter spp., nontyphoidal Salmonella spp., and S. aureus

- Resistance - Tetracyclines, Sulfonamindes, Penicillins



Proportion of antimicrobial compounds with resistance >50% in low-middle income countries

T. P. van Boeckel et al. ***Science*** *365, 1266 (2019)*

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New global (EU and USA) stringent regulations to ban antibiotic use for animal husbandry!

Probiotics as additives?

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2. Probiotics or Direct Fed Microbials (DFM)

- To balance intestinal microbial balance
- To maintain and improve productivity & growth, prevent enteric pathogens

- **Bacteria**: *Latobacillus, Bifidobacterium*, *Enterococcus, Pedicoccus, Bacillus (spore forming)*
- **Non-bacterial** = yeast/Fungi: *Aspergillus*, *Candida pintolopesii*, *Saccharomyces boulardii* & *cervisiae*

- **Multi-species** or **single-species** probiotics

FAO guidelines on probiotics use 2018

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Why Probiotics?

Survive

low pH & bile acids

Adhere to

intestinal epithelium

Produce

Peptide (bacteriocins), metabolites (SCFAs), enzymes (a. amylase)

→ Improve colonisation of healthy microbes and mitigate pathogens

→ Efficient digestion, immunity, increased intestinal villi & villi height = nutrient absorption

One size doesn't fit all !

Opportunities & Challenges

Novel microbial strains? Safety? Genetic drifts during fermentation?

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3. Safety of strains – QPS listing

- Qualified Presumption of Safety (QPS) listed, no ABR, 2007 by EFSA
- Established sufficient knowledge on the strain:
  - Unequivocal taxonomy
  - WGS → linear genome

Table 1: Requirements for scientific information according to the type of feed additive

	Section	Feed additives containing viable microorganisms		Fermentation products	
		Bacteria	Fungi – yeasts	Bacteria	Fungi – yeasts
Identification	2.1	✓	✓	✓	✓
Antimicrobial susceptibility	2.2	✓		✓	
Antimicrobial production	2.3	✓	✓	✓	✓
Toxigenicity and pathogenicity	2.4	✓	✓	✓	✓
Genetic modification	2.5			For GMMs only	For GMMs only
Absence of the production strain	3.1			✓	✓
Presence of DNA from the production strain	3.2			Where relevant	Where relevant
Compatibility with other authorised additives	4.2	Where relevant	Where relevant		

GMM: genetically modified microorganism.

- *Guidance on the characterisation of microorganisms used as feed additives or as production organisms*
- Update of the list of QPS-recommended

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Challenges with EFSA current guidelines

Technical challenges

1. Taxonomy
2. Assessment of GM strains for production purpose?
3. @BaseClear ABR = CARD; Virulence-toxins = VFDB

Fungi and yeast?

BaseClear's approach - tailored bioinformatics analysis:

- Biomarker gene
- Toxin & secondary metabolites producing genes
- Copy number analysis
- Targeted search for metabolic pathways involved in toxigenicity
- Conclusive remarks on safety of strain

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4. Efficacy of feed additives – Microbiome Analysis

- Microbiome analysis – technology

  Microbial profiling VS Shotgun metagenomics

  - Study design (prebiotics, probiotics, bioactives, enzymes and/or a combo)
  - Conduct the study
  - Results for interpretation

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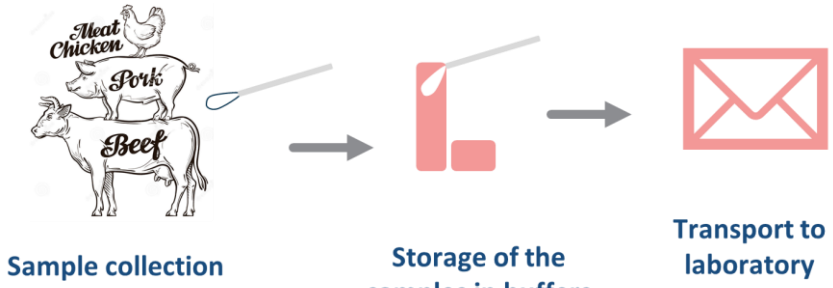
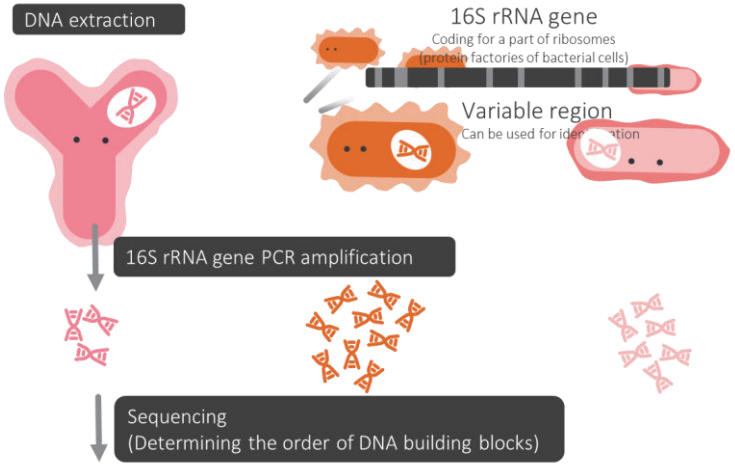
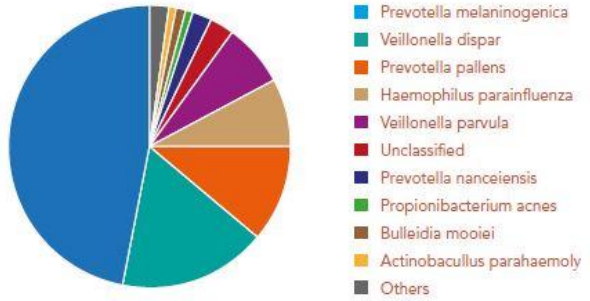
Typical workflow for pre/clinical trials

01	02	03	04	05	06	07
Sampling and logistics	DNA and/or RNA extraction	Data generation	Collection of metadata	Data Visualisation	In-depth biostatistics	Sharing results with participants







@Proprietary pictures of BaseClear

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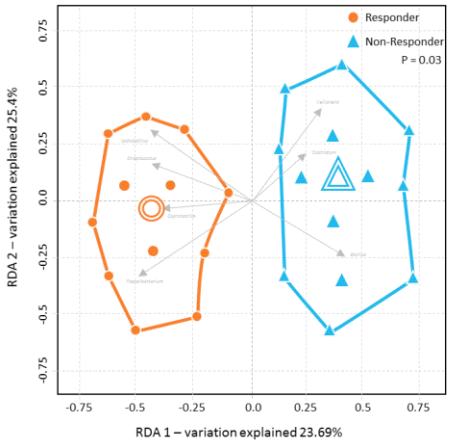
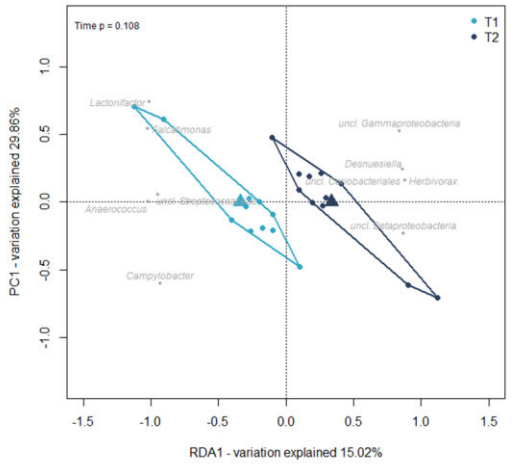
Microbiome Analysis: points of attention





- Study design is crucial !!
- Involve experts before drawing conclusions

Other technological challenge:
shotgun metagenomics

Host vs microbial gDNA

(BaseClear deals with it bioinformatically)

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5. Other alternatives to microbial strains?

Faecal microbiota transplantation (FMT) in animals:

- Links between intestinal microbiota, growth, feed efficiency in pigs[a]
- Reprogram intestinal microbiota for transfer of host physiological traits like leanness, and gut microbial composition
  - no significant results
  - exploring FMT as AB alternative

[a]McCormack et al (2017)
[b]McCormack et al (2018)

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General Thought!

Aim to improve the overall health of an animal and so go beyond antimicrobial use!

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