Interimmun-APEC: Differentiation of Avian Pathogenic *E. coli* (APEC) field isolates and their early detection and control in poultry farming

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TSPC 2026 Chester, UK – March 2026

INVAC at TSPC 2026

Our Journey

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Our world – and a question it posed

02 On the matter I
E. coli and the burden of co-infections

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A summary – and over to you

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Once upon a time …

… there were four friends who believed in evolving and advancing solutions for animal health –
and in the power of achieving this together with others,
as successful companions.

01 How it came to be

INVAC 2026

>30
R&D PROJECTS

12
SPECIES

vaccine production

research & development

laboratory diagnostics

individual advice

INVAC DEUTSCHLAND

SMB

INVAC POLSKA

15
COUNTRIES

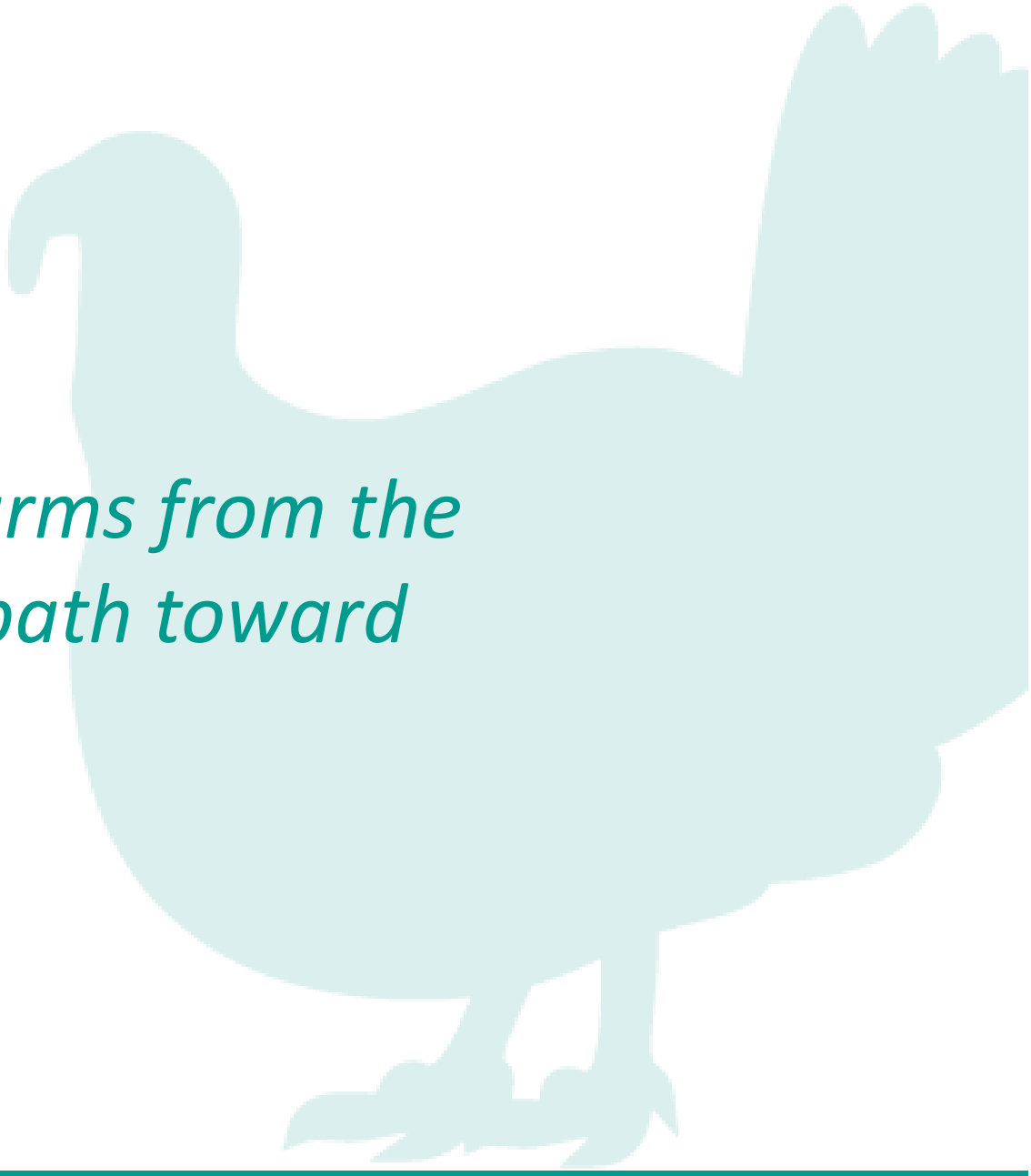
60+
EMPLOYEES

3
PRODUCTION FACILITIES
(IN GERMANY AND POLAND)

>30 Mio
VACCINE SHOTS PER YEAR

A question that occured

"How can we protect turkey farms from the burden of APEC – and pave a path toward an antibiotic-free future?"



A joint project: Interimmun-APEC

Dr. Ronald Günther

Interception and immuno-prophylaxis of avian pathogenic *E. coli* (APEC) and associated infections to reduce antibiotic use in commercial poultry production

October 2021 – Submitting the project concept → April 2023 – Notification of funding → April 2023 – Project start date → April 2026 – Project end date

Bundesministerium für Ernährung und Landwirtschaft

Bekanntmachung zur Förderung von Maßnahmen in der Geflügelhaltung, die zur Reduktion des Auftretens von Infektionserkrankungen und der Notwendigkeit zur Behandlung mit antibiotischen Tierarzneimitteln beitragen

Vom 2. Juli 2021

Gefördert durch

Bundesministerium für Ernährung und Landwirtschaft

aufgrund eines Beschlusses des Deutschen Bundestages

Bundesanstalt für Landwirtschaft und Ernährung

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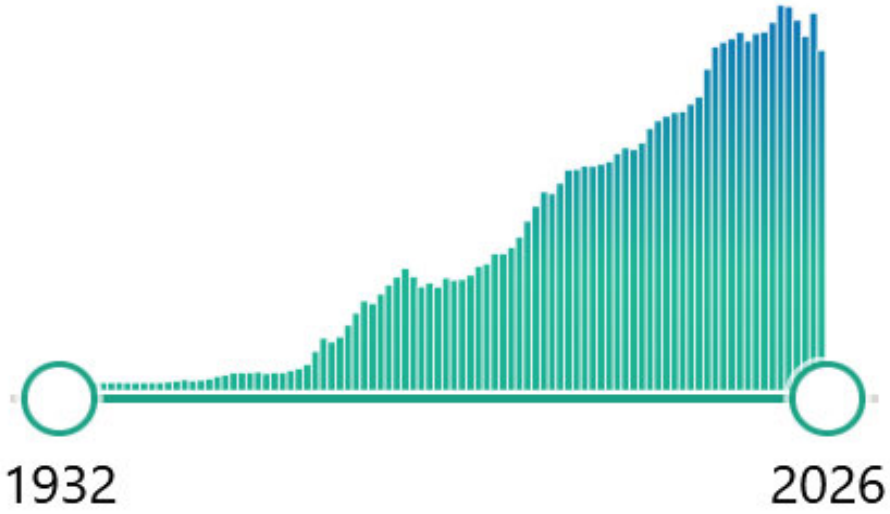
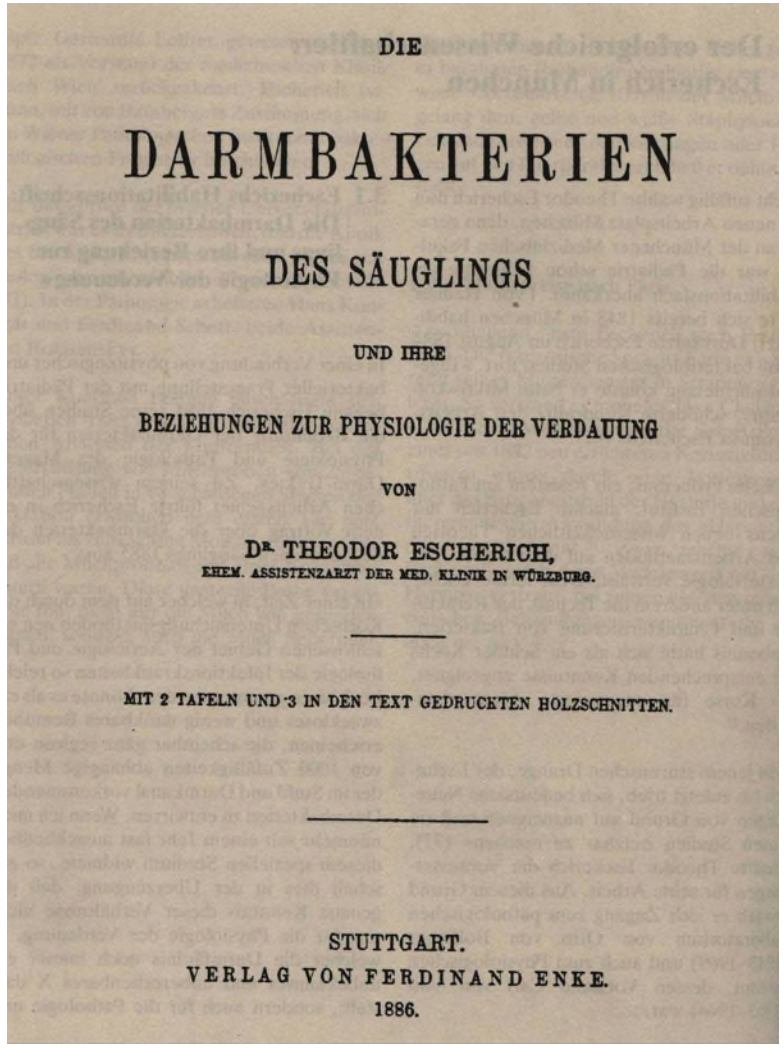
Escherichia coli in research

Publications, PubMed (9 March 2026)

- *Escherichia coli* 461.159
- APEC 3.555
- *Ornithobacterium rhinotracheale* 218

RESULTS BY YEAR





DIE

DARMBAKTERIEN

DES SÄUGLINGS

UND IHRE

BEZIEHUNGEN ZUR PHYSIOLOGIE DER VERDAUUNG

VON

Dr. THEODOR ESCHERICH,

EHEM. ASSISTENZARZT DER MED. KLINIK IN WÜRZBURG.

MIT 2 TAFELN UND 3 IN DEN TEXT GEDRUCKTEN HOLZSCHNITTEN.

STUTTGART.

VERLAG VON FERDINAND ENKE.

1886.

E. coli – friend or foe?

Commensal bacterium in the intestines of vertebrates:

- Probiotic, competitive exclusion
- Induces the immune system to fight infections
- Produces vitamins for the host

Pathogens in poultry and mammals:

- Septicemia pathogens, zoonotic pathogens
- Economic damage in poultry production
- Antibiotic consumption, development of resistance

Commensal, Probiotic

Secondary pathogen

Primary pathogen

Diversity of *E. coli* in poultry intestines

Genetic diversity of *E. coli* in poultry intestines is **extremely high:**

- many strains occur simultaneously
- significant variation in gene content
- intensive horizontal gene transfer
- dynamic population structures
- fluid boundaries between harmless and pathogenic

Table 1 *E. coli* isolates sequenced from different chickens

Sample	Number of *E. coli* Isolates Collected	Number of *E. coli* Isolates Sequenced	Number of *E. coli* Strain Types Observed	Phylogenetic Groups
1	39	21	5	A, B1
2	47	14	6	A, B1, E, B2
3	128	20	11	A, B1, D1, B2
4	79	20	2	B1
5	104	15	9	A, B1
6	46	17	5	A, B1, D2

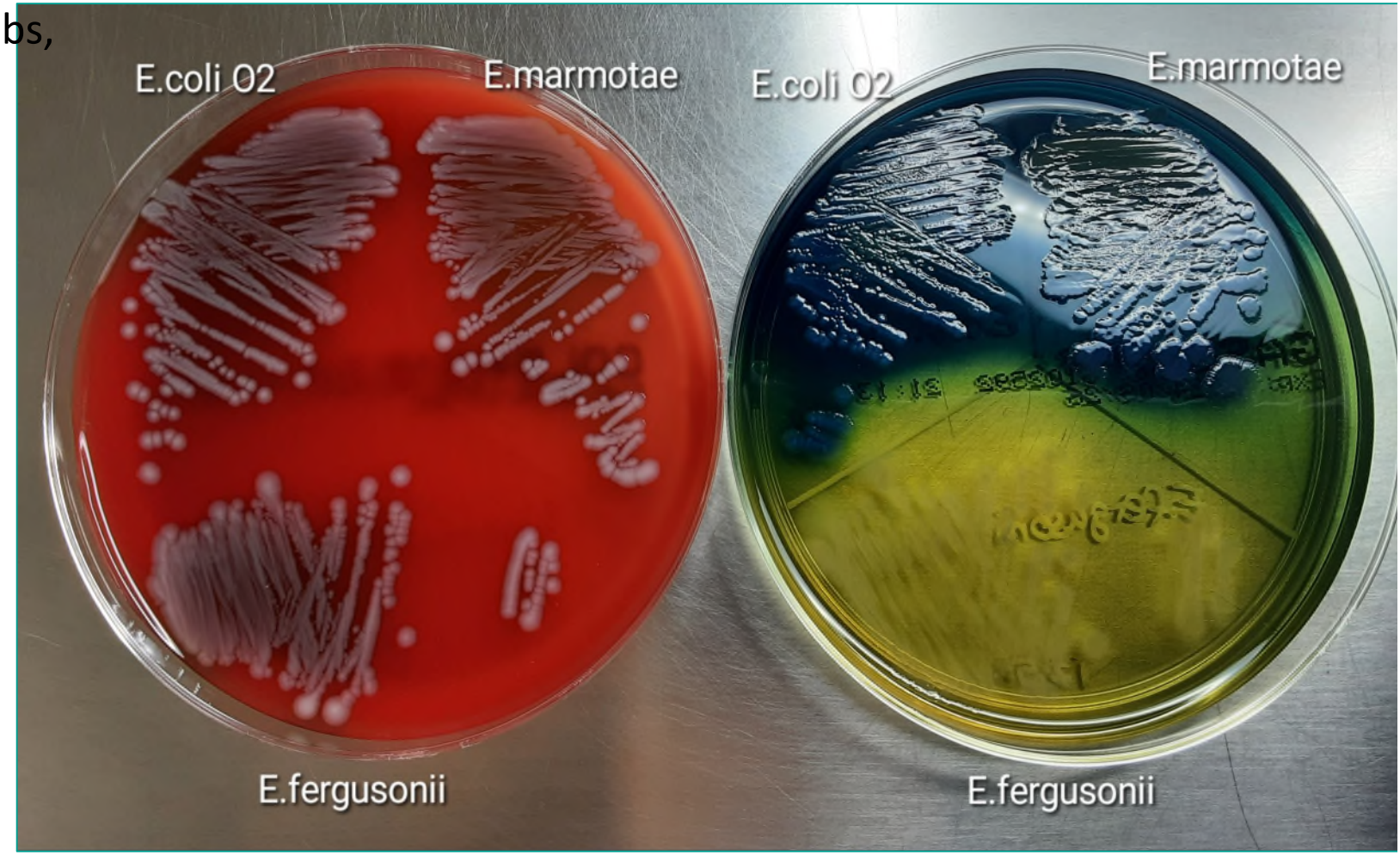
Feng *et al.*, 2025

Two *E. coli* strains from the same chicken can be genetically more different from each other than some bacteria of different species.

Diagnosis of *E. coli* – *Project workflow*

Samples: animal carcasses, swabs, litter, drinking troughs...

1. Cultivation
2. MALDI-TOF-MS
3. Serotyping
4. APEC-PCR
5. APEC-PCR 2.0
6. NGS

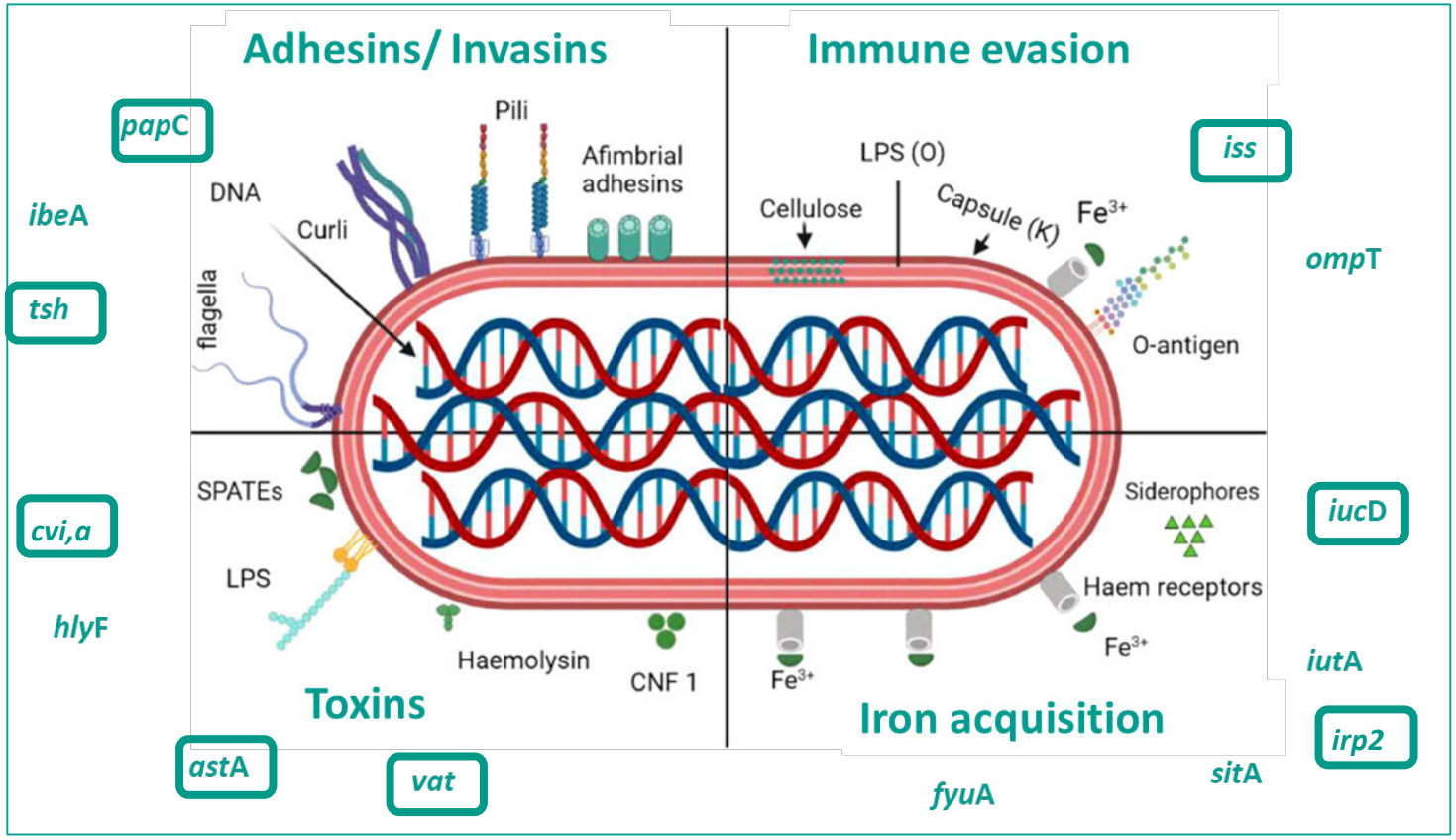


Bacterial counts in feces:
TBC: 10^9-10^{11} CFU/g
E. coli: 10^6-10^9 CFU/g

APEC-PCR

Conventional APEC-PCR: (Ewers, C. *et al*., 2005)

- 8 virulence factors
- Pathogenic isolates = APEC = 4-8 virulence factors
- Non-pathogenic isolates: max. 3 virulence factors

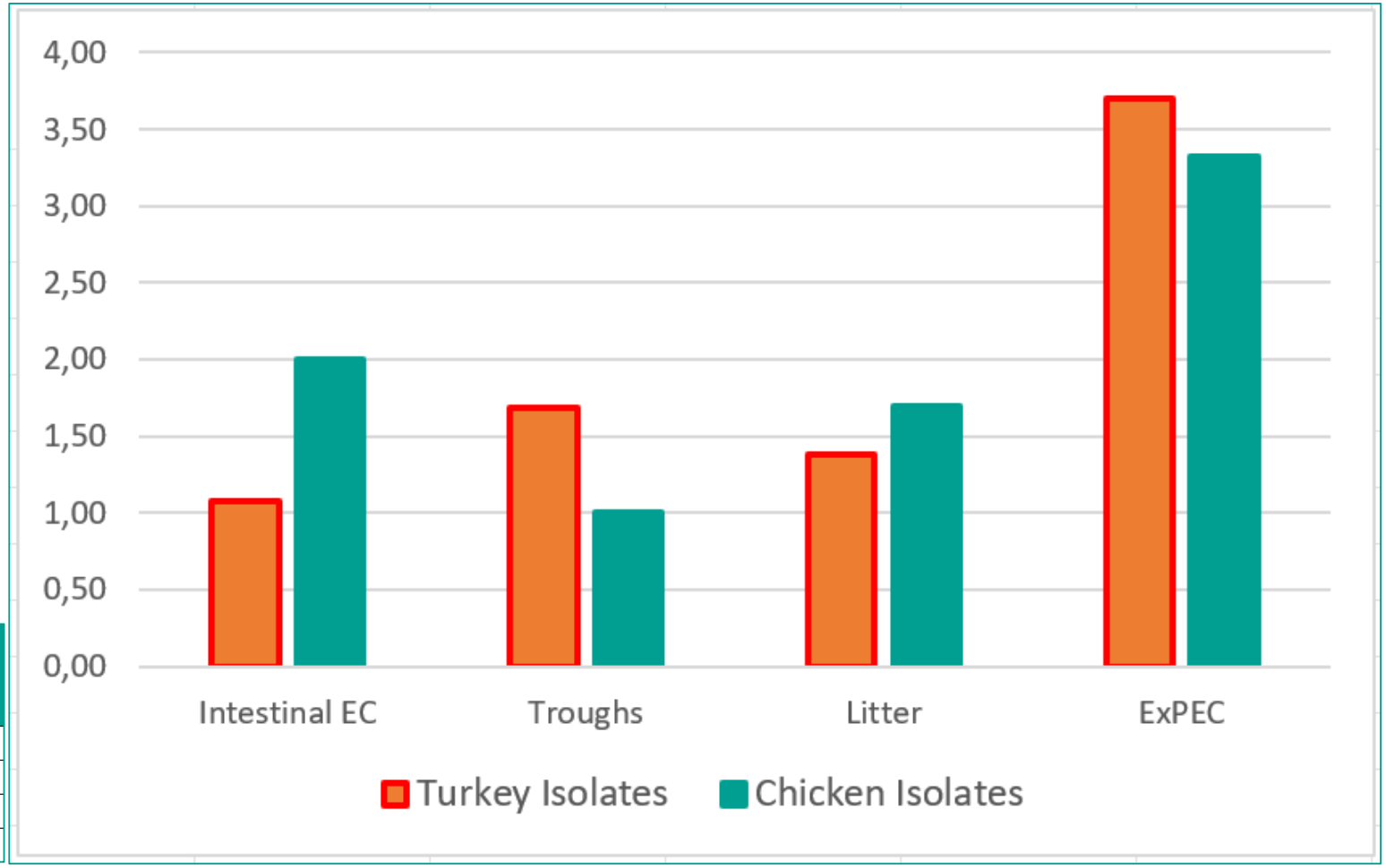


APEC share in poultry houses

APEC virulence factors depending on their habitat (463 isolates)

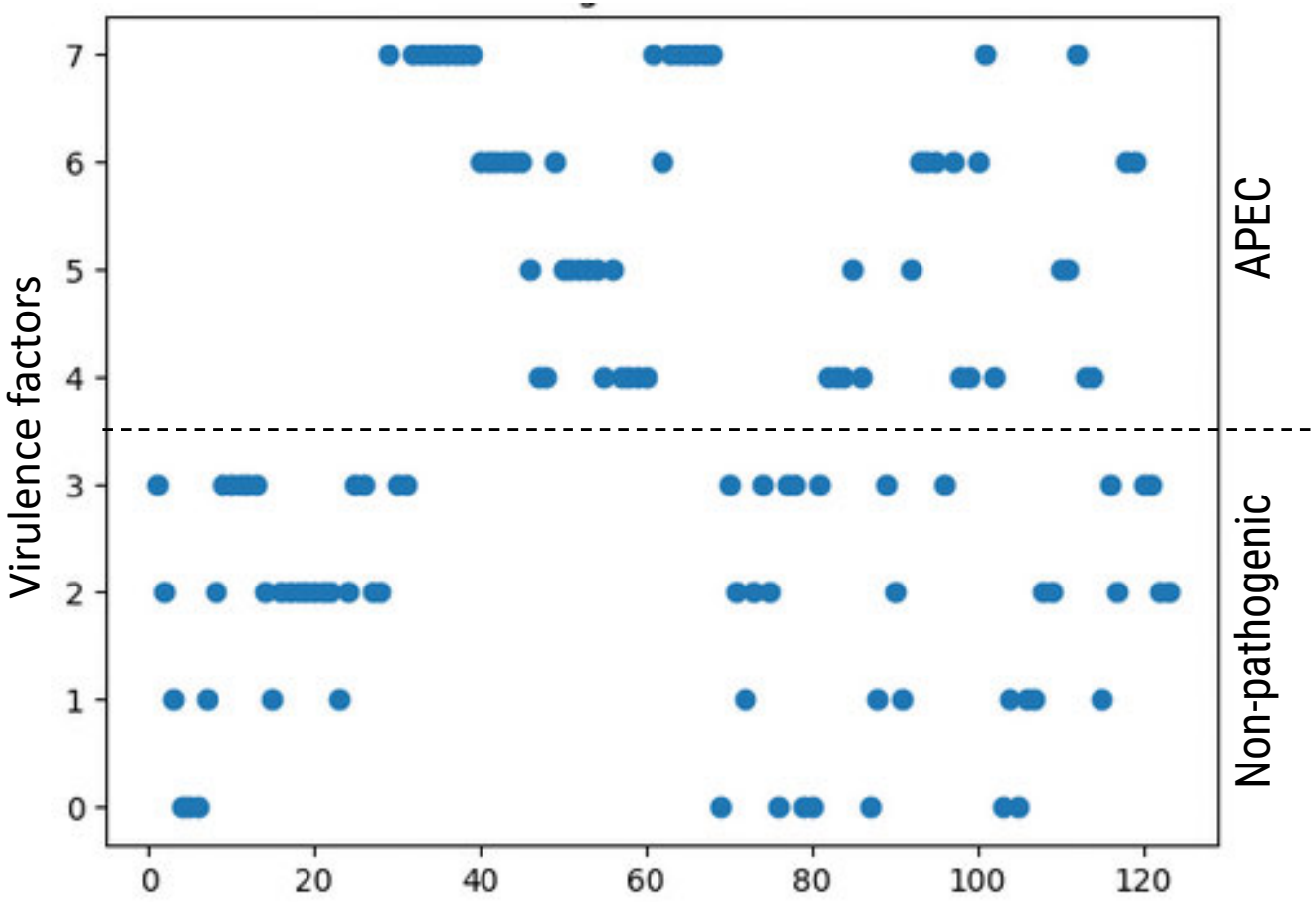
ExPEC = Extraintestinal Pathogenic E. coli

Source	Turkey Isolates	Turkey Virulence Factors	Chicken Isolates	Chicken Virulence Factors
Intestinal EC	25	1,08	3	2,00
Troughs	67	1,69	24	1,00
Litter	83	1,38	43	1,70
ExPEC	122	3,70	90	3,32



APEC share ExPEC isolates from turkeys

„How can non-pathogenic E. coli lead to septicaemic infections?"



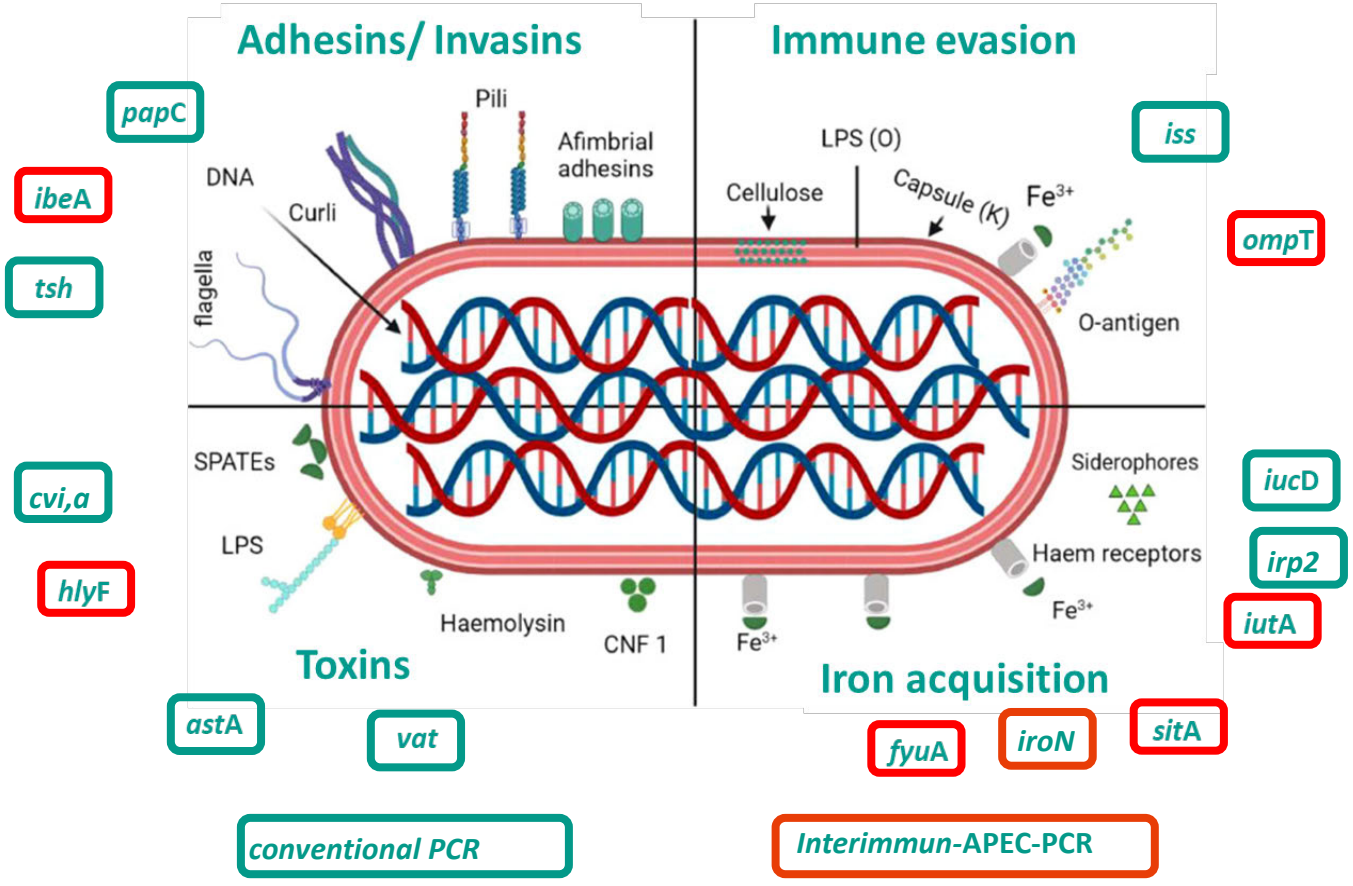
Scatter plot of 123 ExPEC isolates from turkeys

Interimmun-APEC-PCR

Conventional APEC-PCR: (Ewers *et al.*, 2005)

New:
Interimmun APEC-PCR:
(Bergmann *et al.*, unpublished)

Additional virulence factors are associated with colibacillosis



APEC serotypes by continent

North America

APEC Serotypes:
O1, O2, O78, O157, O26, O45, O103, O111, O121, O145, O1:K1, O2:K1, O6:K2, O18:K1, O7.

Africa

APEC Serotypes:
O55, O111, O6, O148, O78, O124, O143, O164

South America

APEC Serotypes:
O1, O2, O78, O157, O111, O55, O111, O119, O114, O6, O148, O78, O124.

Europe

APEC Serotypes:
O1, O2, O78, O157, O26, O45, O103, O111, O121, O145, O104, O1:K1, O2:K1, O6:K2, O18:K1, O7

Australia

APEC Serotypes:
O1, O2, O78, O157, O26, O111, O45, O103

Asia

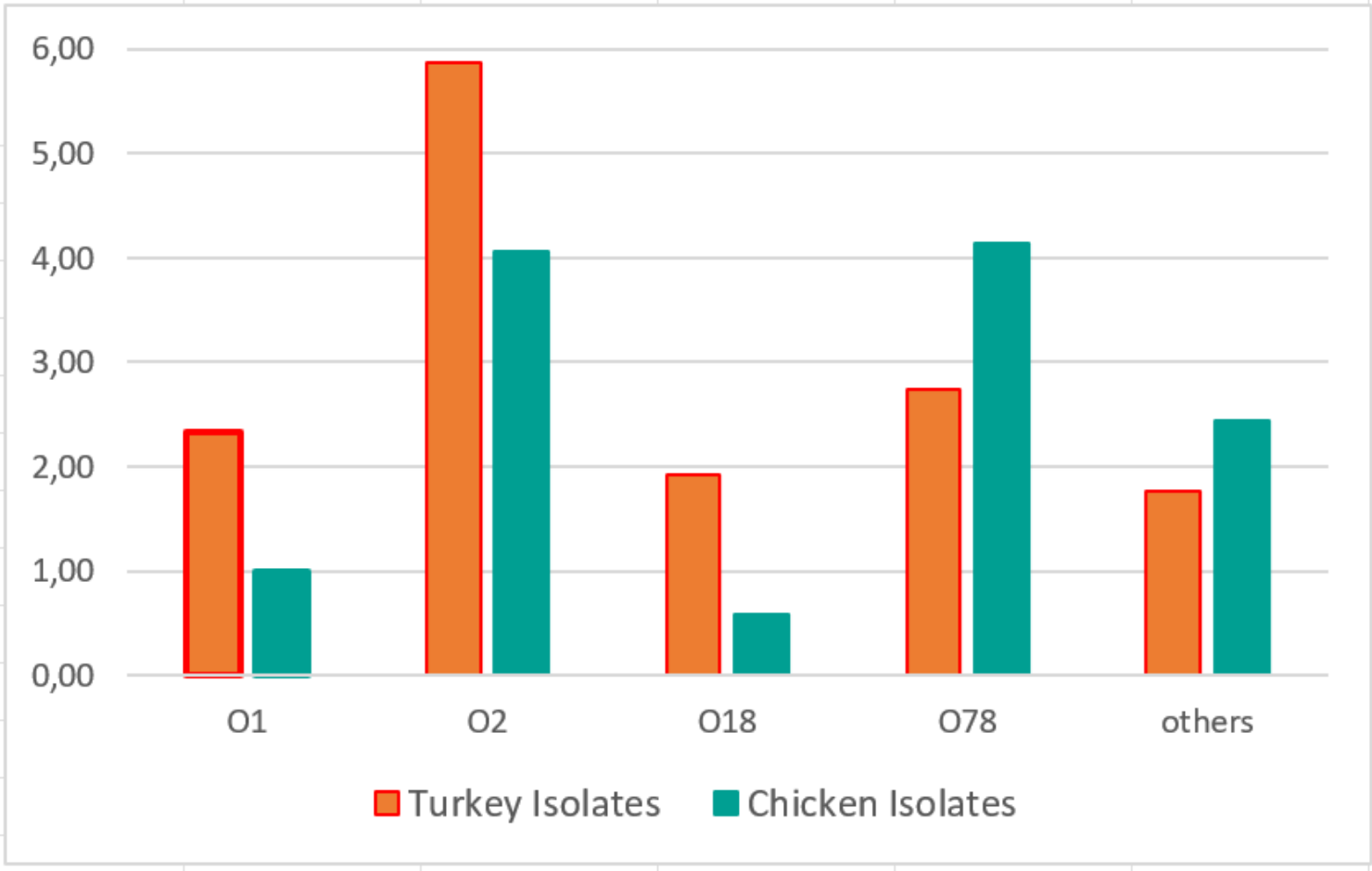
APEC Serotypes:
O1, O2, O78, O157, O26, O111, O55, O111, O119, O114, O6, O148, O78, O124, O143, O164, O18:K1, O7

Nawaz et al., 2024

APEC depending on the serotype

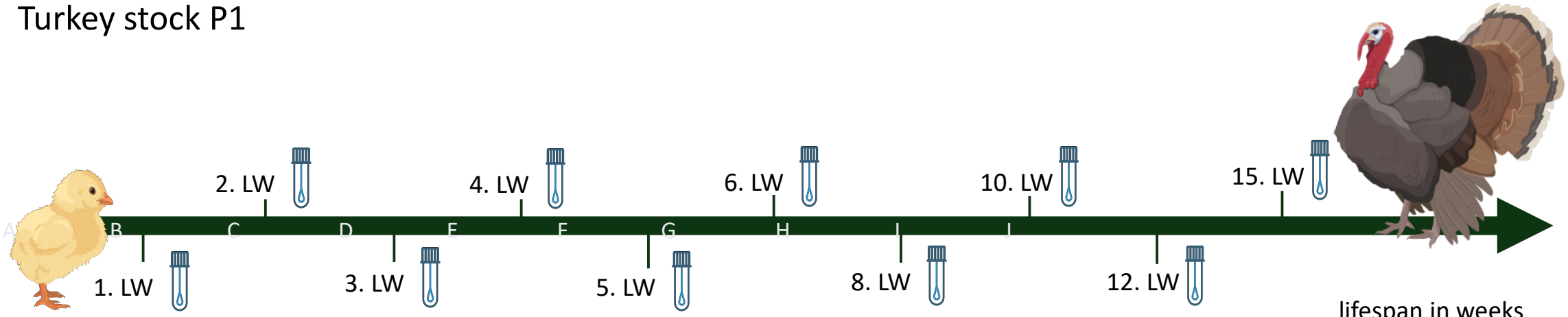
O2 and O78 are associated with colibacillosis

Serotype	Turkey Isolates	Turkey Virulence Factors	Chicken Isolates	Chicken Virulence Factors
O1	3	2,33	2	1,00
O2	31	5,87	18	4,06
O18	44	1,93	12	0,58
O78	19	2,74	7	4,14
others	183	1,77	126	2,44



Coinfections of Colibacillosis

Turkey stock P1



Group D rotaviruses (RVD)

Group A rotaviruses (RVA)

astroviruses

Pathogenic *E. coli* O2, 7 VF

adenoviruses

P1 = turkey stock 1
LW = week of life
VF = virulence factor(s)

Illustration and results C. Kiesewetter

Coinfections of Colibacillosis

Preliminary results and outlook:

- Detection of various viruses even without clinical symptoms
- Interception and “early warning system” is difficult
- APEC screening possible

Coinfections promote colibacillosis (leaky gut)

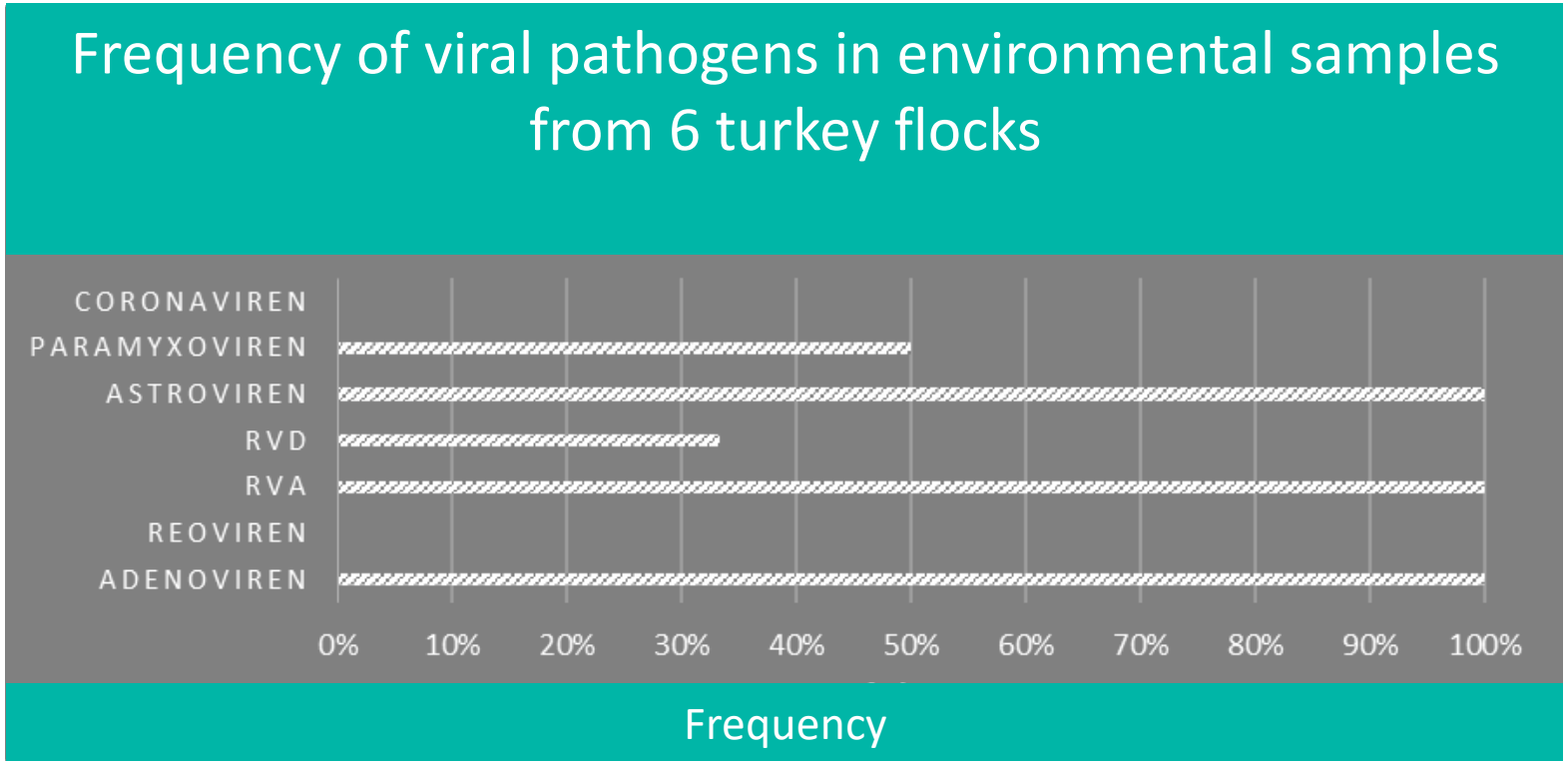
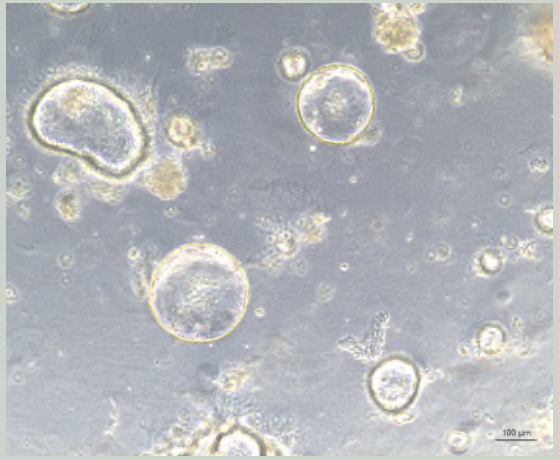
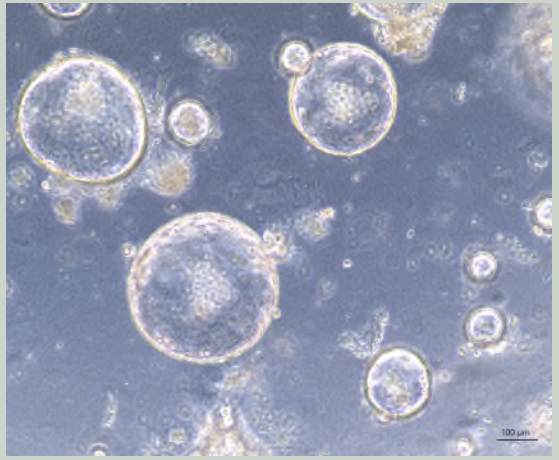
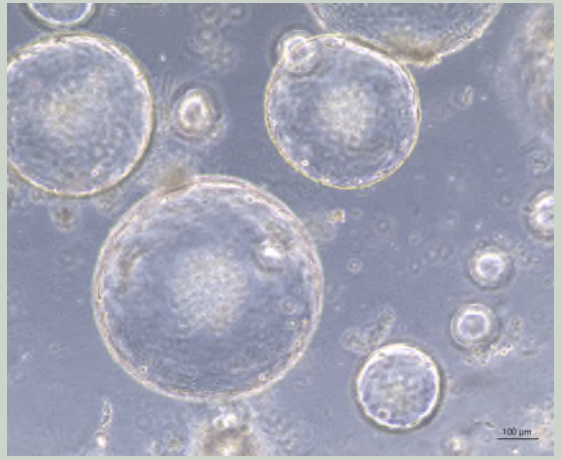
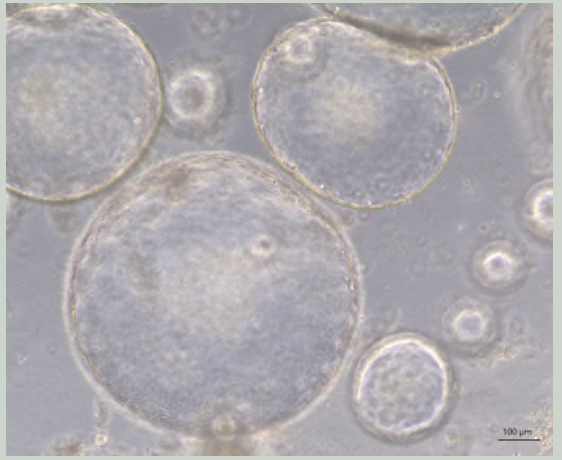


Illustration and results C. Kiesewetter

Coinfections of Colibacillosis

Co-infections with **H9N2 AIV and APEC** synergistically exacerbates oviduct inflammation in laying hens (Han et al., 2026)

Results demonstrated that the typical salpingitis model can be successfully replicated by co-infection with specific dose of **IBV and *E. coli*** (Xiang et al., 2026)

24h nach Split	48h	72h	96h
			

Avian intestinal organoides in Matrigel 3D, passage 9, day 1-4, small intestine, ID: Kü2MMT, Keyence Mikroskop, 1,000x magnification (Kiesewetter)

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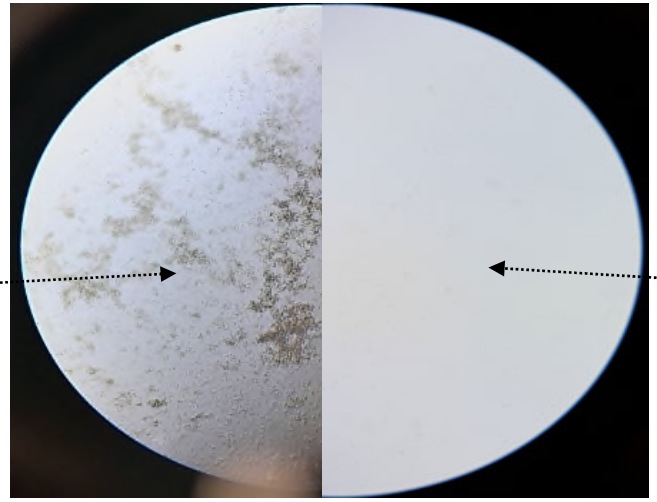
Development of an *E. coli* O2 ELISA

- Development of an *E. coli* O2-specific ELISA for the detection of antibodies (IgY)
- Use of an *E. coli* O2 field isolate for coating
- Polyclonal test sera as controls: positive O2 and negative O78
- Definition of cut-off, titre groups, etc. still under development
- Gruber-Widal reaction as a control

Positive Gruber-Widal reaction due to agglutination of antibodies with O2 antigen

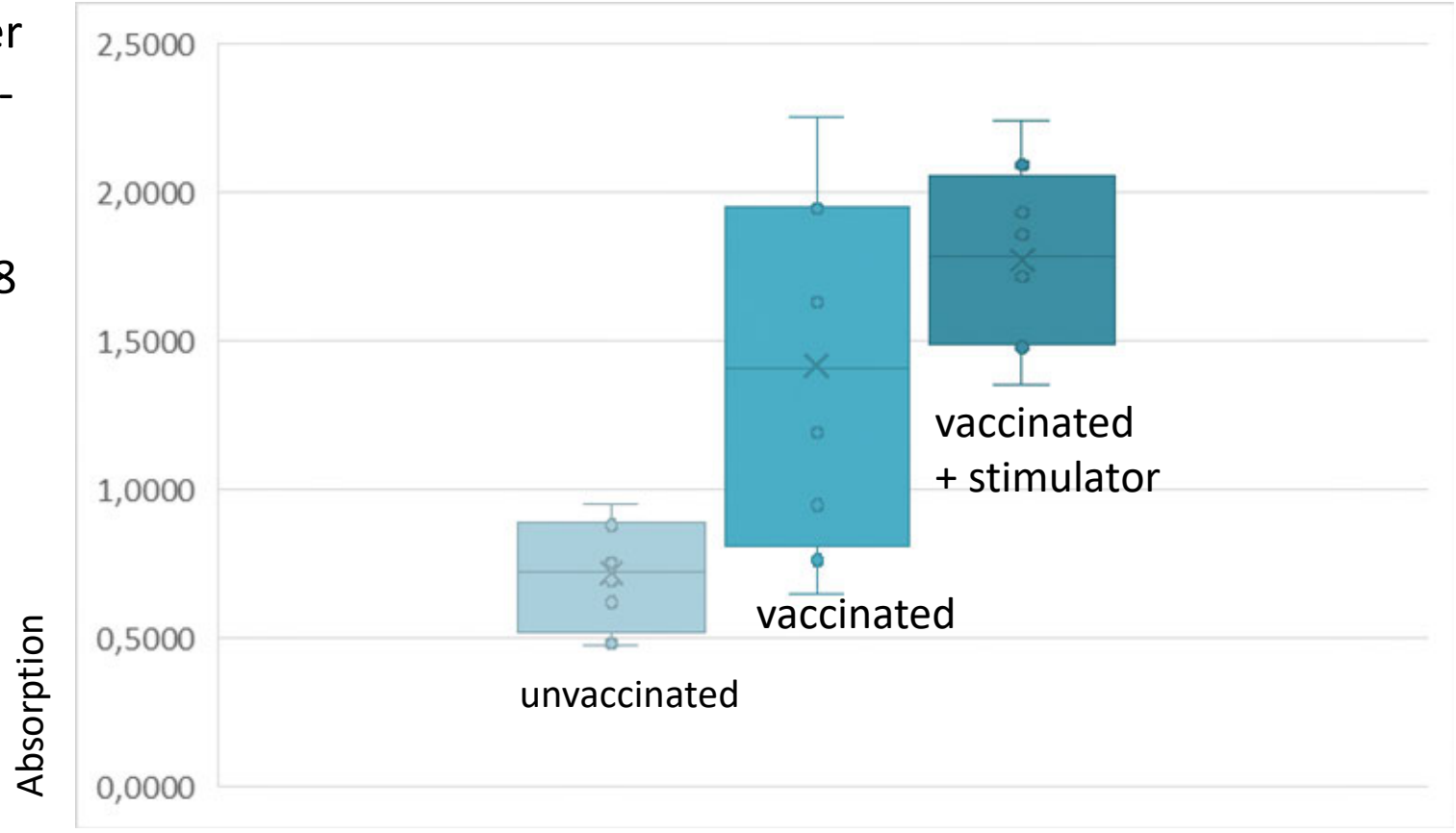


Negative reaction: no agglutination of O2 antigen with serum

K. Zocher and F. Rezazadeh (ILU)

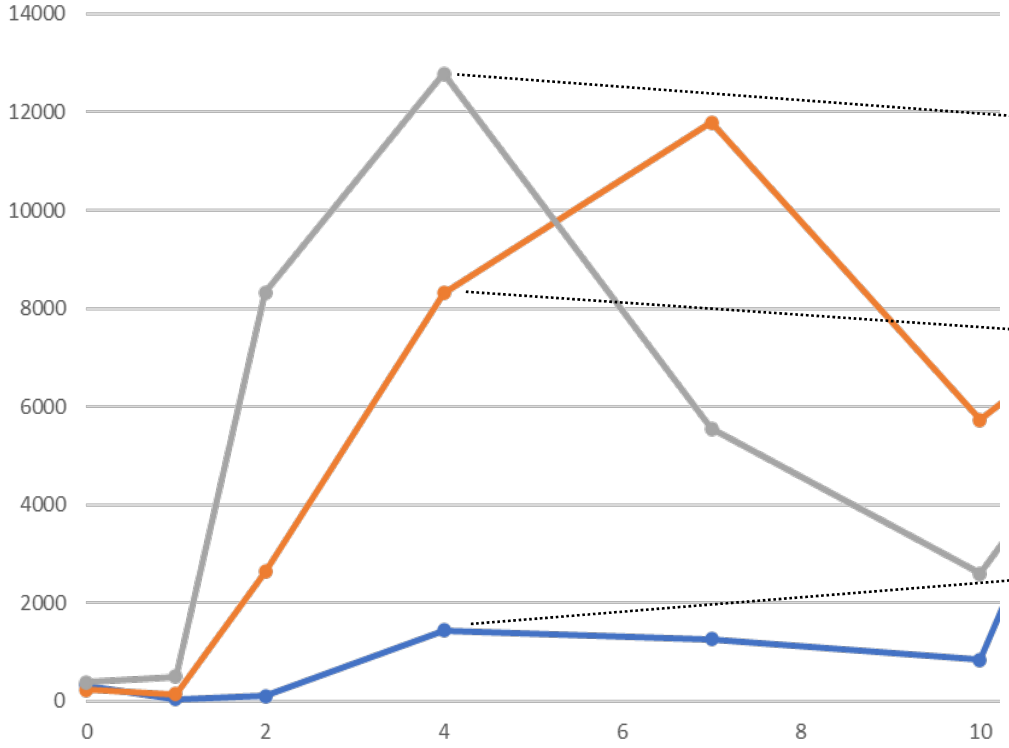
Development of an *E. coli* O2 ELISA

- O2 antibody titre 4 weeks after vaccination of approx. 5-week-old turkeys
- Autogenous vaccine with *ORT* and *E. coli* O2, w/o emulsion, 8 animals each

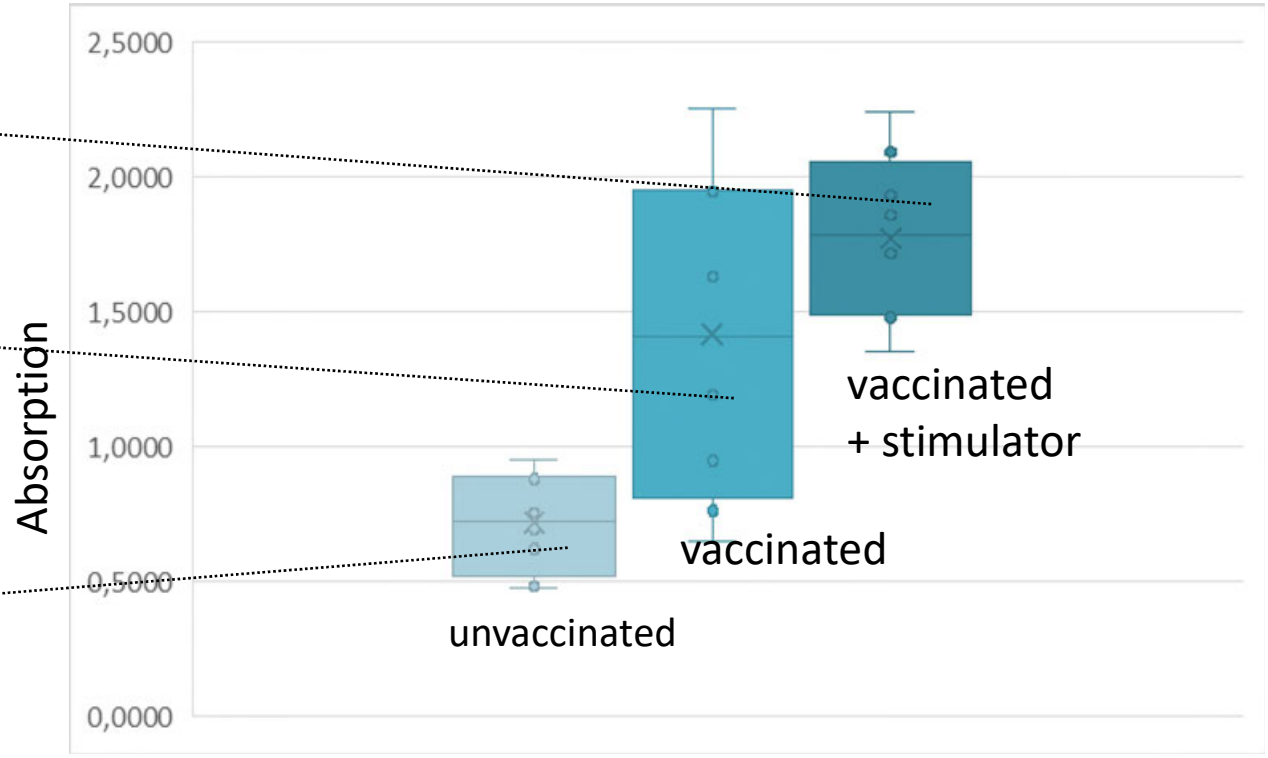


Results of an *E. coli* O2 ELISA comparing vaccinated and unvaccinated turkeys (K. Zocher and F. Rezazadeh)

Development of an *E. coli* O2 ELISA



Results of an ORT ELISA comparing unvaccinated (blue), vaccinated (orange) and vaccinated with immune stimulator (grey) turkeys



Results of an *E. coli* O2 ELISA comparing vaccinated and unvaccinated turkeys (K. Zocher and F. Rezazadeh)

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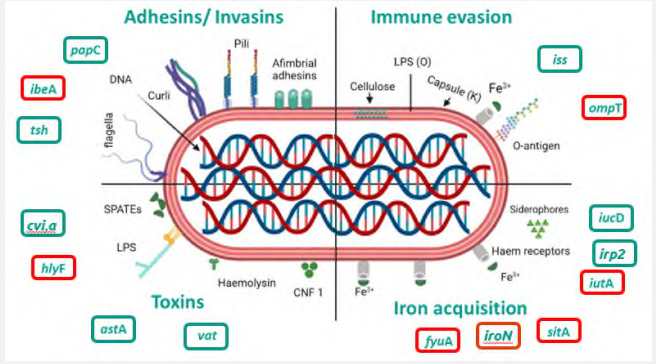
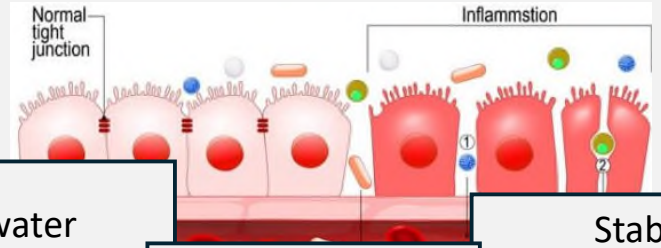
Multiple factors of colibacillosis

APEC virulence/prevalence

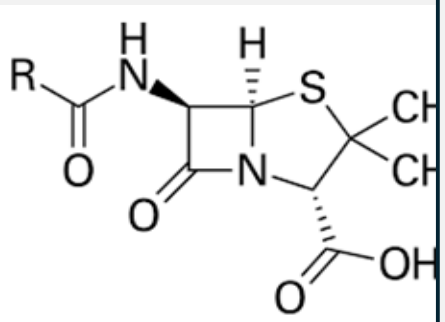


Co-infections

- respiratory tract (IBV, aMPV, TRT)
- immunosuppressant (IBD, CAV)
- Bacterial (MG, MS, ORT)
- Enteritis (Leaky Gut)



Infection pressure (selection, antibiotics)

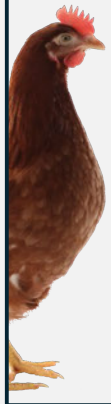


Animal health, immune status

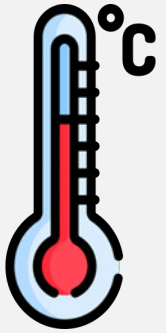
Red mite (Dermanyssus gallinae) as APEC reservoir; type O2 dominates Schiavone et al., 2020

Drinking water (biofilms)

Genetic, age



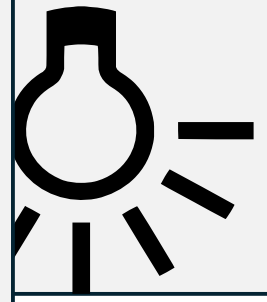
Stable climate



Stable hygiene (disinfection, bedding)

Feed (quality, composition)

Light regime (feather pecking)



Long journey short

- Colibacillosis is multifactorial and can use the intestine as a point of entry
- *E. coli* can be commensal, secondary and primary pathogen
- O2, O78 from septicaemia, most likely APEC
- Interimmun-APEC-PCR adapted to current virulence factors (early detection)
- Better selection for optimized autogenous immune prophylaxis
- *E. coli* O2 ELISA as a new tool (for optimizing immune prophylaxis)

Over to you: Your thoughts and questions…

Thank you!