Strategic use of feed ingredients, nutrients and feed additives to enhance performance and health of weaned pigs

Satellite Symposia of Evonik at DPP 2025

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SCIENCING THE GLOBAL FOOD CHALLENGE

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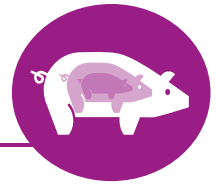
Outline



1. Introduction – gut health challenges in weaned pigs

2. Effect of nutrients (CP, AA) on performance and health of weaned pigs

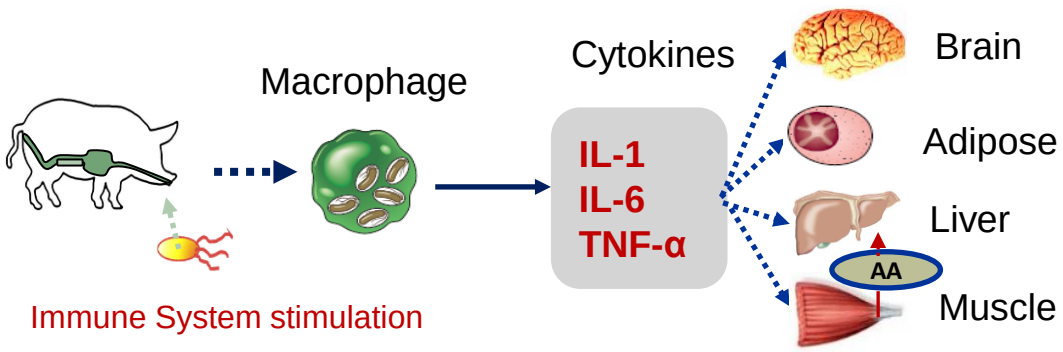
3. Effect of ingredients (fiber) on performance and health of weaned pigs

4. Effects of selected feed additives on gut health and performance of weaned pigs

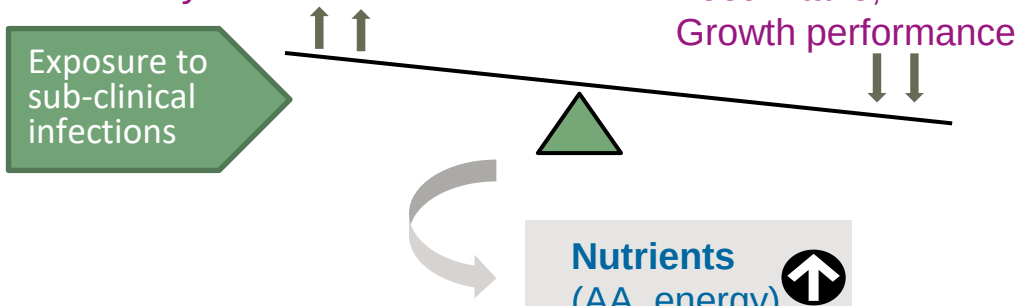
5. Take-home message

Introduction
Sub-optimal immune status and post-weaning diarrhea are key challenges

Poor immunity / subclinical disease

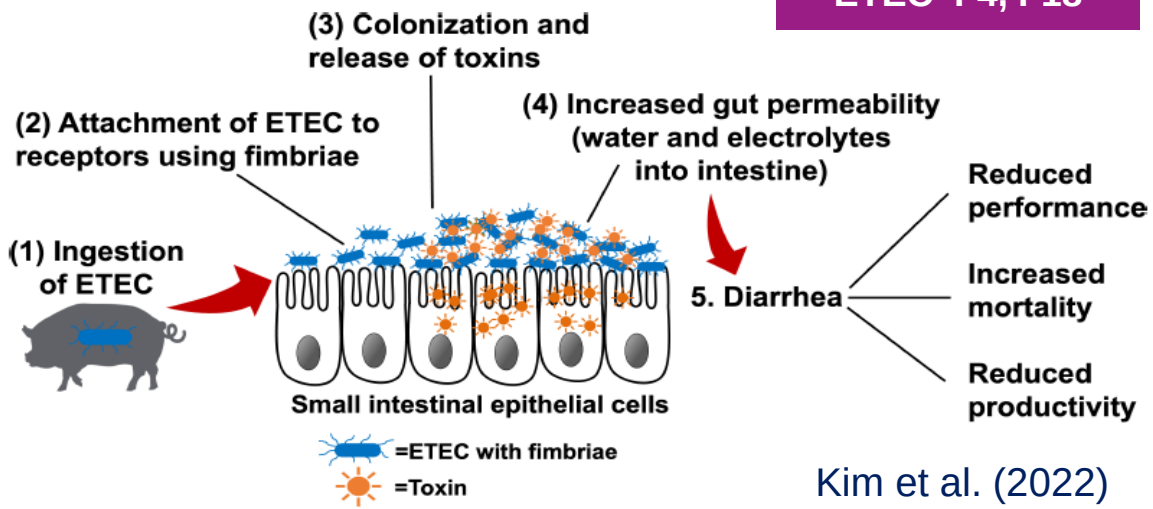


- ISS redirects nutrients towards immune cells (liver).
- Changes in protein synthesis affect AA requirements.



Post-weaning diarrhea

ETEC F4, F18



Kim et al. (2022)

Pre-deposing factors

- Weaning stress, diet change (high CP)
- Immature (leaky) gut
- Sanitation (environment)

- Economic loss (PWD): 40 $ (€)/sow/yr (Amezcua et al., 2002; Sjölund et al. 2014).

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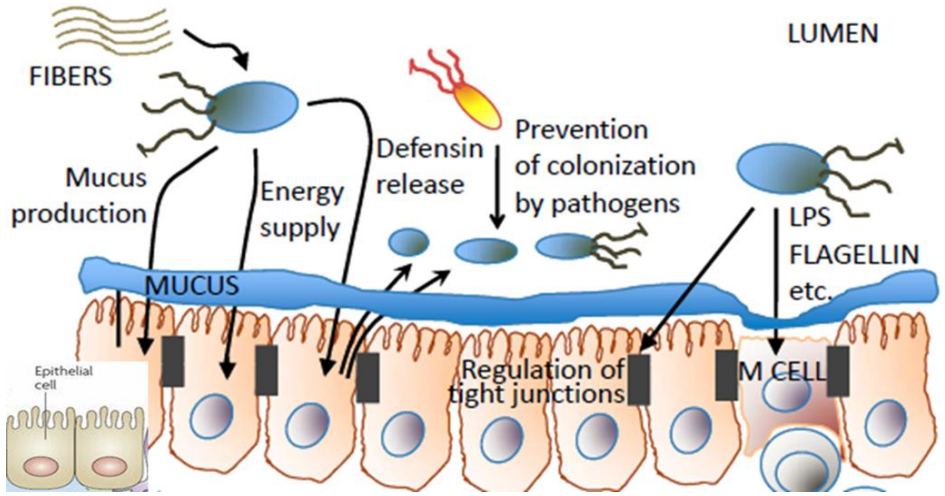
Introduction
Gut health & feed additives (AGP-free concept) to improve gut health of pigs



Bischoff (2011)

Optimal "gut health"

- ✓ **relates to 5 major criteria:**
  1. Effective digestion and absorption of feed
  2. Absence of gastrointestinal illness
  3. Normal and stable intestinal microbiome
  4. Effective immune status
  5. Status of 'well-being'

MoA / FA	Suppress *pathogens*	Microbiota balance	Gut barrier	Immunity	Nutrient digestion
Organic acids	✓	✓	✓		✓
Probiotics	✓	✓	✓	✓	✓
Functional AA			✓	✓	
Prebiotics (fiber)		✓	✓		
Phytogenic (EO)		✓	✓	✓	✓

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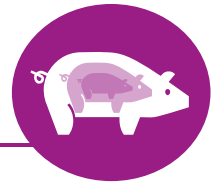

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Low CP-precision feeding concept as the basis to reduce diarrhea incidence

High protein diets

↓

Undigested substrates in the gut lumen ↑

↓

Proliferation of pathogenic bacteria and metabolites ↑

↓

Gut morphology ↓

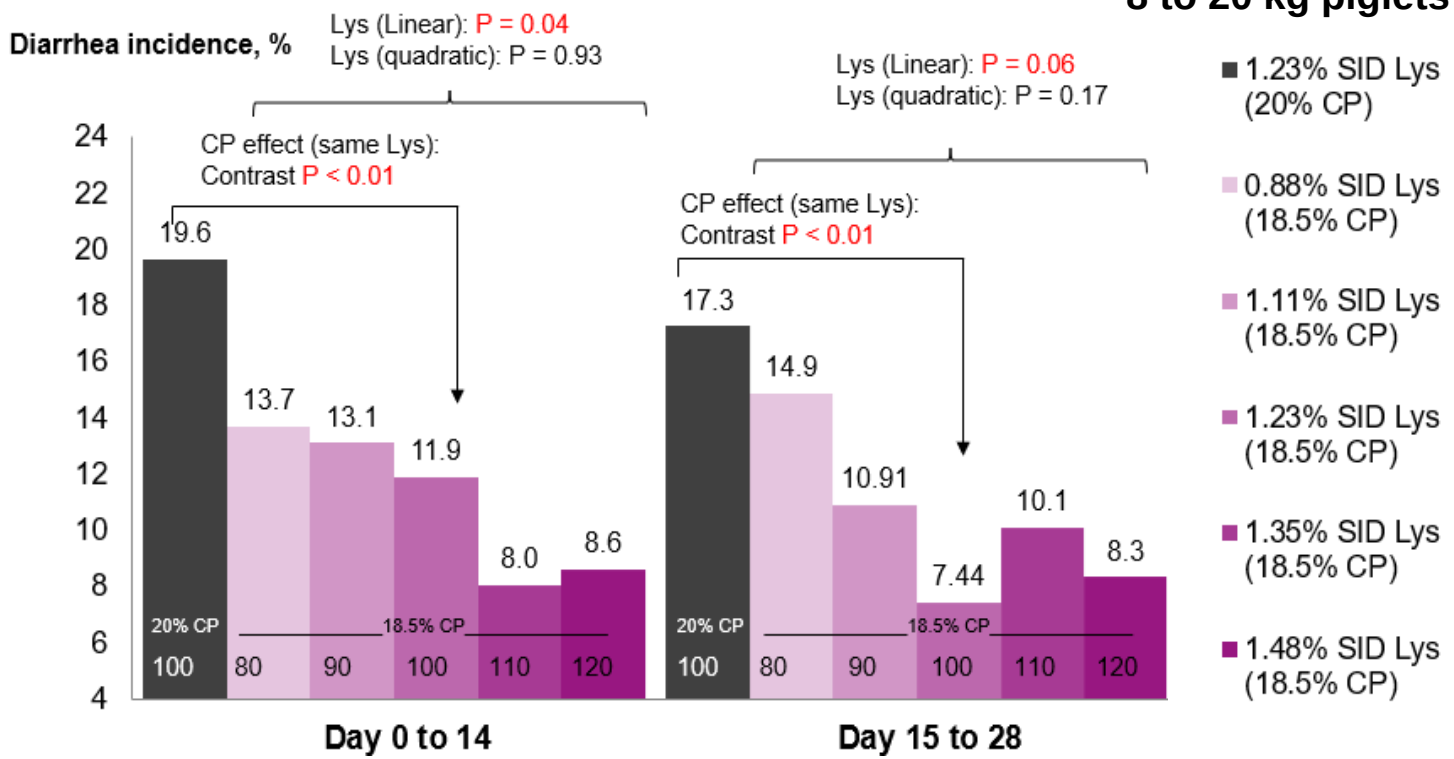
↓

Post-weaning Diarrhea ↑

Reduced CP diet

- Balancing adequate level of AA (CAA) and NE
- No impairment in pig performance (Ideal AA ratio)

8 to 20 kg piglets



E. coli can utilize nitrate for anaerobic respiration (Winter et al., 2013)

- Reducing CP from 20 to 18.5% (4 wk post-weaning) reduces PWD
- Increasing SID Lys (above NRC) further reduces PWD

Zhou et al. (2019)

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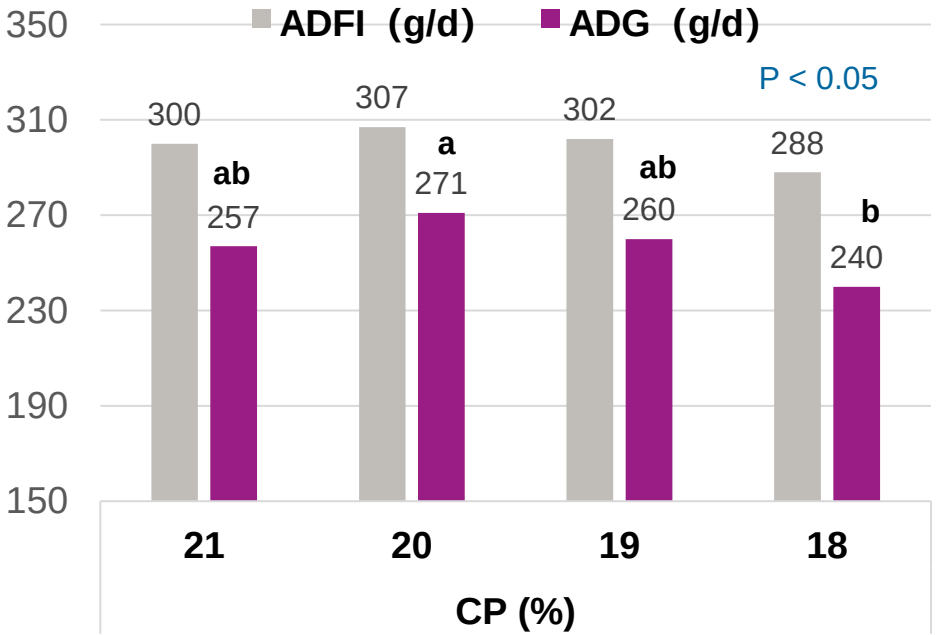
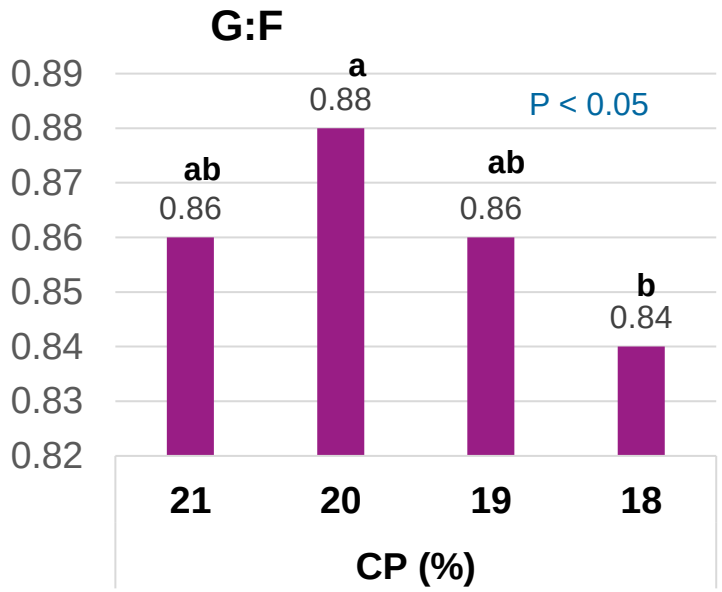
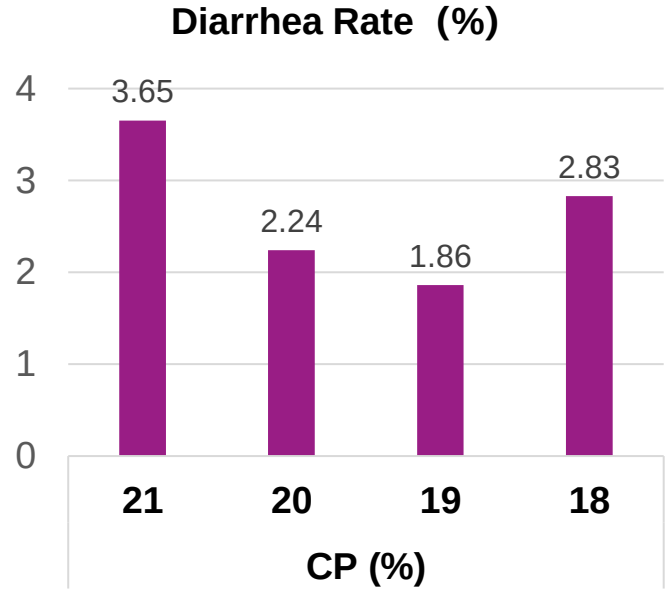
Effects of reducing dietary CP (adequate EAA and increasing SID Lys:CP ratio) on performance and diarrhea of weaned pigs

384 weaned pigs (6.3 ± 0.82 kg BW; 12 rep pens/trt; 8 pigs/pen; 14-d)

Diet 1) **21% CP** (corn, SBM, whey, plasma; 5 CAA; 1.35% SID Lys, 10.7 MJ/kg NE; EAA-adeq.; **SID Lys:CP, 6.4%**
Diet 2) **20% CP** (corn, soy, FM, whey; 6 CAA; 1.35% SID Lys, 10.7 MJ/kg NE; EAA-adeq.; **SID Lys:CP, 6.8%**
Diet 3) **19% CP** (corn, soy, FM, whey; 6 CAA; 1.35% SID Lys, 10.7 MJ/kg NE; EAA-adeq.; **SID Lys:CP, 7.1%**
Diet 4) **18% CP** (corn, soy, FM, whey; 6 CAA; 1.35% SID Lys, 10.7 MJ/kg NE; EAA-adeq.; **SID Lys:CP, 7.5%**







- SID Lys:CP ratio of ~ 7% optimized ADG, G:F and reduced diarrhea rate.
- SID Lys:CP ratio of 7.5% impaired ADG, G:F and increased diarrhea rate.

Commercial facility in China

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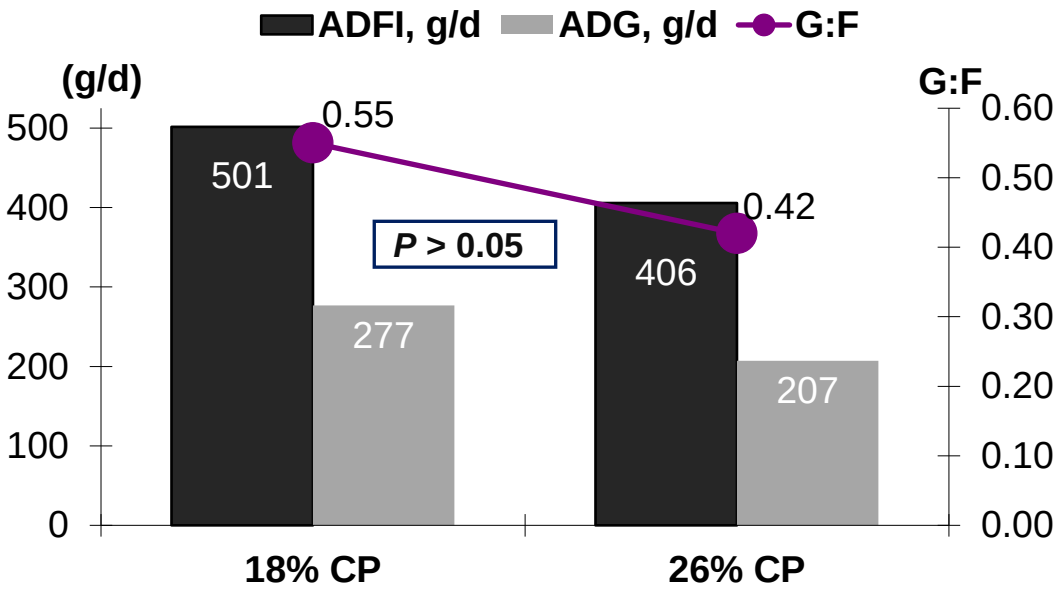
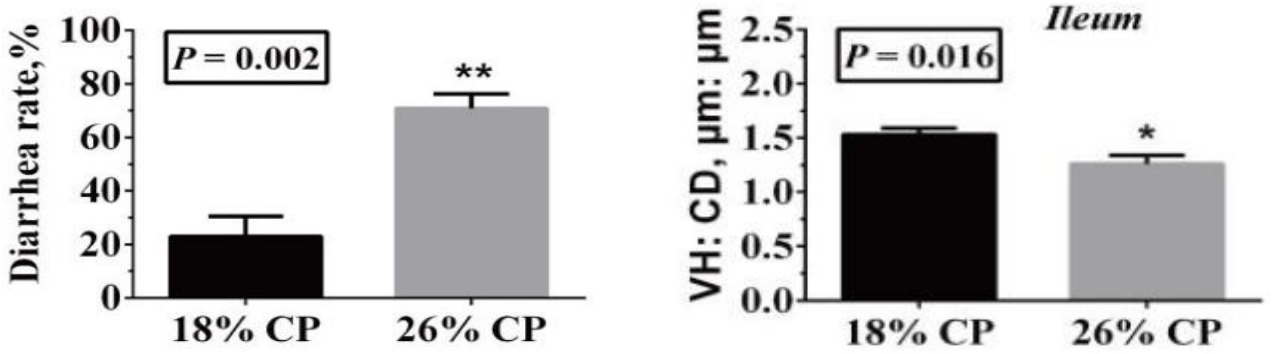
Feeding low CP diet improves intestinal function and reduces diarrhea without affecting performance of weaned pigs

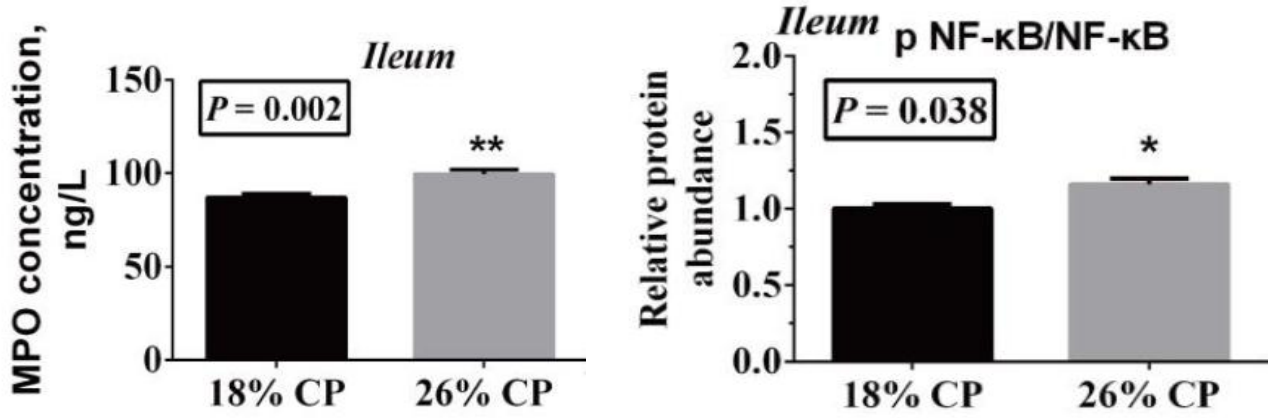
1) **26% CP** (corn, soy, 7% FM, whey; without CAA; AA-adeq); 2) **18% CP** (4 CAA; 3% FM; AA-adeq; same Lys, NE); **d 0-12**



Piglets fed low CP diet had lower diarrhea through enhanced morphology which may be due to decreased activation of NF-κB signaling to induce intestinal inflammation.



Diarrhea rate and VH:CD in ileum



Myeloperoxidase (MPO) and phosphorylation of NF-κB:NF-κB ratio in ileum

Yin et al. (2021)

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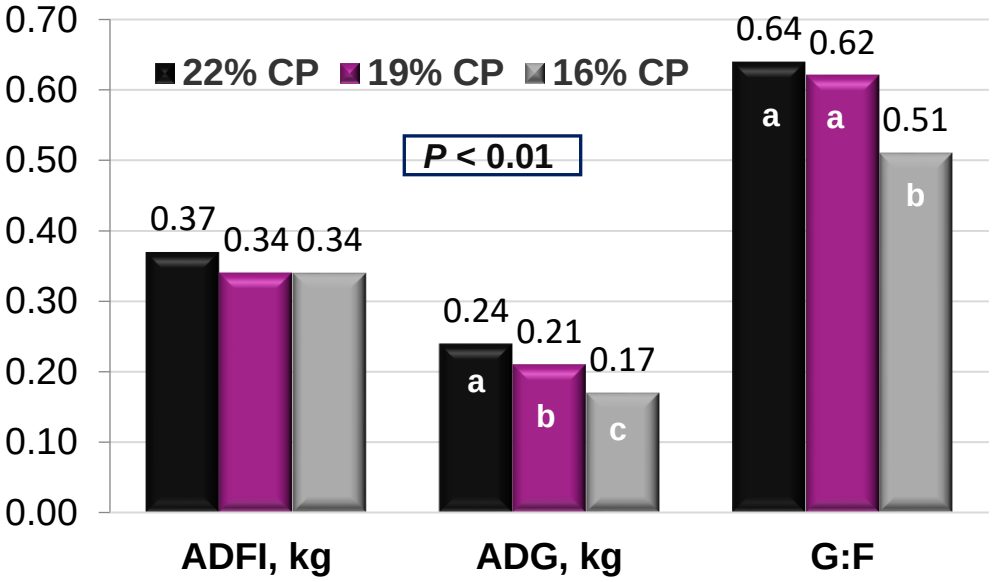
Effect of dietary CP level on growth performance and indicators of intestinal health in weaned pigs (d 0-28)

180 weaned pigs (5.5 ± 0.88 kg BW; 12 rep pens/trt; 5 pigs/pen; 28-d; 2 phase feeding); **d 0-28**

3 diets: 1) **22% CP** (corn, soy, FM, whey; 3 CAA; AA-adeq, 1.6% Lys; 7.3% Lys:CP); 2) **19% CP** (corn, soy, FM, whey; 7 CAA; AA-adeq, 1.5% Lys; 8.1% Lys:CP; 3) **16% CP** (corn, soy, FM, whey; 3 CAA; AA-def (1.2% Lys); NRC (2012) basis.



- Piglets fed low CP-AA adeq. diet maintain performance and improve fecal score and gut morphology
- Piglets fed low CP-AA def diet reduces performance and impairs gut morphology

Fecal scores and blood characteristics of pigs affected by dietary CP levels

	22% CP	19% CP	16% CP	*P*-value
Blood urea N, mg/dL(d 27)	9.33^{c}	5.25^{ab}	4.83^{a}	0.01
Haptoglobin, mg/mL (d 27)	0.70	0.37	0.88	0.43
Fecal score (d 1-28)	1.52^{a}	1.36^{ab}	1.19^{b}	0.02

Intestinal morphology of pigs affected by dietary CP levels

	22% CP	19% CP	16% CP	*P*-value
Ileum				
Villous height, µm	278^{b}	328^{a}	301^{ab}	**
Crypt depth, µm	213	192	210	ns
VH:CD	1.44^{b}	1.85^{a}	1.54^{ab}	**
Jejunum				
Villous height, µm	242	207	248	ns
Crypt depth, µm	200^{a}	161^{b}	172^{b}	***
VH:CD	1.22	1.30	1.37	ns

ns: not significant; ** P <0.05; *** P < 0.001

Limbach et al. (2021)

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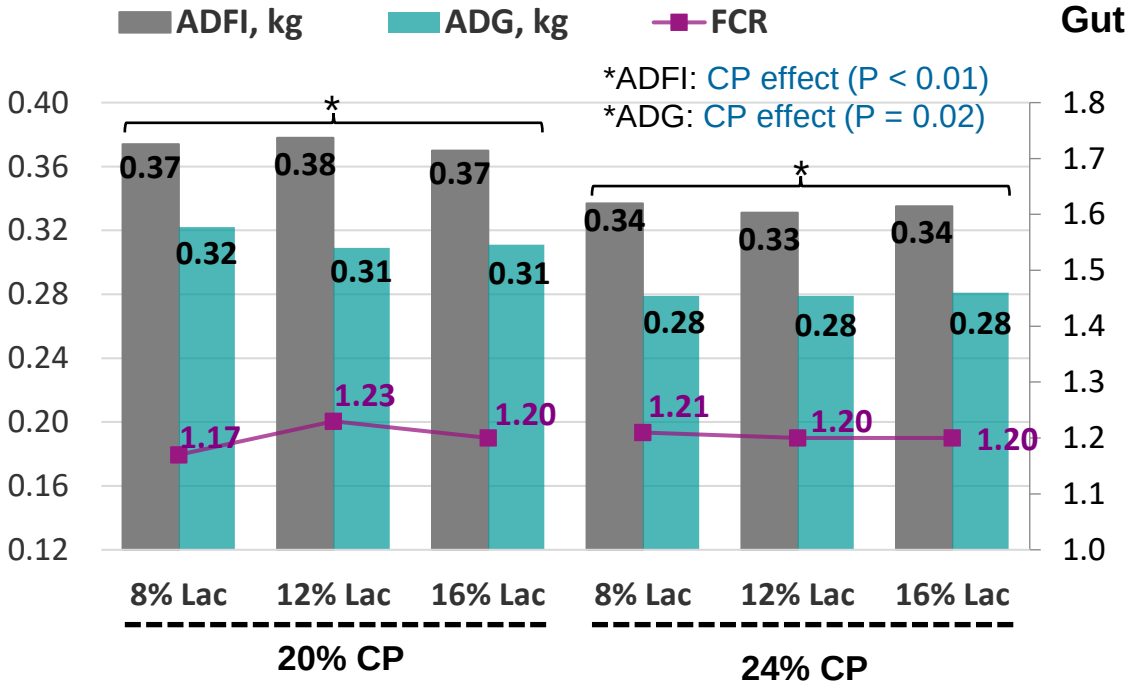
Effect of dietary CP and lactose levels on growth performance and intestinal morphology of weaned pigs

144 weaned pigs (7.2 ± 0.97 kg BW)

2 x 3 factorial; 2 CP (20 vs 24%) and 3 lactose level (8, 12 and 16%); 8 rep/trt; 3 pigs/pen; **14-d**)

[24% CP (without CAA); 20% CP (4 CAA); lactose was replaced with starch; same SID Lys and ME; 0.3% ZnO]



Gut morphology and tight junction proteins in jejunum at 14 d post-weaning)

Item	20% CP Lactose, % 8	12	16	24% CP Lactose, % 8	12	16	P-values CP	LAC	CP x LAC
Villous height:crypt depth (VH:CD), µm									
Duodenum	1.99	2.38	2.40	1.94	2.41	2.37	ns	***	ns
Jejunum	2.56	2.71	2.86	2.24	2.64	2.74	**	***	ns
Ileum	2.74	2.43	2.55	2.23	2.62	2.69	ns	ns	***
Gene expression of tight junction proteins in the jejunum									
Occludin	2.29	3.46	3.04	2.33	3.10	2.77	ns	**	ns
ZO-1	1.74	2.15	2.13	1.21	2.27	1.79	ns	**	ns

ns: not significant; ** P <0.05; *** P < 0.001

Lowering dietary CP level increases feed intake and BW gain of weaned pigs.
Inclusion of lactose at 12% may improve intestinal morphology and integrity.

Soares et al. (2020)

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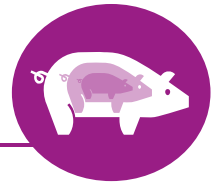

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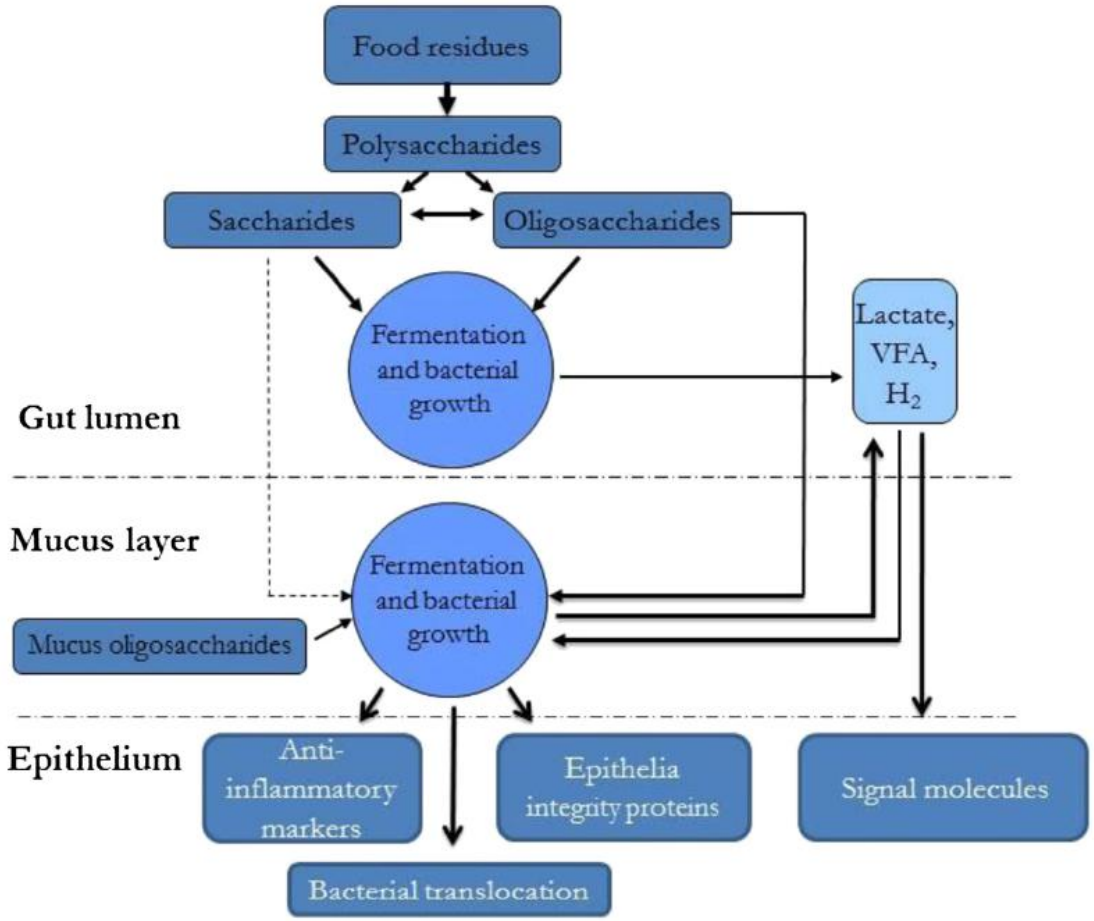
Dietary fiber and its interactions with gut environment, gut microbiota on intestinal health



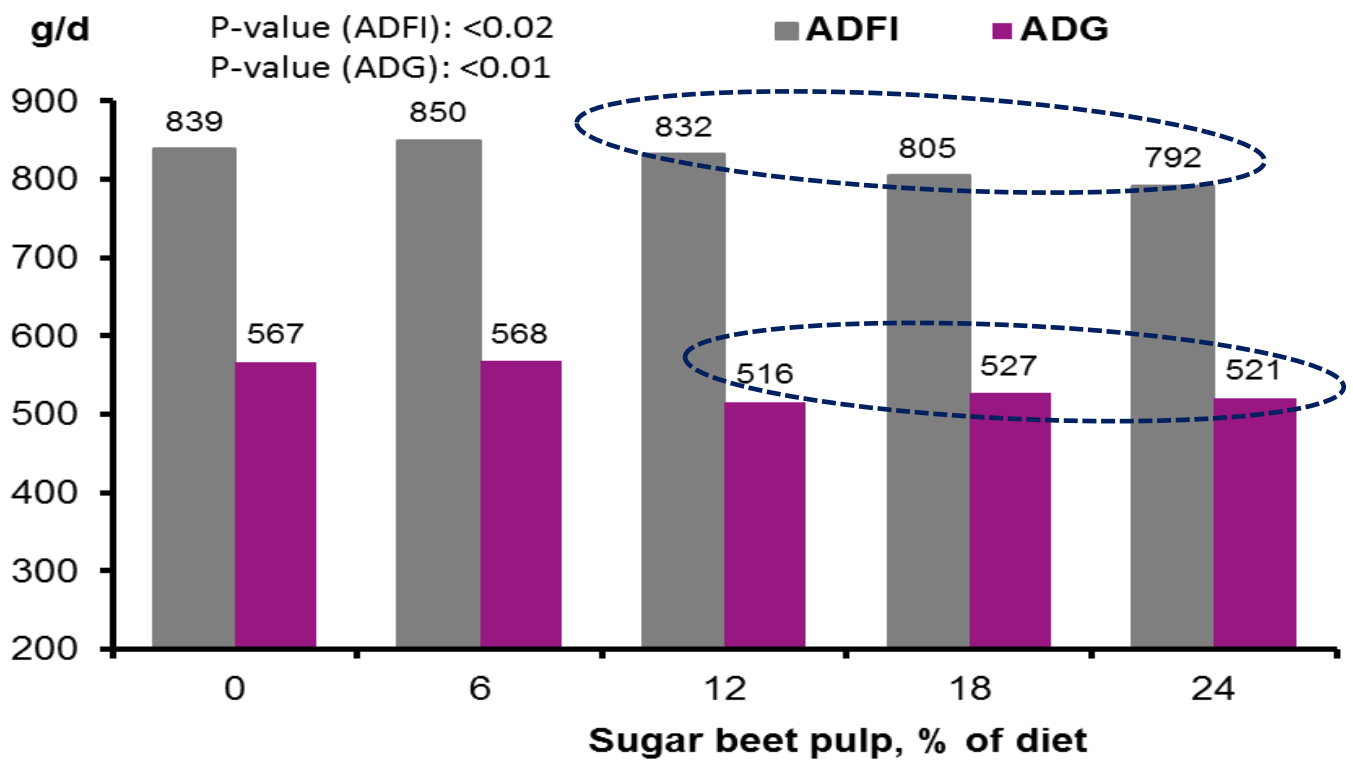
Lindberg (2014)

Dietary fiber

- **Plant derived polysaccharides** that are not digested by endogenous digestive enzymes and served as substrates for bacterial fermentation in the hindgut (Bach Knudsen et al., 2013).
- Alternative feedstuffs contain more fiber
- Dietary fibers can **reduce FI and nutrient digestion** but can act as **prebiotics, i.e.** main fermentation products are SCFAs (lactate, acetate, propionate and butyrate), which are energy source for epithelium cell and intestinal health
- Includes oligosaccharides (**OS**), resistant starch (**RS**), **soluble/insoluble hemicellulose**, **cellulose** and **lignin** (Bach Knudsen and Laerke, 2018).
- Moderate dietary inclusion of insoluble fiber or in combination with soluble fiber seems to have beneficial effects on gut health.

Effect of sugar beet pulp (soluble/fermentable fiber) on performance of weaned pigs

Animals	220 weaned pigs (initial BW of 7.5 kg); 35 d
Diets	Wheat, SBM based diets with 5 fiber level (0, 6, 12, 18 or 24% SBP (sNSP))



Sugar beet pulp (SBP)
(co-product of processing sugar from sugar beets)

- TDF = 54.9%
- IDF = 38.2%
- SDF = 17.3%
- ADF = 24.9%
- CP = 9.0%

- Supplementing sugar beet pulp up to 6% (6.5% ADF) maintained ADFI and ADG of weaned pigs.

Wang et al. (2016)

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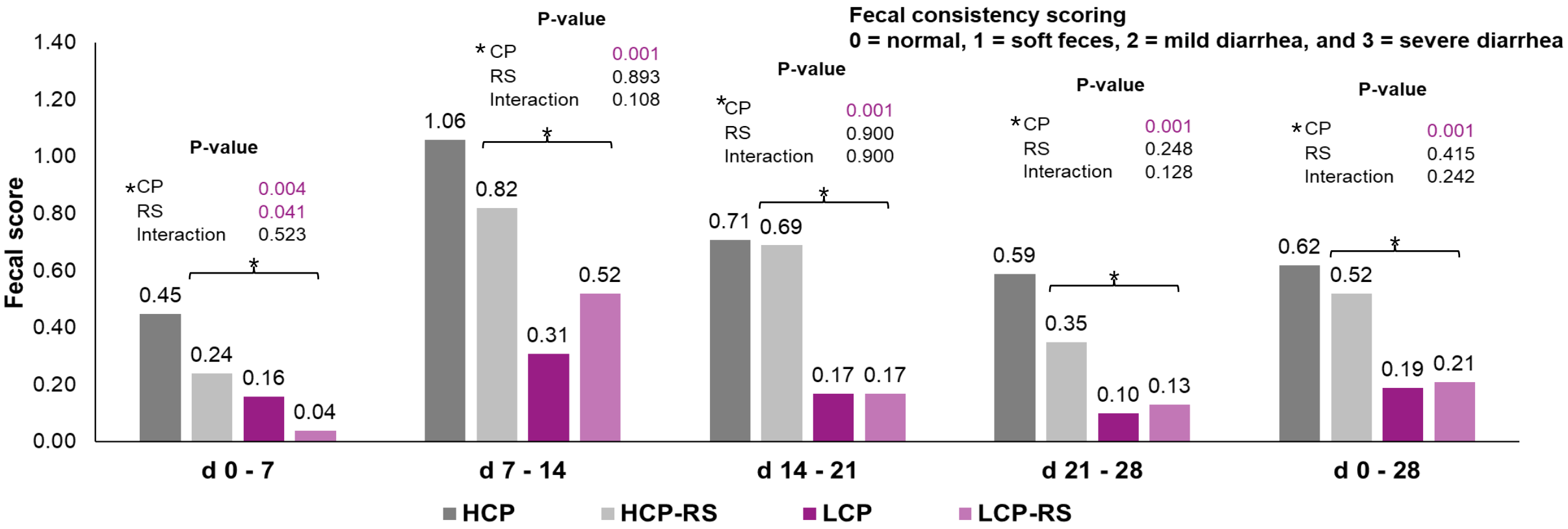
Effects of CP content and potato resistant starch supplementation on fecal scores in weaned pigs

Animals	96 mixed-sex weaned pigs (7.06 ± 0.45 kg); 28 d
Diets	2 x 2 factorial; 2 CP (23 vs 19%) and 2 RS (0 vs and 1%); 2,560 kcal (10.7 MJ)/kg NE; 1.35% SID Lys



Lee et al. (2024)

- Reducing dietary CP consistently lowered fecal score (all periods).
- Reduced fecal score was found in RS-supplemented groups during d 0-7.

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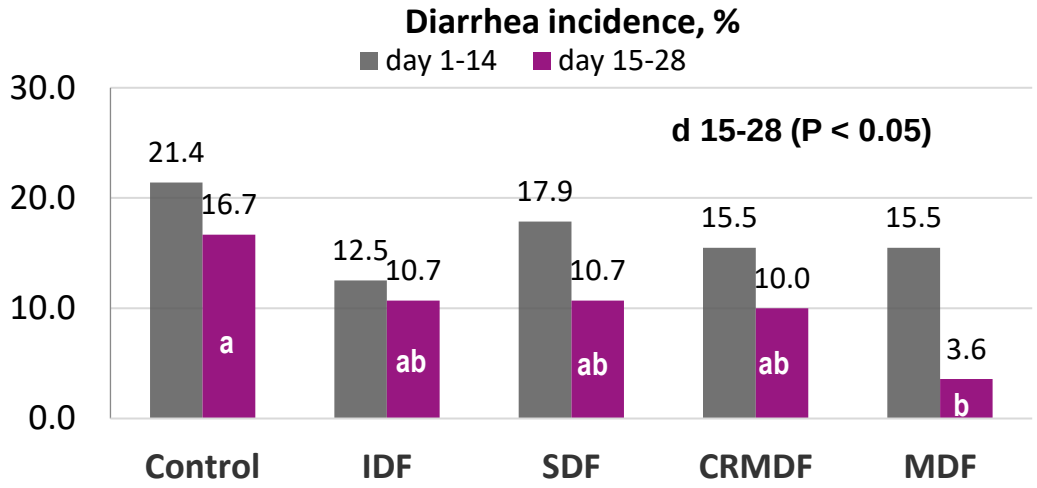
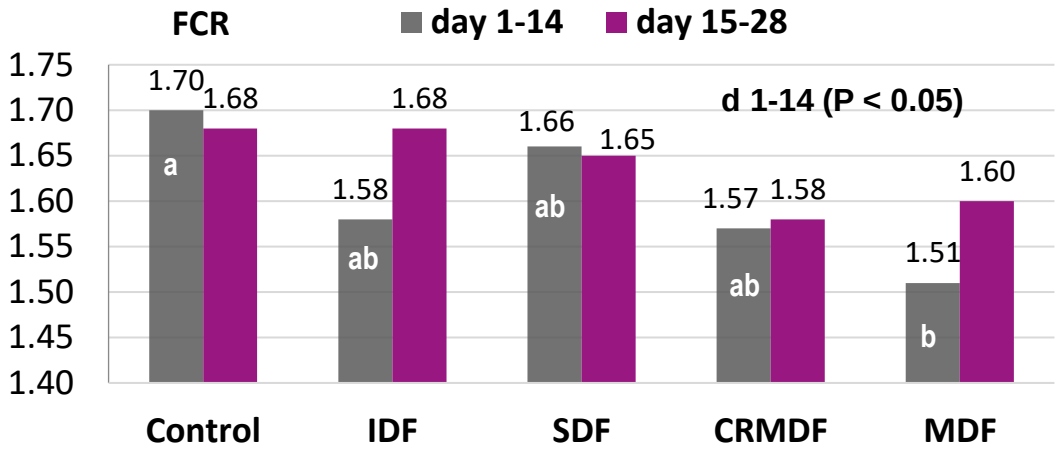
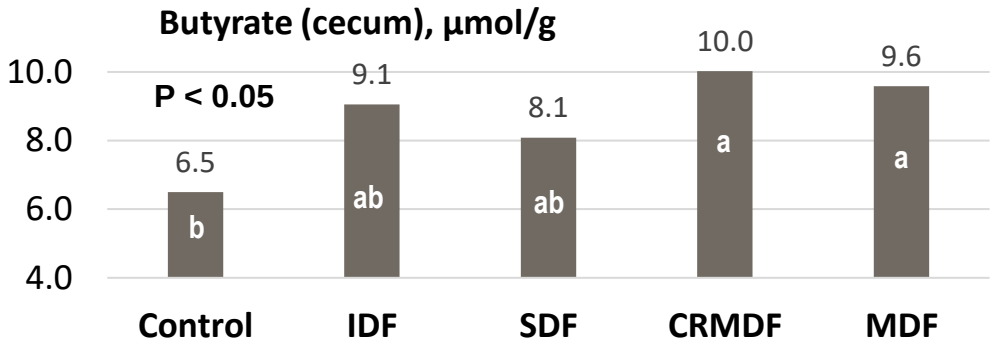
Effect of supplemental insoluble to soluble fiber ratio on gut health and performance of weaned pigs

30 piglets (weaned 24 d of age; 6 pigs/Trt; 28-d study)

Control: basal diet (corn-SBM-fish meal-whey; 1.29% SID Lys, 19% CP)
IDF: 1% insoluble fiber (lignocellulose)*
SDF: 1% soluble fiber (inulin)
CRMDF: d 1-14 (0.75% IDF + 0.25% SDF) / d 15-28 (0.25% IDF + 0.75% SDF)
MDF: 0.5% IDF + 0.5% SDF
* Fiber sources added replacing corn.







- Combination of moderate level of IDF (0.5%) and SDF (0.5%) increased production of butyrate and better FCR and reduce diarrhea rate.

Chen et al. (2020)

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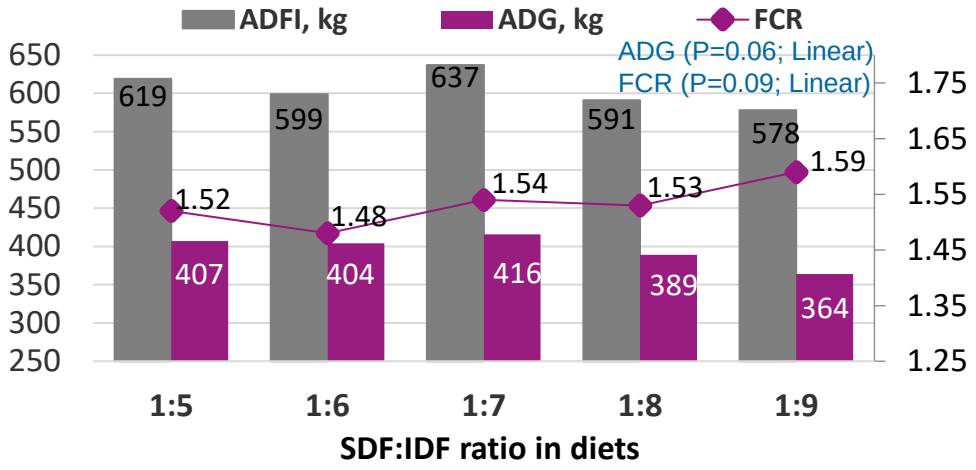
Total dietary insoluble to soluble fiber ratio on to improve fecal consistency score and fecal VFA in weaned pigs

240 piglets (7.98 kg; 5 Trts; 28-d study)

Diet type: corn starch-soy protein-whey-SBP-corn bran (1.35% SID Lys)

Treatments: SDF:IDF ratios (1:5, 1:6, 1:7, 1:8, 1:9); TDF (12.3 to 12.6%)

Growth performance (d 1-28)



Fecal VFA concentration (mg/g) of weaned pigs (d 28)

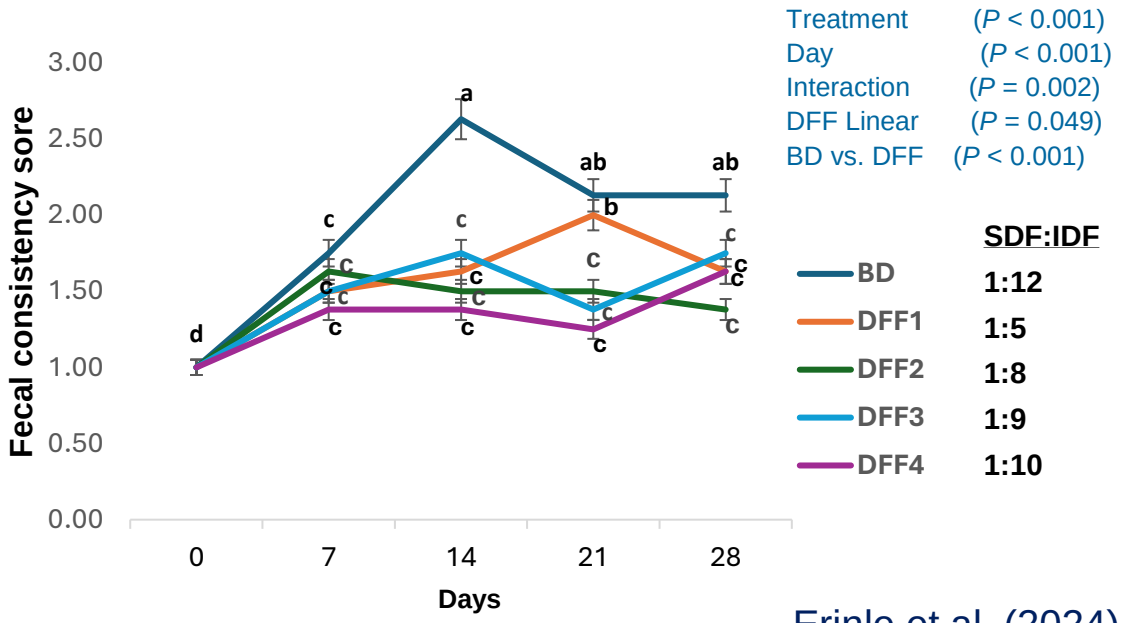
	SDF:IDF					P-value	
	1:5	1:6	1:7	1:8	1:9	ANOVA	Linear
Butyrate	1.67^{a}	1.57^{a}	1.66^{a}	1.19^{ab}	0.87^{b}	0.01	0.01
Total VFA	10.1^{a}	9.7^{a}	9.1^{ab}	8.2^{ab}	7.2^{b}	0.03	0.01

Lv et al. (2020)

200 piglets (7.56 kg; 5 Trts; 28-d study)

Basal (BD): corn-SBM-whey-corn gluten meal (1.35% SID Lys)

DFF 1-4: inulin (0.5 to 2%) and lignocellulose (1.15 to 2%) added (SDF:IDF ratios: 1:5, 1:8, 1:9, 1:10); TDF (11.3%)



Erinle et al. (2024)

SDF:IDF ratio of 1:7 (Trial 1) and **1:8** (Trial 2) seems to be optimum for fecal score and butyrate.

Replacing wheat with rye as the main ingredient reduces fecal Salmonella counts in nursery pigs infected with *S. Typhimurium* (ST)

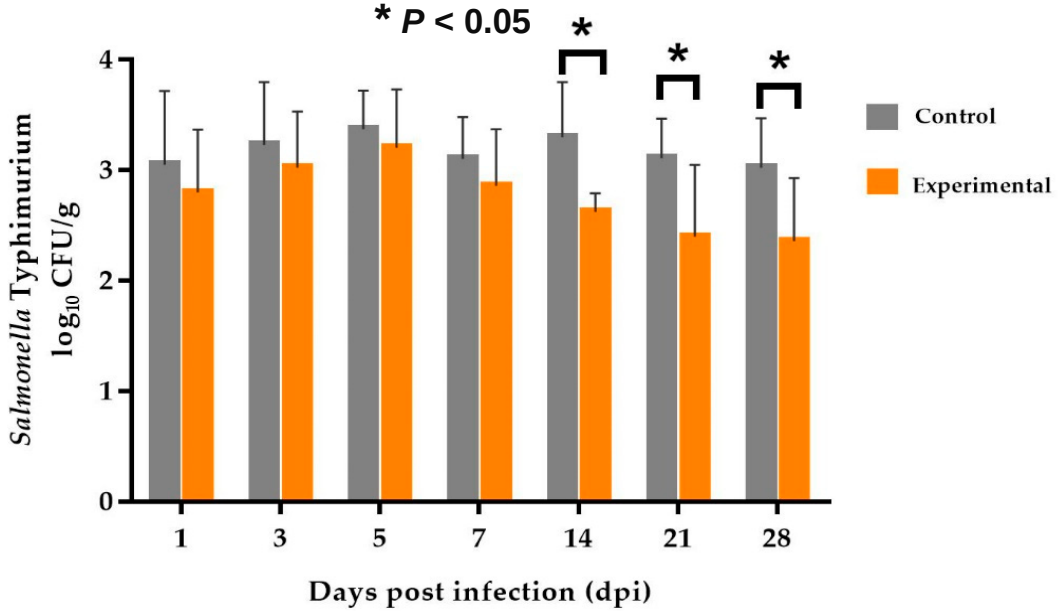
Hybrid rye

- lower concentrations of ANFs, e.g. trypsin inhibitors, (Schwarz et al., 2015)
- rich in fiber (arabinoxylans and fructans) ➔ hindgut microorganism fermentation (SCFA, **butyrate** formation) ➔ reduce the penetration of Salmonella into intestinal epithelial cells (Gantois et al., 2006)

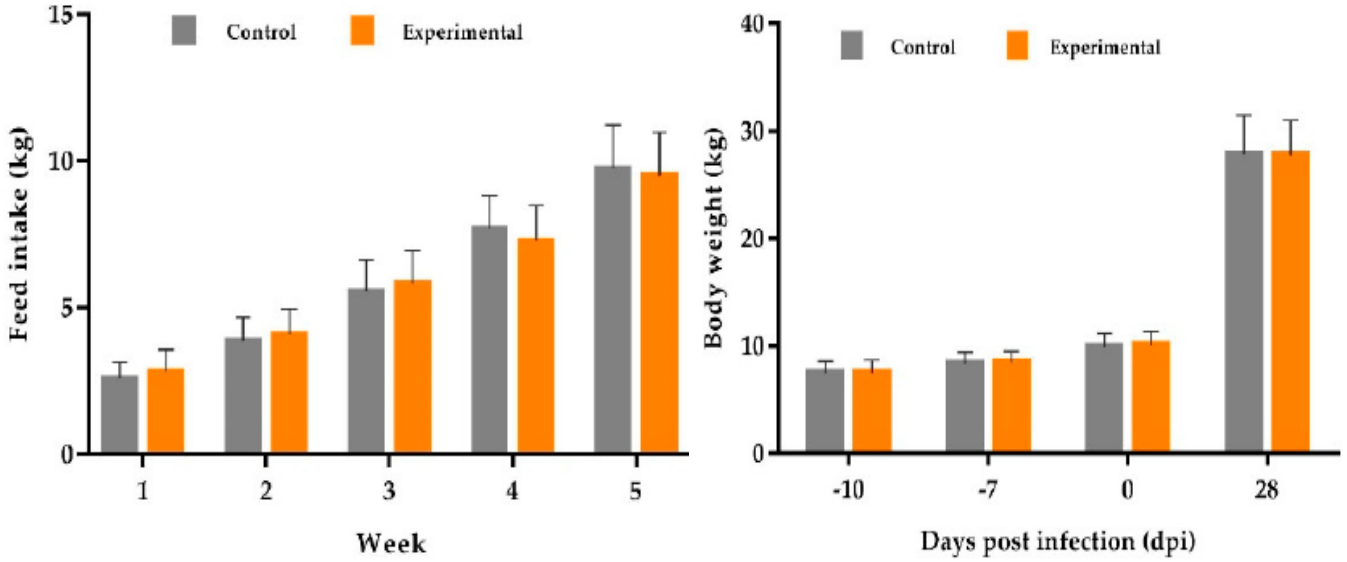
Diets: Control: wheat (69%)-SBM diet (12.3% NSP, 6.3% AX), **Exp:** rye (69%)-SBM based diet (14% NSP, 7.4% AX*)

*Arabinoxylans (hemicellulose; SDF); **Animals:** 7.5 kg weaned pigs; 28 d challenged with ST (7 d adaptation)

Fecal Salmonella (log10 CFU/g) of piglets (post-infection)



Feed intake and body weight of piglets



Rye (70%) in nursery pig diets reduces fecal ST shedding but performance was not different. Chuppava et al. (2020)

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Replacing corn with “hybrid rye” in weaned pig diets does not compromise ADG but may reduce diarrhea incidence (d 0-34)

Composition of weaned pig diets with increasing rate of hybrid rye replacement for corn* *Contained the same whey, SBM, fish meal, soy oil levels.

Item	Phase 1 (day 1 – 7)[a]					Phase 2 (day 7 – 21)[a]					Phase 3 (day 21 – 34)[a]				
g/kg corn replacement:	0	75	150	225	300	0	100	200	300	400	0	250	500	750	1000
Ground hybrid rye	–	30.0	60.0	90.0	120.0	–	53.4	106.8	160.3	213.6	–	150.7	301.6	452.5	603.4
Ground corn	399.6	369.9	339.8	309.8	279.8	534.0	480.7	427.4	373.9	320.7	602.8	452.4	301.6	150.9	–
Crude protein, g/kg	233.7	235.7	229.4	228.8	225.8	202.5	208.6	210.9	212.3	219.5	201.8	213.4	215.3	224.1	224.3
Insoluble dietary fiber, g/kg	85.0	84.0	81.0	86.0	86.0	92.0	90.0	97.0	99.0	103.0	113.0	123.0	124.0	133.0	147.0
Soluble dietary fiber, g/kg	6.0	8.0	15.0	10.0	10.0	8.0	21.0	15.0	17.0	15.0	17.0	15.0	18.0	28.0	28.0
Total dietary fiber, g/kg	91.0	92.0	96.0	96.0	96.0	100.0	111.0	112.0	116.0	118.0	130.0	139.0	142.0	160.0	176.0

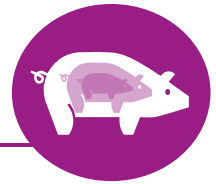
Growth performance and diarrhea incidence of pigs fed diets with increasing rate of hybrid rye

Item	Phase 1/2/3 corn replacement rate[b]						*P* – values	
g/kg corn replacement:	0/0/0	75/100/250	150/200/500	225/300/750	300/400/1000	SE	Linear	Quadratic
Average daily gain, g								
Phase 1, day 1–7	78	84	73	80	95	15	0.553	0.531
Phase 2, day 7–21	226	236	232	225	256	16	0.342	0.549
Phase 3, day 21–34	522	535	527	509	495	20	0.214	0.405
Average daily feed intake, g								
Phase 1, day 1–7	130	138	121	118	141	12	0.936	0.360
Phase 2, day 7–21	343	333	334	330	351	20	0.842	0.449
Phase 3, day 21–34	802	761	770	766	871	30	0.134	0.016
Gain:feed								
Phase 1, day 1–7	0.556	0.599	0.571	0.669	0.626	0.086	0.446	0.885
Phase 2, day 7–21	0.658	0.714	0.693	0.680	0.727	0.021	0.129	0.905
Phase 3, day 21–34	0.654	0.700	0.687	0.664	0.580	0.023	0.018	0.004
Diarrhea incidence[d], %								
Phase 1, day 1–7	45.83	58.33	16.67	12.50	45.83	10.170	0.106	0.024
Phase 2, day 7–21	42.86	58.93	44.64	26.79	51.79	6.677	0.457	0.531
Phase 3, day 21–34	7.14	12.50	7.14	3.57	5.36	4.419	0.278	0.809

- Replacing **corn** with **hybrid rye** had no effect on ADG
- ADFI increased and G:F reduced at 100% replacement in phase 3
- Diarrhea rate was lower when rye inclusion at 60 or 90 g/kg (15 or 22.5% corn replacement) in phase 1.

McGhee & Stein (2021)

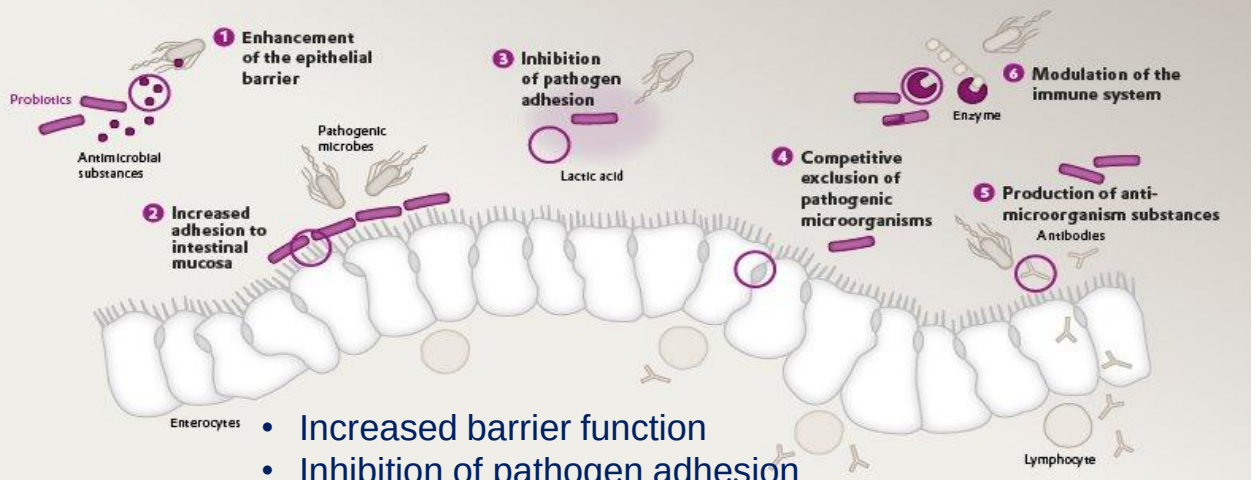
Outline



1. Introduction – gut health challenges in weaned pigs
2. Effect of nutrients (CP, AA) on performance and health of weaned pigs
3. Effect of ingredients (fiber) on performance and health of weaned pigs
4. **Effects of selected feed additives on gut health and performance of weaned pigs**
5. Take-home message

Roles of probiotics to improve gut health of pigs

- **Live microorganisms**, when supply in adequate amount confer health benefit (FAO/WHO, 2002).



- Increased barrier function
- Inhibition of pathogen adhesion
- Secretion of antimicrobial substances
- Competitive exclusion of pathogens
- Stimulation of the host immune system

GutPlus®

Bacillus* DSM *32540

- form spores, resistance to acidic and pelleting
- can inhibit inhibits *E. coli F18* and *Streptococcus suis, Entero. Cecorum*
- produce lactic acid
- increase performance, gut barrier function and microbiota profile in weaned pigs (Park et al., 2020; He et al., 2020)

GutPlus® Virsorb

Multi-strain (Bacillus strain DM 2763 and DM 3021)

- form spores, resistance to acidic and pelleting
- secretes of antimicrobial substances
- can inhibit *Gram⁺ and Gram⁻ bacteria (E. coli F18, F4, Salmonella* and *Strept. suis, E. Cecorum)*
- can bind PED virus and Rota virus

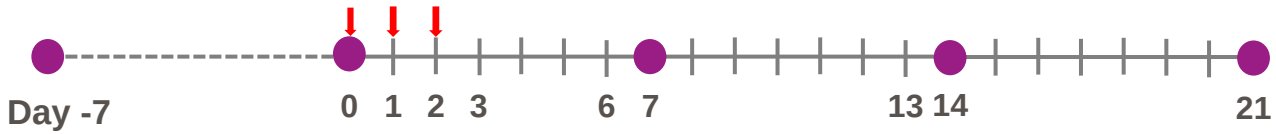
Supplementation of GutPlus® decreases diarrhea and increases growth of weaned pigs challenged with ETEC F18

36 weaned piglets (21 d old; 7.1 ± 1.3 kg BW; 28 d trial)

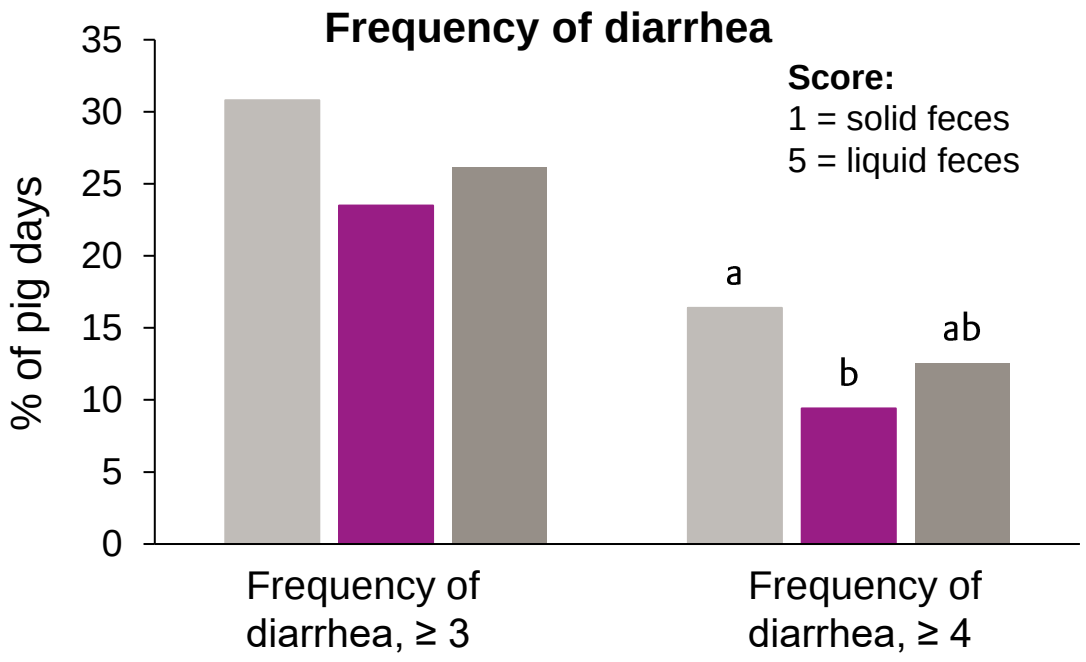
Diets: 1. **Control**, 2. GutPlus (500 g/t)*; 3. Bacillus control*

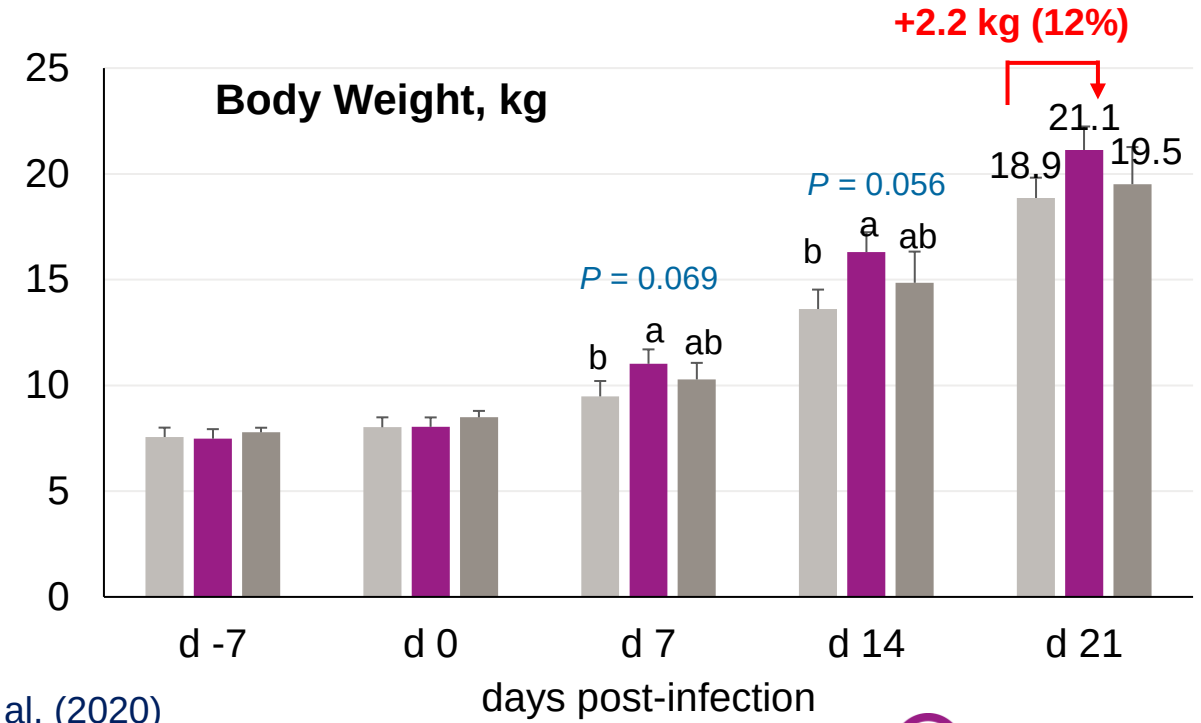
*Dose: (1.0 x10^9 CFU/g of feed)

F18 *E. Coli* challenge (10^{10} CFU 3 mL dose/day)



Control GutPlus® Bacillus Control Strain





He et al. (2020)

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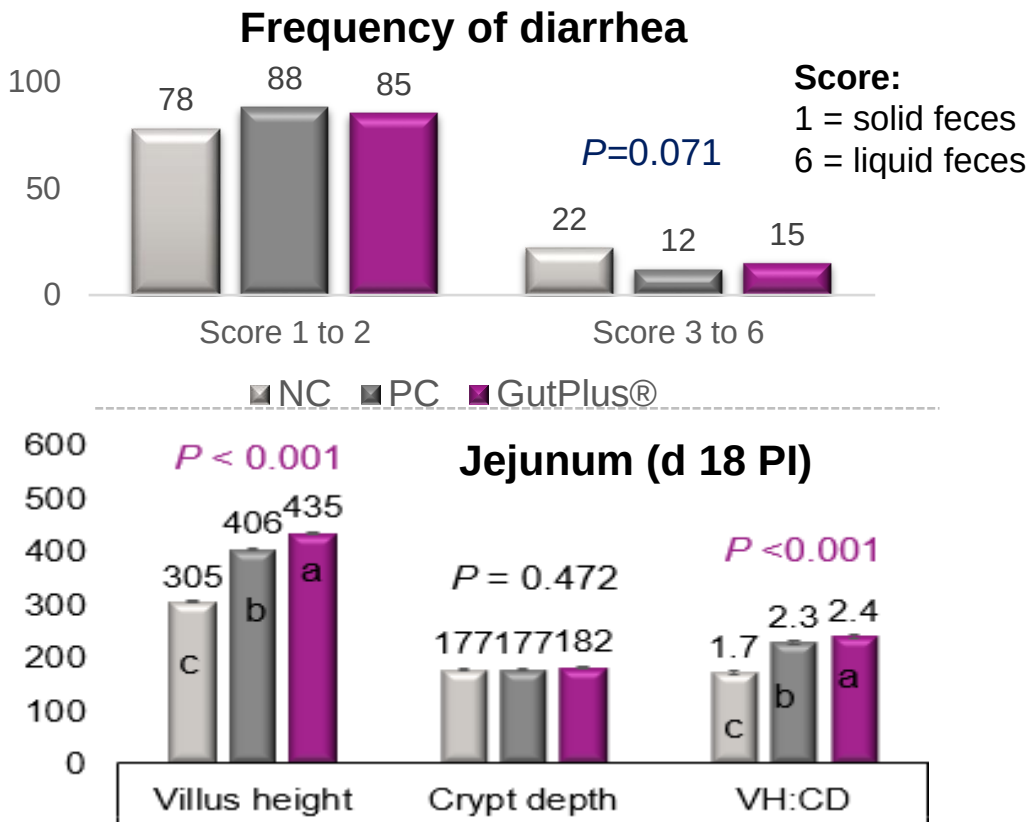
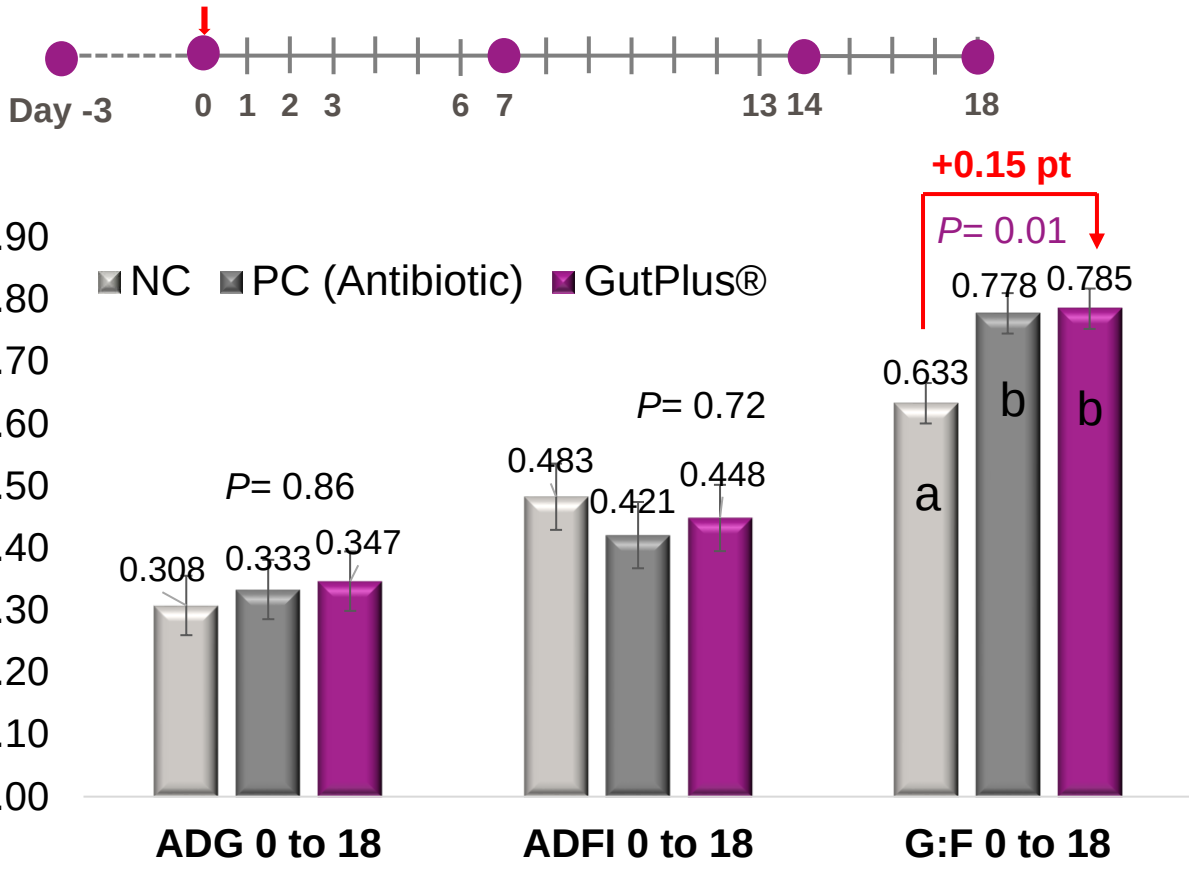
Supplementation of GutPlus® decreases diarrhea, increases intestinal morphology and growth of weaned pigs challenged with ETEC K88 (F4)

21 weaned piglets (21 d old; 8.2 ± 0.77 kg BW; 21 d trial)

Diets: 1. Control, 2. Antibiotic* (2.5 kg/t), 3. GutPlus (500 g/t)

*neomycin and oxytetracycline





Replacing AGP with GutPlus® is possible.

Park et al. (2020)

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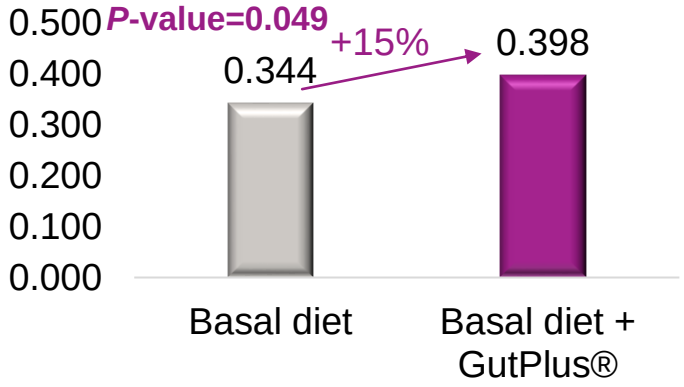
Effect of GutPlus® on diarrhea, performance and fecal microbiota composition of weaned pigs fed AGP-free diets in Spain

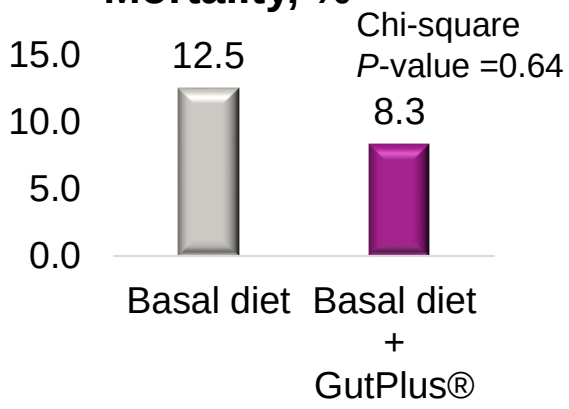
48 piglets (7.1 kg BW; 28 d); 28 d

Basal (corn-SBM-whey-wheat bran; 20.8% CP); Basal + 500 g/ton GutPlus

Overall ADG, kg (0 to 28 d)

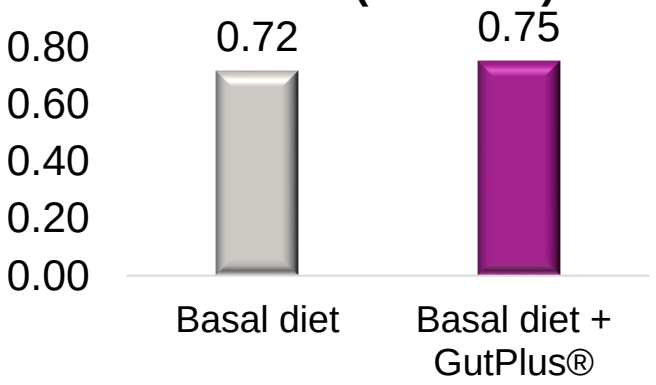


Mortality, %

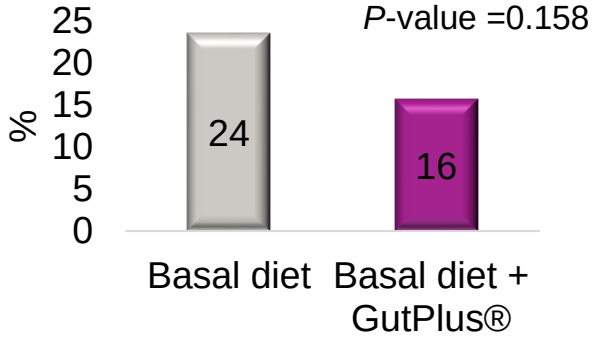


P-value=0.334

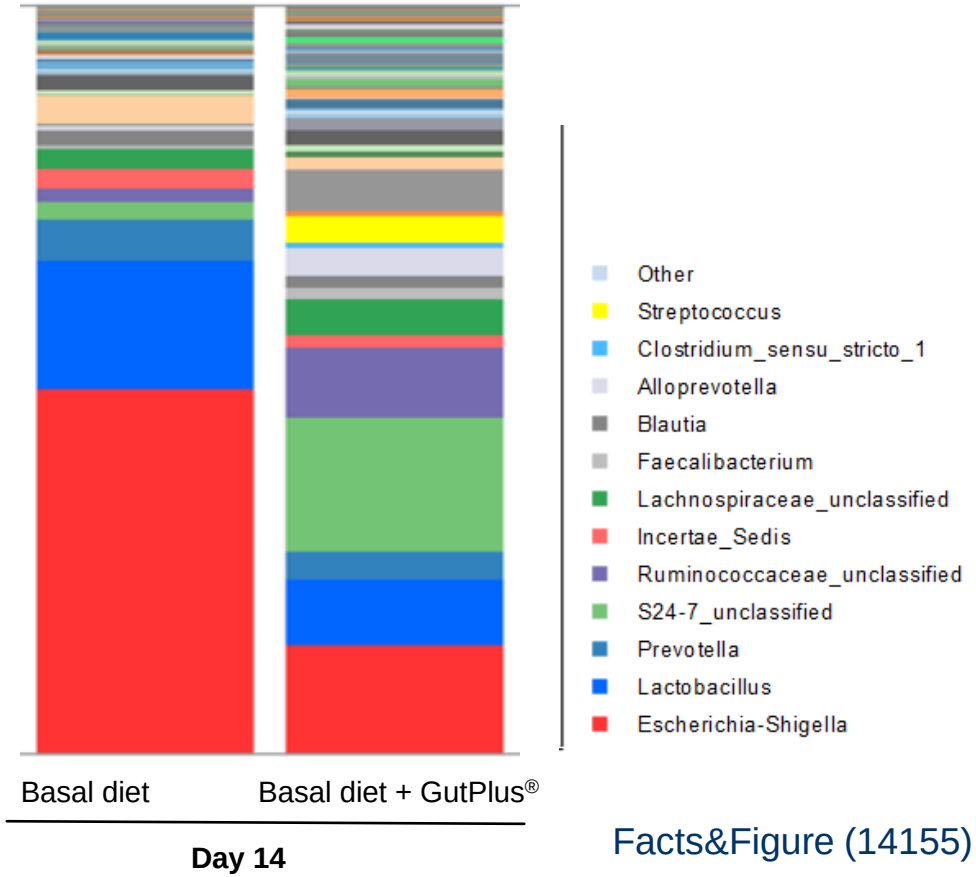
Overall G:F (0 to 28 d)



Frequency of soft feces



Fecal microbial composition (d 14)



Facts&Figure (14155)

At d 14, GuPlus® pigs had less *Escherichia* and *Lactobacillus*, but more *Bacteroidales* (S24-7) and *Ruminococcaceae.*

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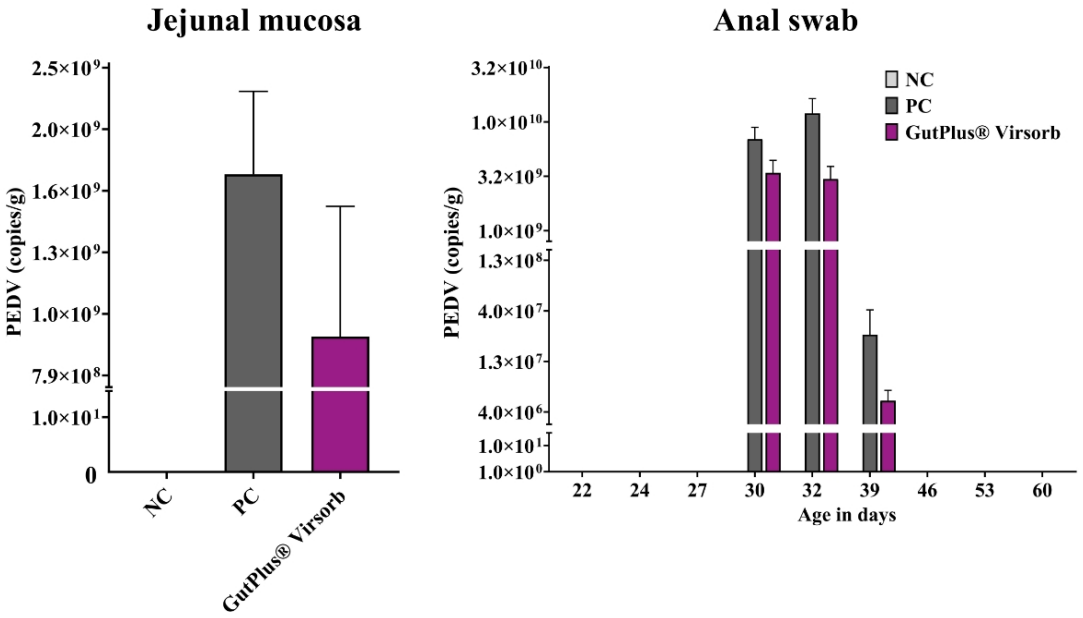
Effect of multi-strain probiotic (GutPlus® Virsorb) on improvement of jejunal mucosal morphology of pigs challenged with PED virus

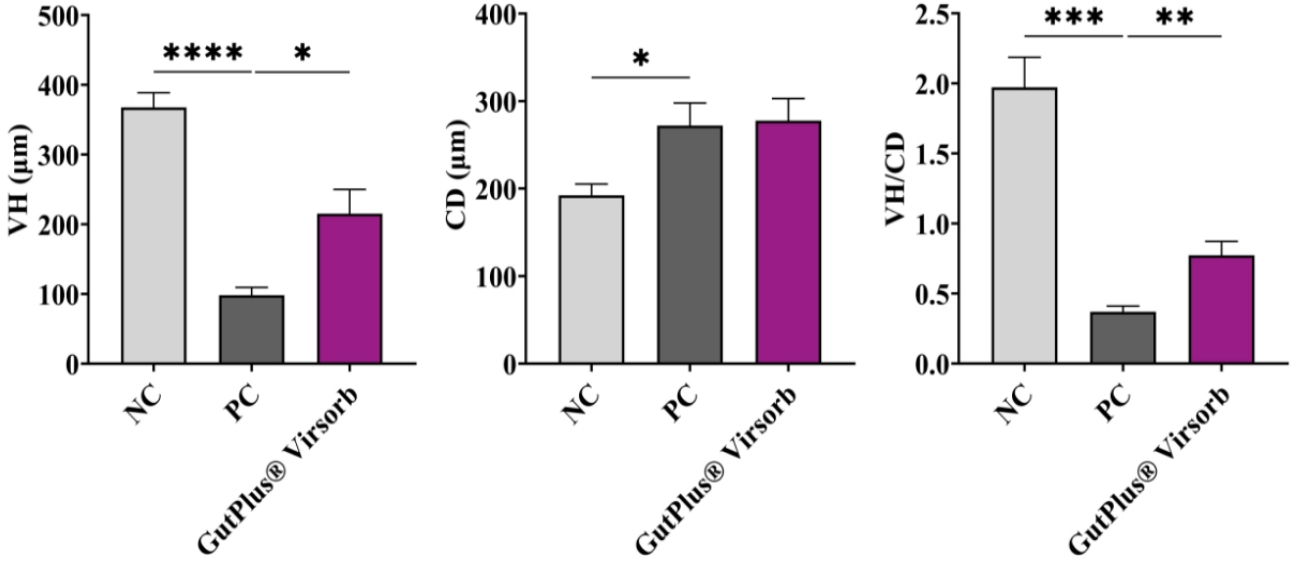
72 piglets (initial BW 5.5 kg; negative for PEDv)
NC: basal diet (unchallenged)
PC. basal diet (challenged with PEDv)
Virsorb : basal diet + GutPlus Virsorb (500 g/t, PEDV challenge)
PEDv challenge (at d 28, after 7 d pre-challenge; d 28 to 60)



PEDV load in jejunal mucosa (2 d PI) and in feces

Jejunal mucosal morphology (2 d post-challenge)

* ($P < 0.05$), *** ($P < 0.001$), **** ($P < 0.0001$)



Facts&Figure (14180)

GutPlus® Virsorb supplementation:

- increased villus height (VH) and VH:CD ratio in jejunum of pigs under PEDV challenge.
- Reduced PEDV load (copies) in jejunal mucosa and feces

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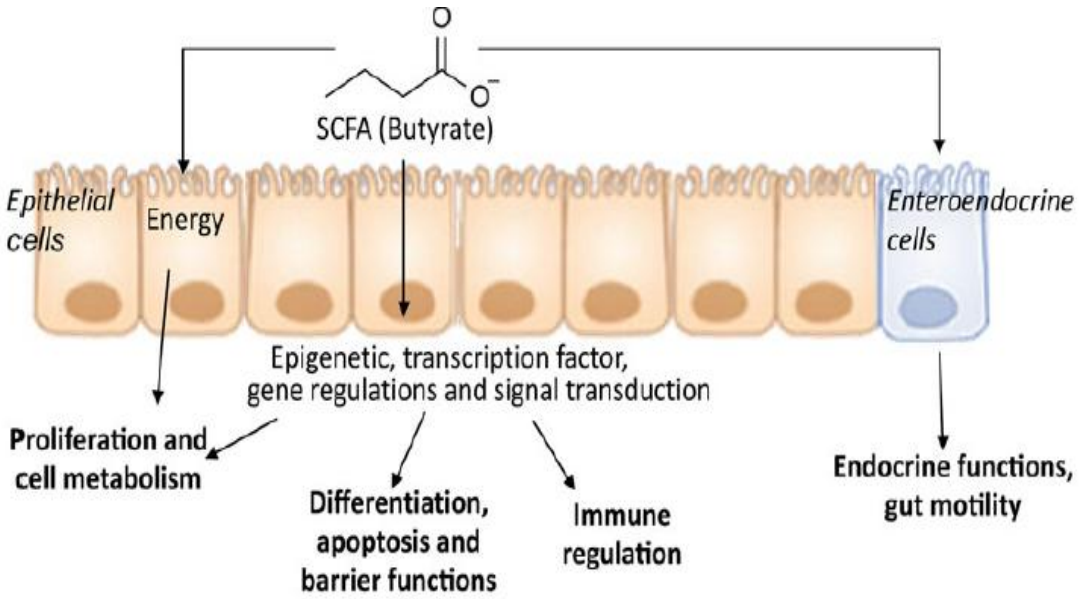
Roles of butyrate (organic acid) in swine

- **Butyrate**, a short-chain fatty acid (SCFA; C4), is major **energy source for colonic epithelial cells** (Salvi *et al*., 2021).
- **Roles of butyrate:** cell proliferation and villi development, mucus synthesis, gut barrier function and immune regulation (Hammer *et al*., 2008, Wang *et al*., 2018; Martin-Gallausiaux *et al*., 2020).
- Dietary butyrate addition has been shown to **enhance piglet health and growth by restoring mucosal barrier integrity and preventing diarrhea** (Piva *et al*., 2002; Kotunia *et al*., 2004).

Main roles of SCFA (butyrate)



Martin-Gallausiaux *et al*. (2020)

Tributyrin supplementation alone or combined with a *Bacillus subtilis* probiotic on performance and gut health of nursery pigs

800 weaned pigs (5.95 kg initial BW) assigned to 4 diets (10 pens/Trt); 42 d trial; 2 phases of 21 d each)

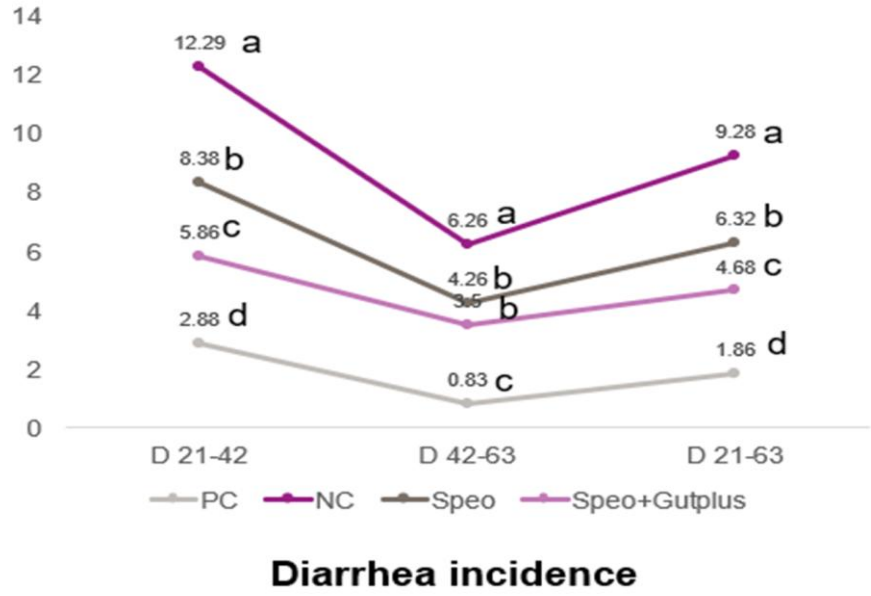
NC: Basal diet (1.42/1.35% SID Lys for Pre-starter/Starter diet)
PC: NC + ZnO (3,000 ppm; d 1-14)
TB: NC + **Speocare™ T60** (Pre-starter: 1.5 kg/ton; Starter: 1.2 kg/ton)
TB+Probiotics: TB + Probiotics (Gutplus®; 500 g/ton; 10e6 CFU/g feed)

Speocare™ T60; Tributyrin content ≥ 60 %), produced out of butyric acid and glycerol with esterification, which allows for the targeted release of butyric acid in the small intestine.

Effect of tributyrin and probiotic on growth performance of piglets

Treatment	Initial BW, kg	Final BW, kg	ADFI, kg	FCR
NC (No AGP)	5.99	23.9 c	0.665 b	1.56 a
PC (BD+AGP)	5.94	26.7 a	0.688 a	1.39 d
TB (SpeoCare)	5.97	25.2 b	0.677 ab	1.48 b
Speo + Gutplus	5.95	25.7 b	0.680 a	1.44 c

Effect of tributyrin and probiotic on diarrhea incidence of piglets of piglets



Jayaraman et al. (2025)

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Functional AA: regulate key metabolic functions (beyond growth) to improve health (immune system), growth, development, lactation, and reproduction of organism[1]

Threonine (Thr)

- Synthesis of **mucins** (high in Thr, 30% of all AA) by the gut[2]
- **Intestinal mucosa** as well as to act as a first line of defense
- Secretion of mucins is increased feeding high fiber diets[3]
- **Immunoglobulins** (antibodies) are mainly made up of Thr (~10.0%)[4]

Methionine (Met)

- **methyl donor** for DNA methylation
- synthesis of Cys, i.e. **glutathione**, a major intracellular antioxidant
- glutathione is involved in the activation of T-lymphocytes and cytokines (**immune functions**)[5]

Tryptophan (Trp)

- **immune function**
  - ✓ IDO enzymes (induced by cytokine IFN-γ during ISS)
  - ✓ More than 95% of dietary Trp not utilized for protein synthesis, is metabolized through kynurenine pathway[6]
  - ✓ Haptoglobin is high in Trp

1)Wu (2009); 2) Lien *et al*., 1997; 3) Myrie *et al*., 2008; 4) Boland, 1966; 5) Wu et al., 2004; 6) Botting, 1995.

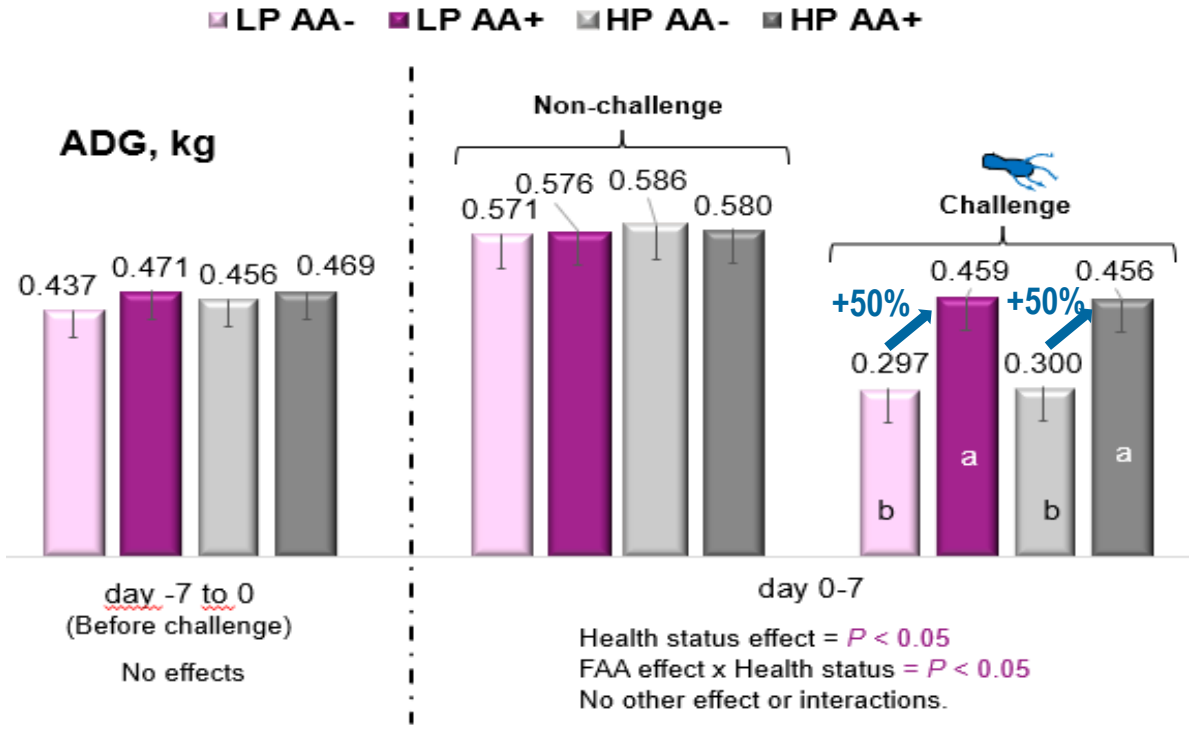
Regardless of CP level, FAA supply reduces negative effect of *Salmonella* challenge on ADG and plasma superoxide dismutase in weaned pigs

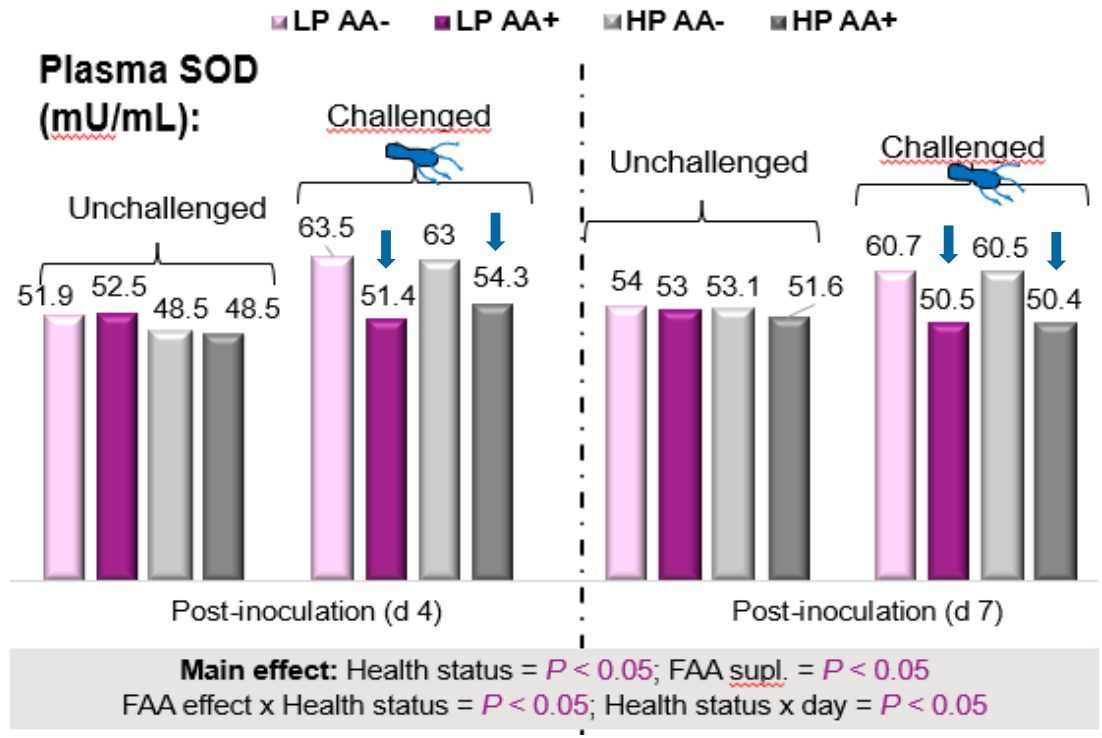
64 piglets (13.9 kg BW)

2 (16 vs. 20% CP) x 2 (FAA- (NRC) vs. FAA+ (+20% Thr, Met, Trp) x 2 (NC vs. ST)

ST Challenge (orally inoculation on d 0; 7 d pre-chall. + 7 d post chall.)

Same SID Lys: 1.28%
SID Thr:Lys: 59 vs 71%
SID Met+Cys: 55 vs 66%
SID Trp:Lys: 16 vs. 20%





Rodrigues et al. (2021a)

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A longer adaptation period to a FAA-supplemented diet improves growth performance and immune status of pigs challenged with *Salmonella*

32 piglets (11.6 kg BW)

FAA- (NRC, 2012) vs. FAA+ (**+20% Thr, Met, Trp**)

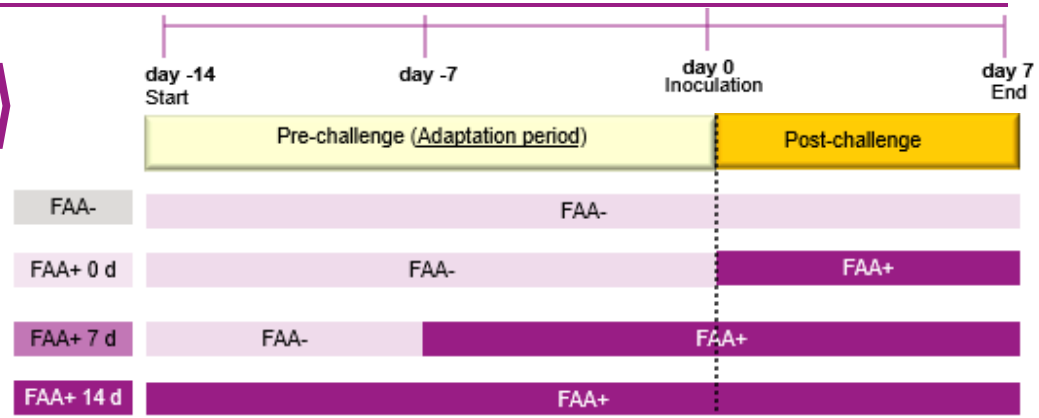
FAA- (NC); **FAA+ 0 d** (no adaptation); **FAA+ 7 d** (7 d adaptation): **FAA+ 14 d** (14 d adaption)

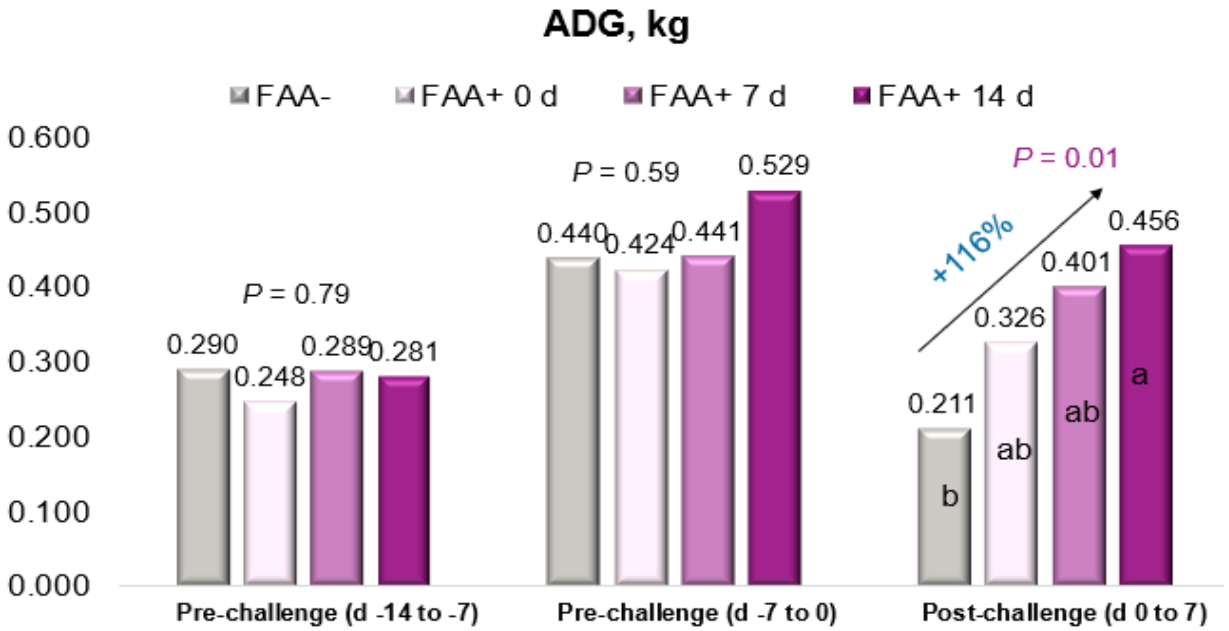
Same SID Lys: 1.28%

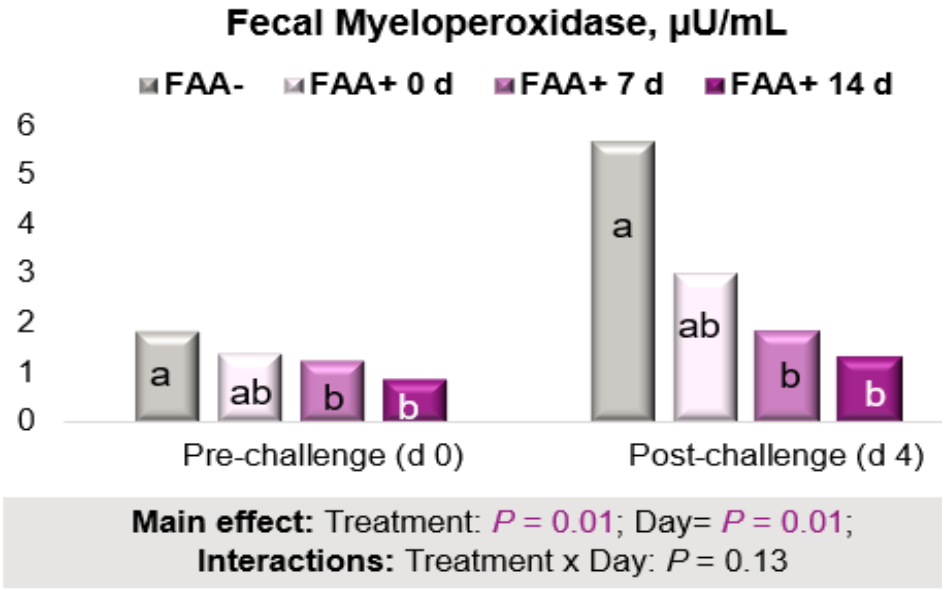
SID Thr:Lys: 59 vs 71%

SID Met+Cys: 55 vs 66%

SID Trp:Lys: 16 vs. 20%







Rodrigues et al. (2021b)

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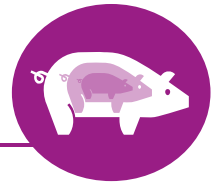
Outline



1. Introduction – gut health challenges in weaned pigs

2. Effect of nutrients on performance and health of weaned pigs
   - ➢Effects of dietary CP, AA and fibers

3. Effect of ingredients on performance and health of weaned pigs

4. Effects of selected feed additives on gut health and performance of weaned pigs

5. Take-home message

Take-home message

- **Feeding pigs with high CP diets increases diarrhea incidence.**
- **Lowering dietary CP** can decrease the proliferation of pathogenic bacteria and reduce **diarrhea incidence**. **Reducing dietary CP diet is the first step as a nutritional strategy for weaned pigs**.
- When dietary CP is reduced ≥ 3 %-point, **SID Lys:CP ratio of 7.0%** should be maintained to avoid insufficient NEAA in the diets.

- Moderate dietary inclusion (1 to 3%) with a **mix of IDF:SDF** seems to have beneficial effects on gut health.
- Total dietary **IDF:SDF** ratio **1:7 or 1:8** seems to improve fecal consistency score and fecal VFA in weaned pigs.
- Fiber rich "**hybrid rye**" inclusion in weaned pig diets reduces diarrhea incidence and fecal Salmonella shedding.

- **Bacillus-based probiotics** (GutPlus and GutPlus Virsorb) supplementations enhances intestinal morphology and decreases diarrhea rate under normal or pathogen infections (*E. coli*, PED virus).
- **Tributyrin (**Speocare™) supplementation can reduce diarrhea incidence and increase growth performance of nursery pigs.
- Increased supply of extra **functional AA** (Thr, Met and Trp), i.e. 20% above requirement can ameliorate the negative effects of pathogen infection or poor immune status.

Thank you for your attention!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