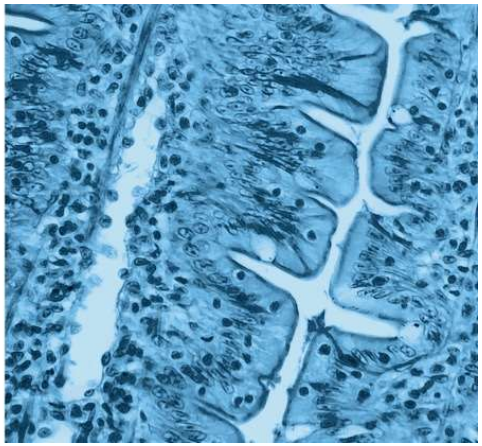
SCHOTHORST FEED RESEARCH

33 Annual CBNA Meeting

11-11-2021





Perspectives on Zn oxide removal from piglet diets

Francesc Molist – R&D Manager SFR

Knowhow to feed

International trends

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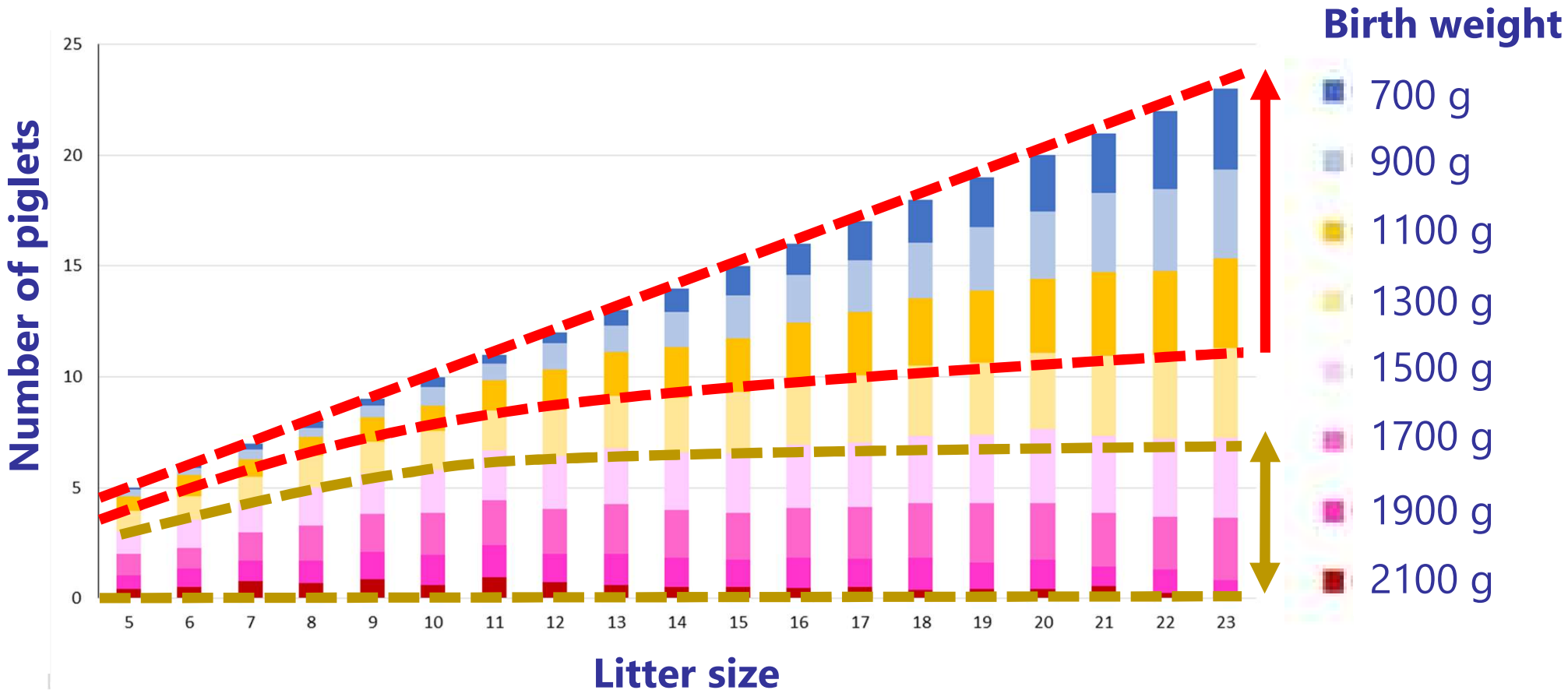
- Fast expansion of animal production in South East Asia and India.
- Increased volatility of feedstuff prices.
- Increased competition for cereals between food, feed and fuel.
- Increased pressure on water and agricultural soil sources.
- Sustainability (animal welfare, antibiotics, environment) become global issues.
- Genetic potential of livestock animals increases.
- Increase world population.
- Less publicly available knowledge.
- **ZnO replacement before August 2022 in EU.**

Genetic development sow - consequences

- Bigger litters → more piglets with a low birth weight (<1100 g)

(SFR / 3113 litters / 2011-2021, unpublished)



Weaning a stressful period

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In absence of in-feed antibiotics, higher risk of PW disorders

LACTATION

INTENSIVE PRODUCTION

Day 21-28

PRODUCTIVE EFFICIENCY

WEANING

- New environment
- New diet
- Mixing with animals from different dams +
- Immature immune and intestinal system

Antibiotic growth Promoters (AGP)

RISK OF POST WEANING (PW) DISEASES ?

After weaning the digestive tract is still relatively immature

WEANING

15 DAYS

5 - 10 days

5 days

ACUTE PHASE

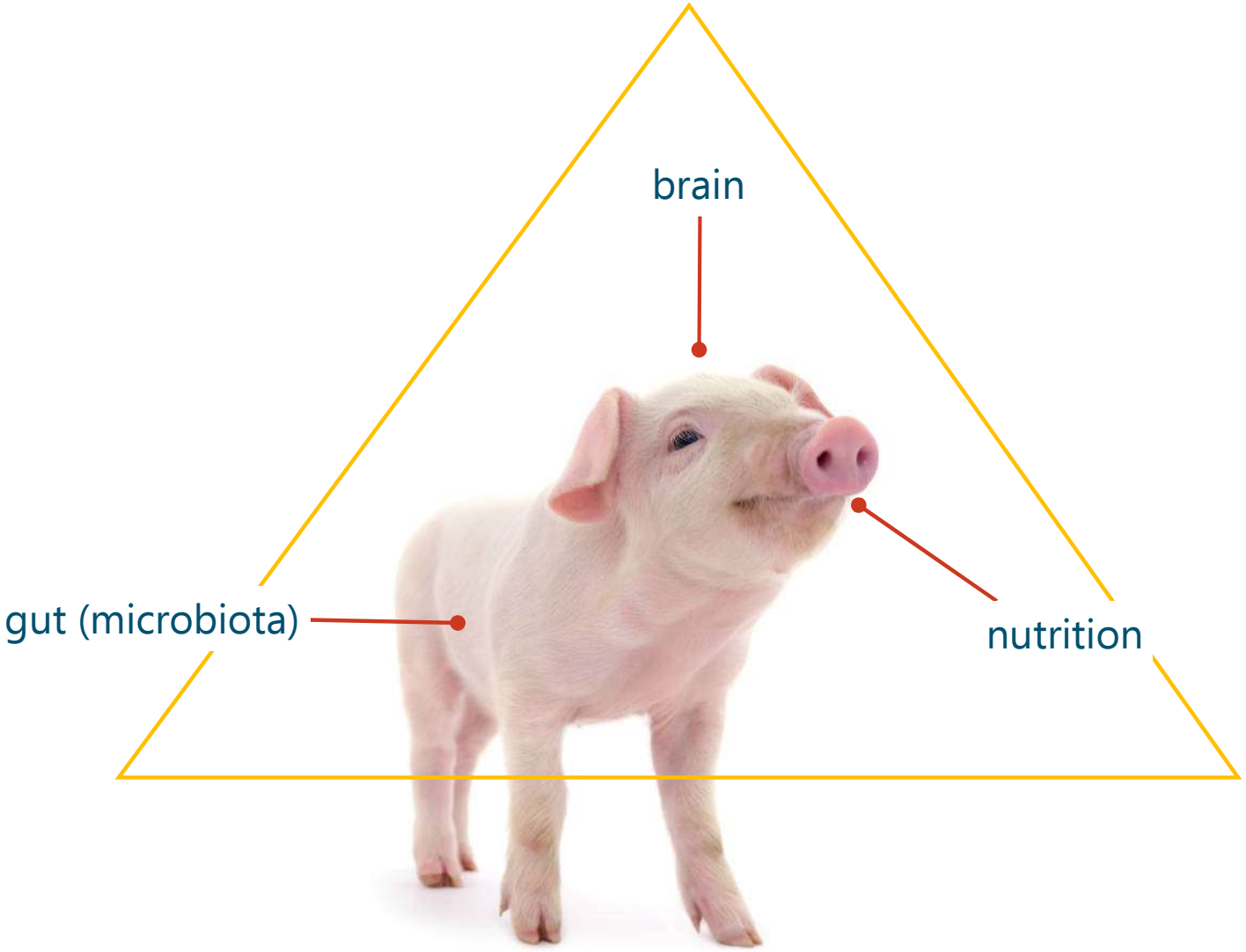
MATURATION PHASE

- Anorexia & intestinal stasis
- Nutrient digestion & absorption
- Intestinal damage

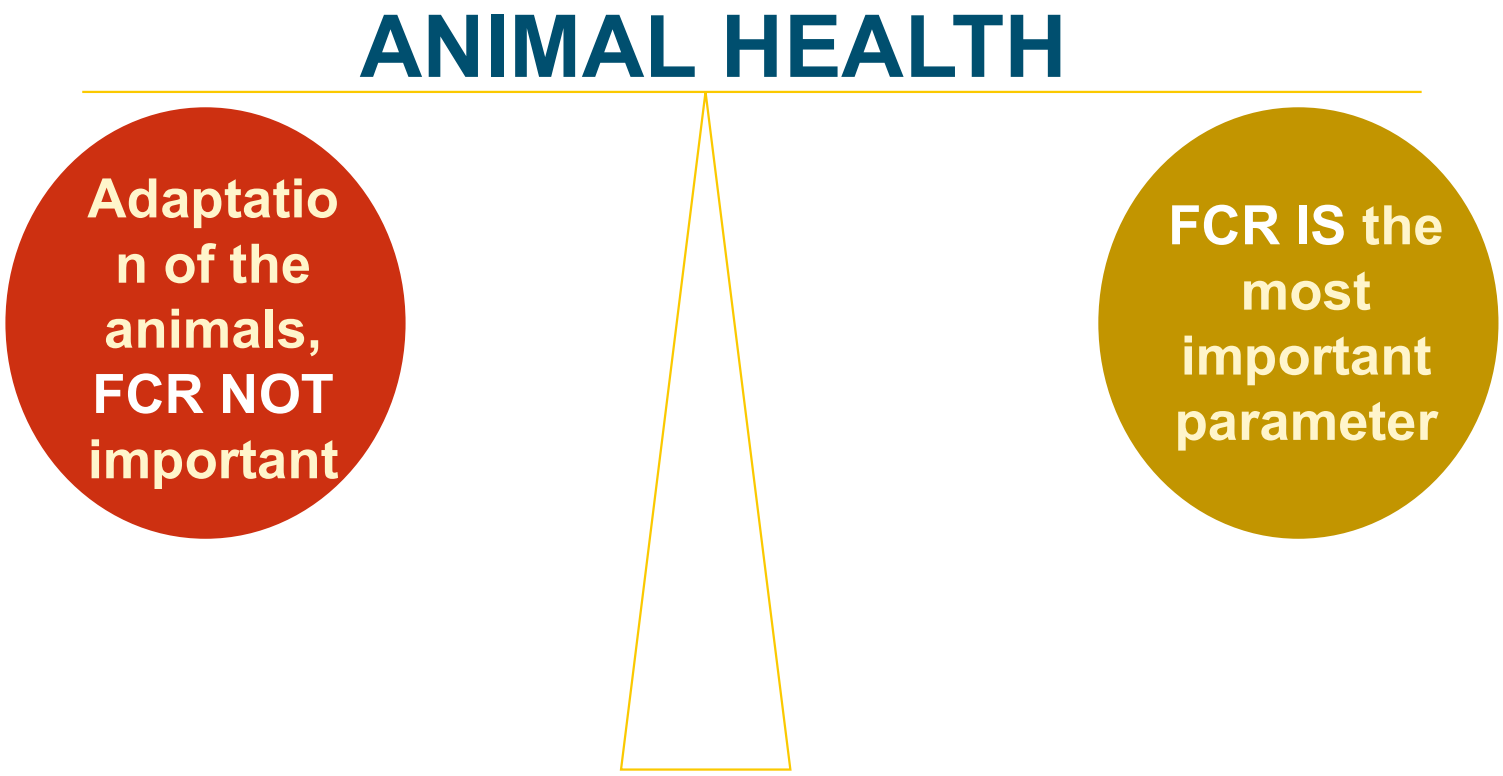
PW DIARRHOEA (PWD)

- Feed intake
- Nutrient digestion & absorption
- Fermentation capacity
- Establishment microbiota GIT
- Recovering functional activity

Microbiota-gut-brain axis examples before weaning



What is important in the PW period?



Epidemiological studies

No diarrhea ← → ***Diarrhea***

	1	2	3	4	5
BW at weaning	8,4	8,3	7,8	7,6	7,8
ADFI 1st wk post-weaning	1,71	1,52	1,30	1,22	1,09

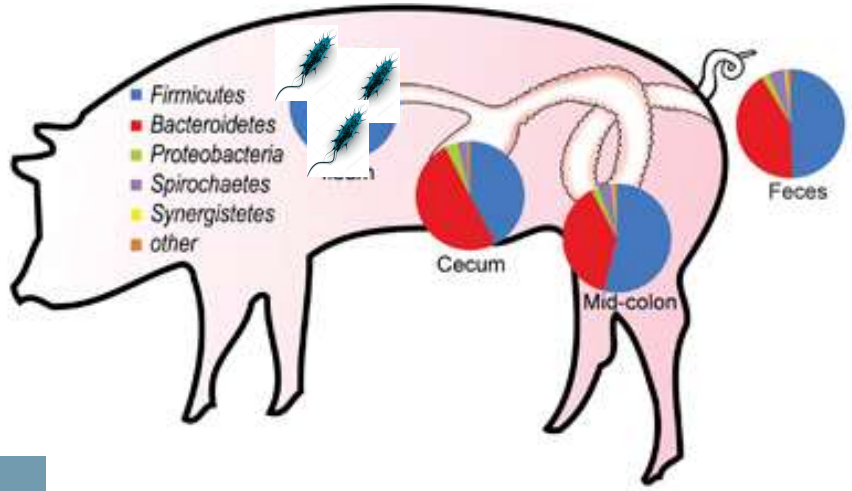
ADFI/ pig 1st week

Probability ratio	
< 1 kg	*34*
1 – 1,36	*18*
1,36 – 1,72	*1,1*

(Madec et al., 1998)

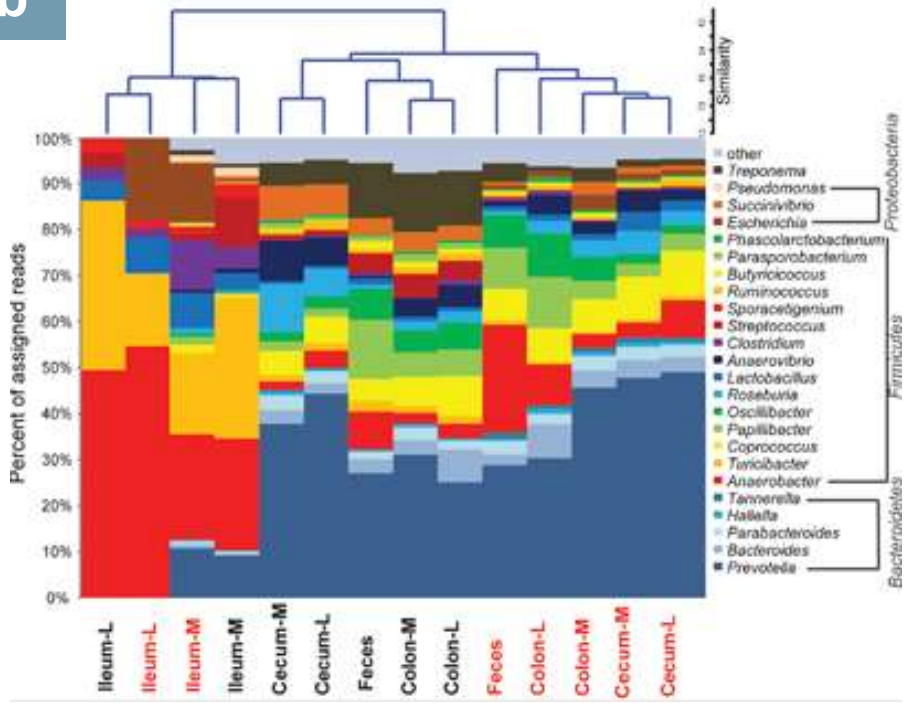
ADFI of the piglets in the 1st week post-weaning is important.

Excess non-digested nutrients in the GIT



Higher risk of diarrhea

No feed ab



(Looft et al., 2014)

How we can help the piglets to have a good start?

MODIFIERS OF THE MICROBIOTA OF THE GIT

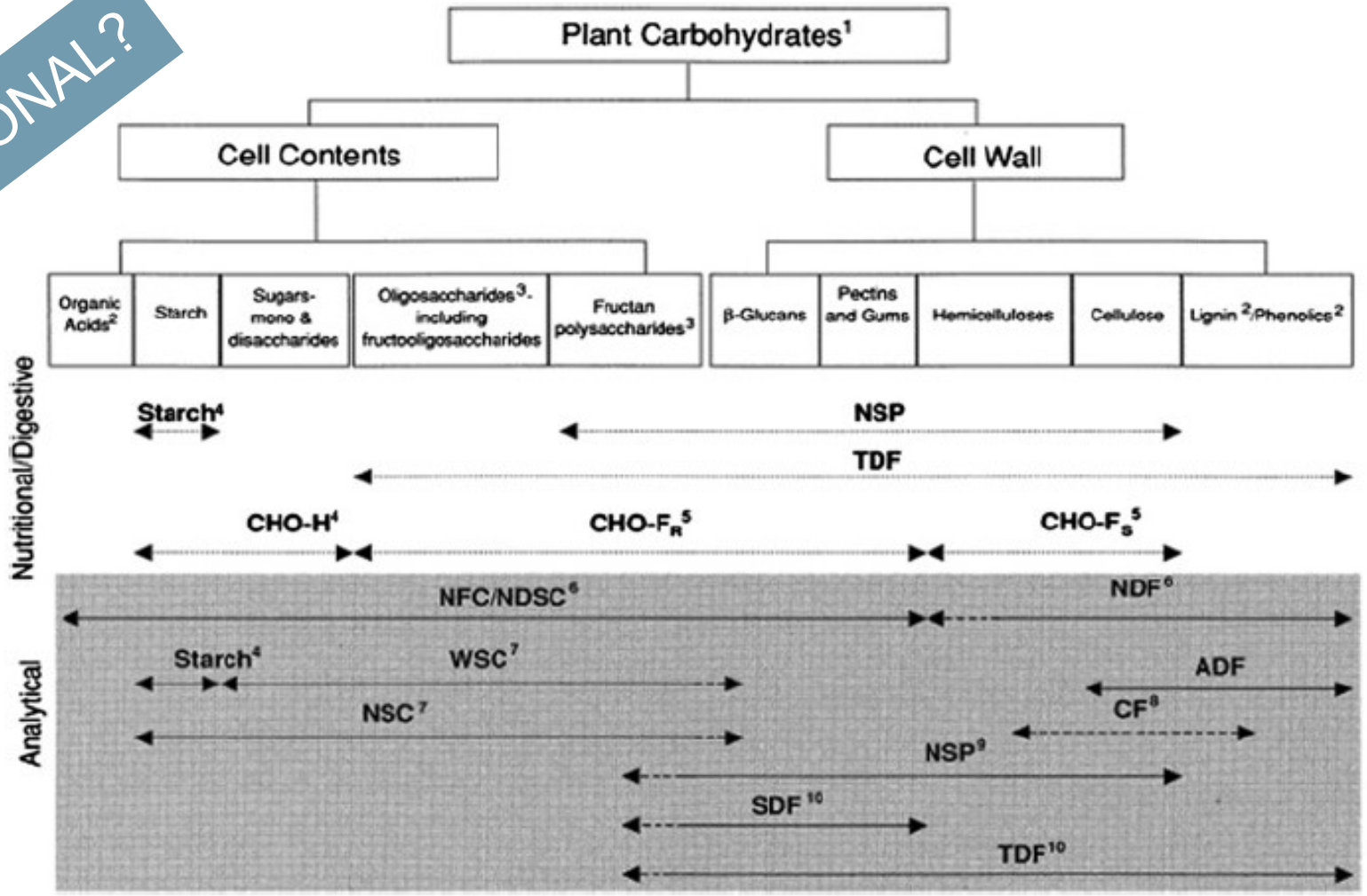
- Acidifiers
- Prebiotics
- Probiotics
- Symbiotics
- Plant extracts
- Minerals: ZnO & Cu
- Dietary fibre
- Low CP diet
- Role of fat

PROMOTERS OF FOOD CONSUMPTION AND PRODUCTION ENHANCERS

- Palatable ingredients
- Digestible ingredients
- Flavours
- Synthetic amino acids

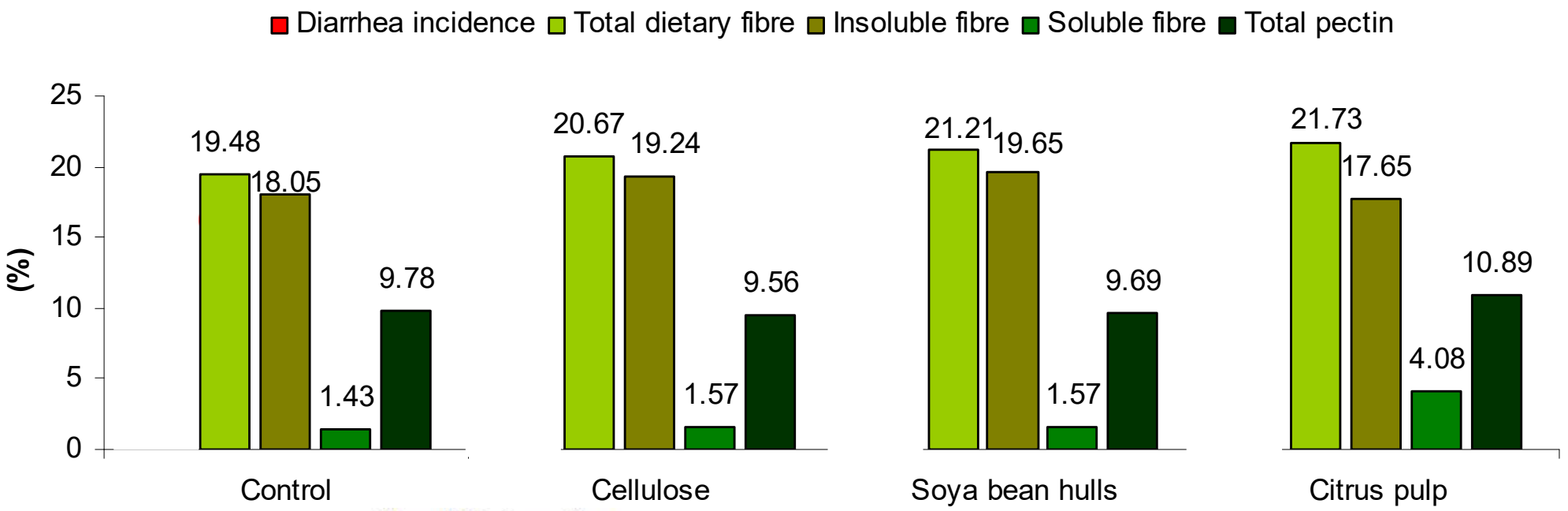
Is the analytical characterization of dietary fiber a good approach?

FUNCTIONAL?



Kerr and Shurson et al., 2013

Effect of diet composition on diarrhea incidence the first 2 weeks PW



Fonseca et al., 2012

21 and 35 days of age

	C	CEL	SH	CP
Corn	47.13	45.09	44.19	38.73
Soybean meal	29.63	29.98	29.49	29.32
Milk product[2]	17.14	17.14	17.14	17.14
Soybean oil	1.48	1.96	1.86	1.62
Citrus pulp	-	-	-	9.00
Soybean hulls	-	-	3.00	-
Purified cellulose	-	1.50	-	-

The analytical characterization does not predict the functional effect of fibre ingredients in piglets.

Gives functionality of fibre ingredients a better characterization?

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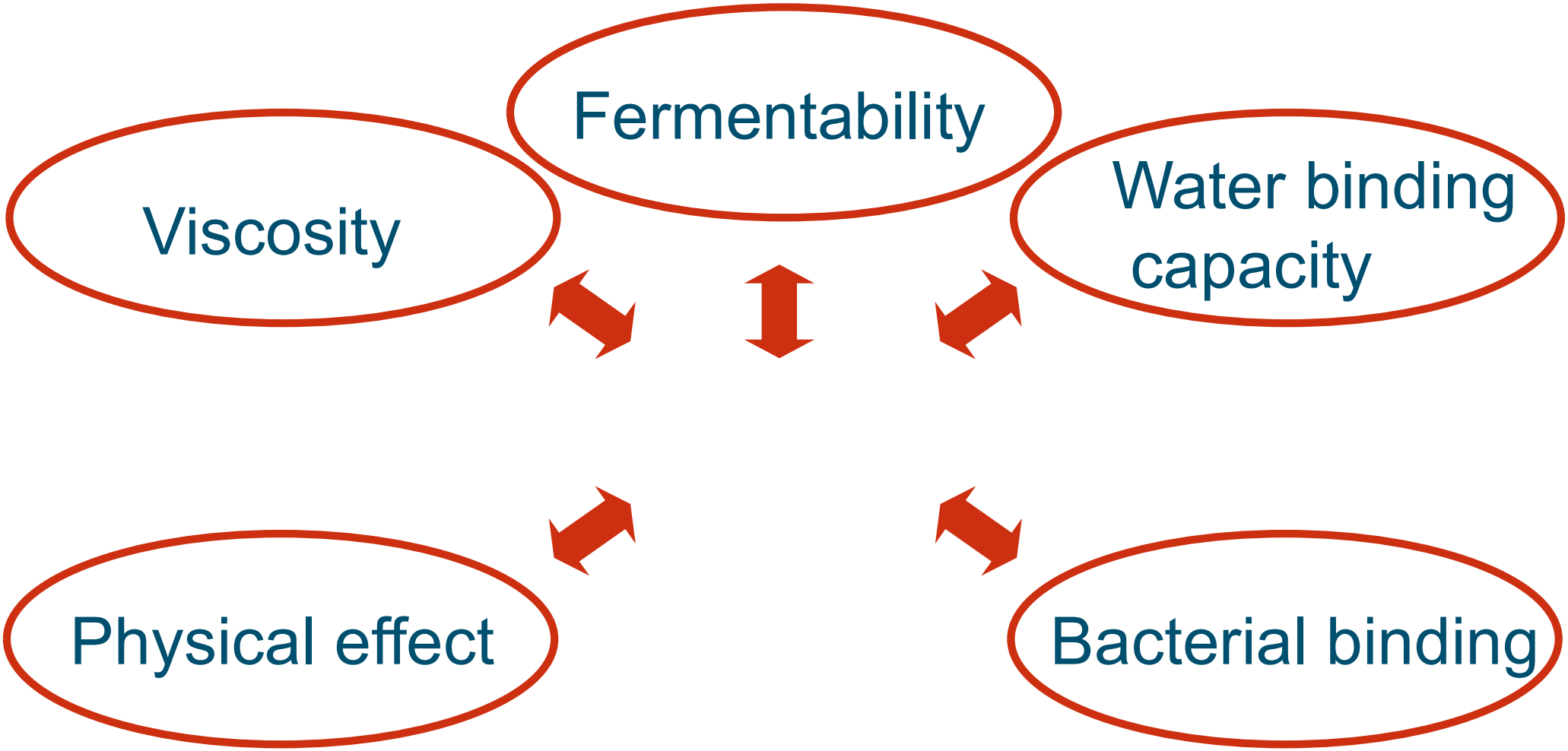
Is fibre an ANF in PW diets?



Viscosity

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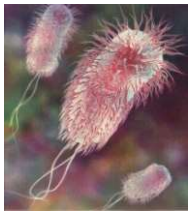
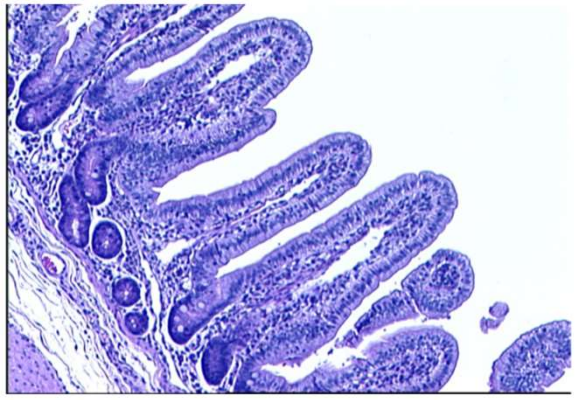
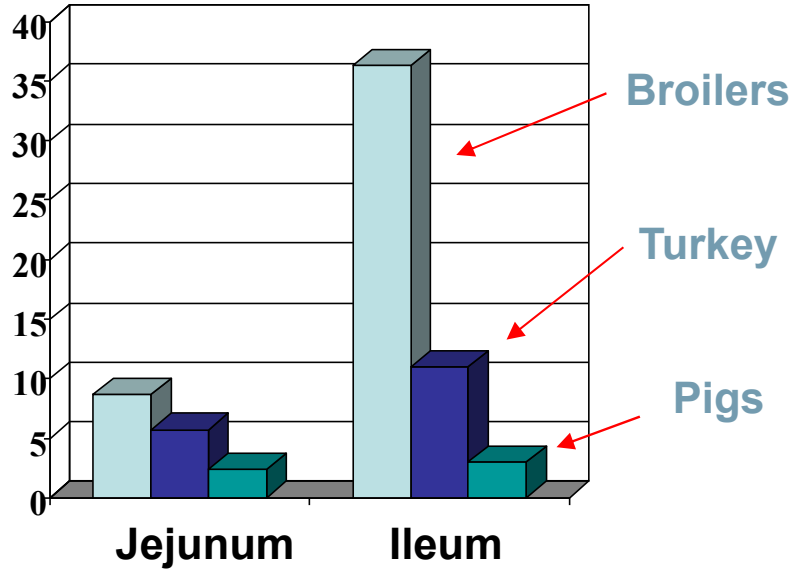
- Slow gastric empty rate
- Increase nutrient absorption





Intestinal Viscosity (mPa.s)



(Danicke et al., 1999)

- Reduce enzymatic digestion
- Decrease and stop intestinal transit
- Increase risk of bacterial growth in the intestine
- Hidrolize bile salts

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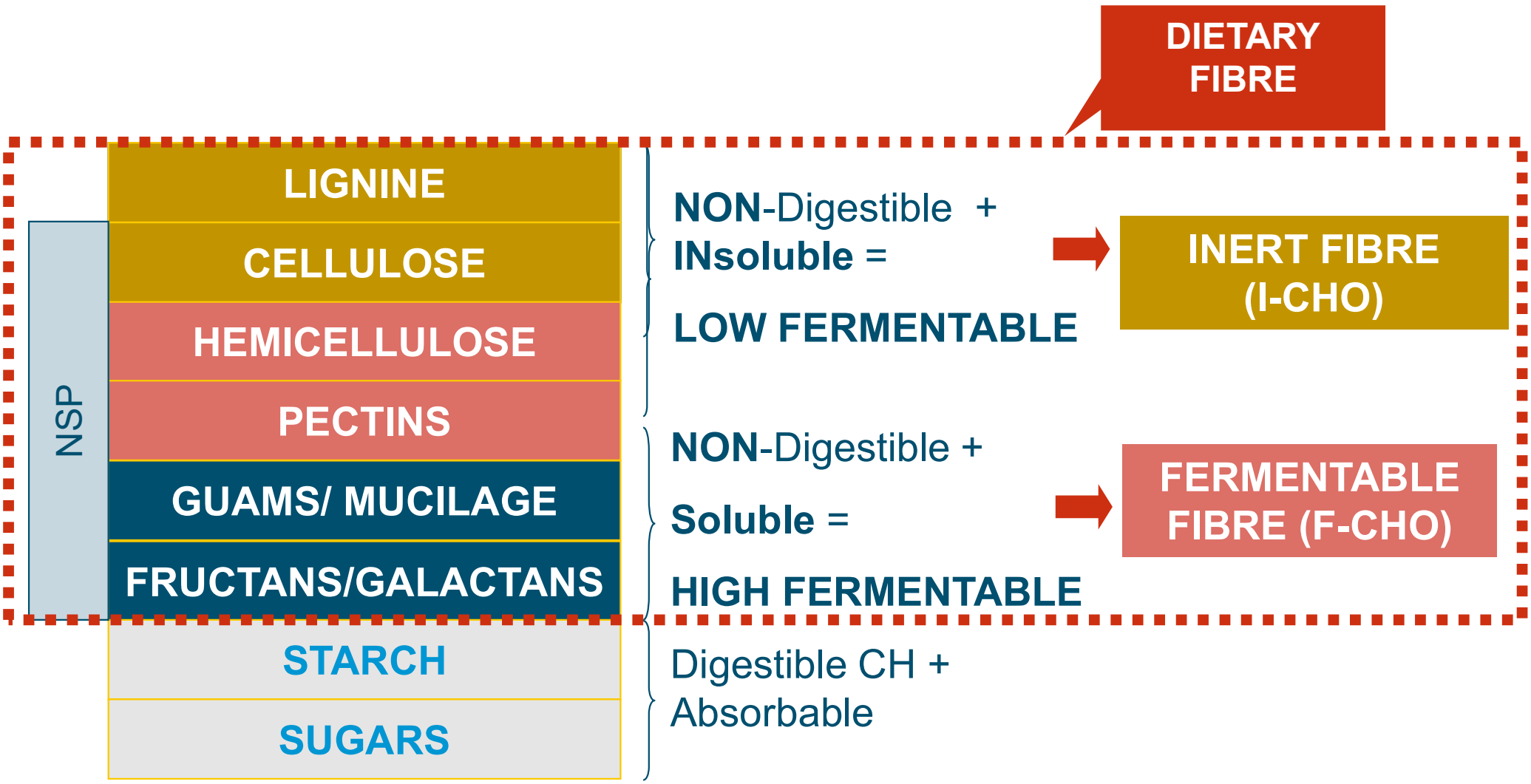
Effect of digesta viscosity in post-weaning diarrhea

	Days after weaning			
	Day 7	Day 8	Day 9	Day 10
Rice	0/8	1/8	0/8	0/8
Rice+ low viscous CMC	5/8	3/8	4/8	4/8
Rice+ high viscous CMC	7/7	7/7	7/7	5/7
P-value	<0.005	<0.005	<0.005	<0.005

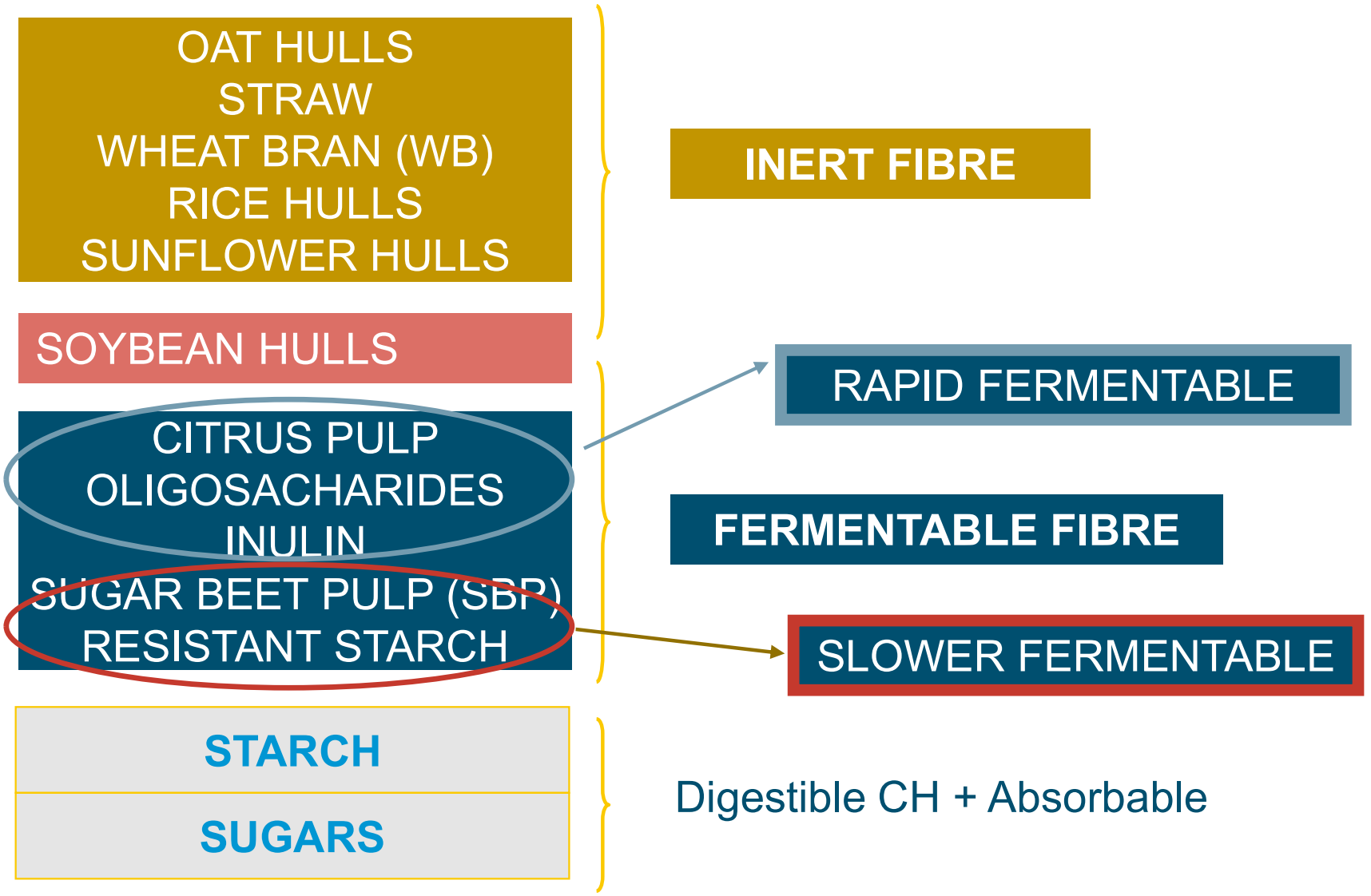
McDonald et al., (2001)

Increasing the digesta viscosity, especially in the ileum, increases the risk of post-weaning diarrhea

Fermentability & Solubility



Fermentability & Solubility



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Is the inclusion of inert fibre better than fermentable fibre in PW diets?

INERT FIBRE

Improve digestive function
Modifies microbiota GIT
Enhances microbial fermentation
Reduces nutrient digestibility
Penalizes animal performance

NSPs

FERMENTABLE FIBRE

Slows gastric emptying
Proximal fermentation in the hindgut
Increases luminal viscosity

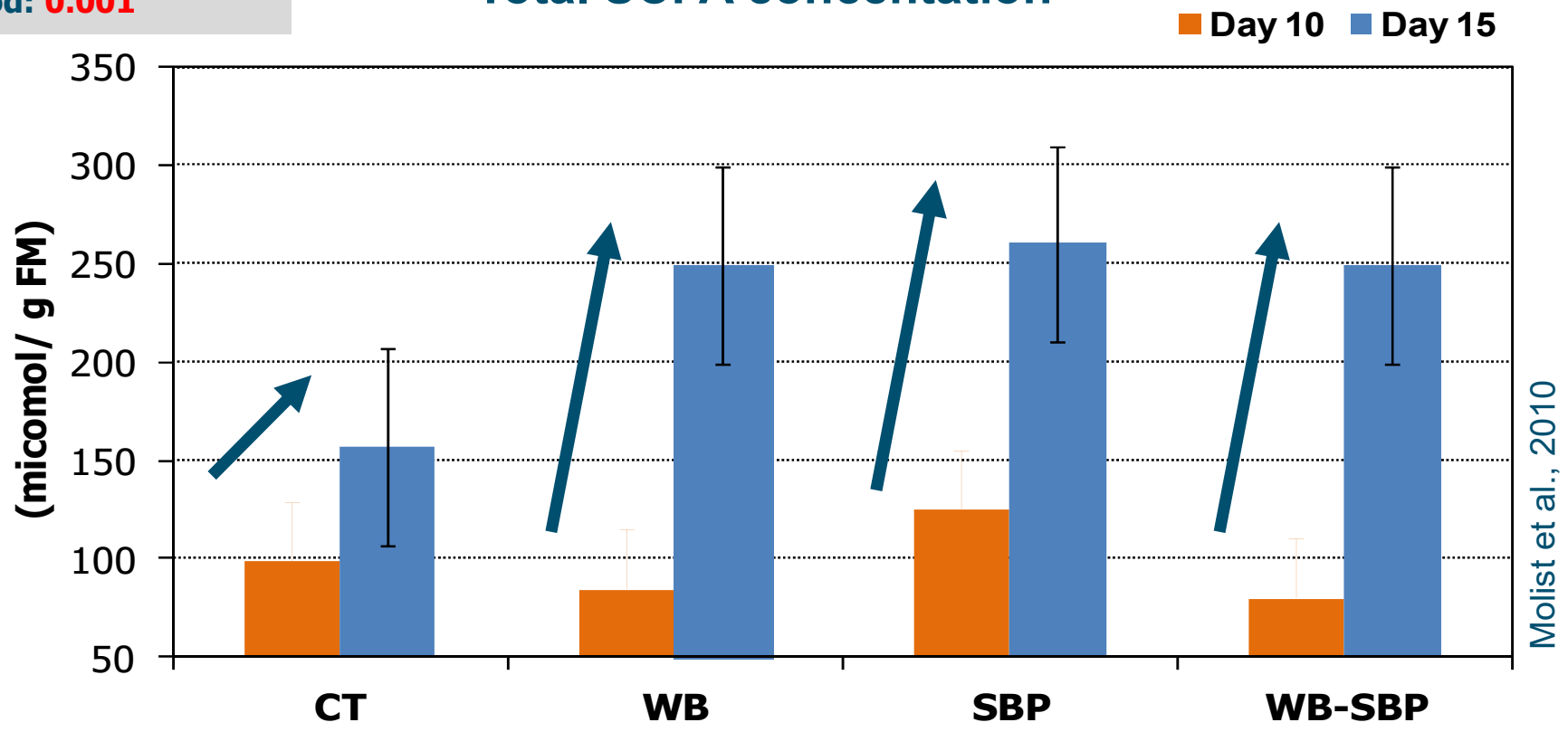
Fermentability & Solubility

P-Diet 0-10: 0.173

P-Diet 10-15: 0.115

P-Period: 0.001

Total SCFA concentation



Between 10 and 15 day post-weaning occurs an increased of the fermentation capacity of the animals associated with the maturation of their intestinal tract

Fermentability & Solubility

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Diet composition

Fermentable (x3)

Inert (x1)

Table 1. Formulation and chemical composition of the experimental diets[1]

	Experimental diet			
	Phase I		Phase II	
Item	Control I	Fiber I	Control II	Fiber II
Ingredient, g/kg (as-fed basis)				
Wheat	225	198	350	303
Corn	200	175	200	172
Barley	120	105	150	129
Soybean meal (48% CP)	240	230	250	230
Dried whey	150	150	-	-
Dehydrated sugar beet pulp	-	60	-	90
Soybean hulls	-	20	-	30
Vegetable oil	25	25	10	10
Dicalcium phosphate	10	9.8	11.2	11.5
Calcium carbonate	11.3	9	11.2	7.3
L-Lys·HCl	5.6	5.2	4.6	4.2
DL-Met	2.7	2.7	1.6	1.6
L-Thr	2.5	2.4	1.9	1.9
L-Trp	0.8	0.8	0.4	0.4
Salt	2	2	4	4
Premix[1]	5	5	5	5
3-phytase[2]	0.1	0.1	0.1	0.1
Calculated composition, g/kg DM				
NE, MJ/kg	10.4	10.0	9.8	9.3
Digestible Lys	13.0	12.5	11.6	10.9
Digestible P	3.8	3.7	3.2	3.1
Chemical composition, g/kg DM				
Ash	64.5	64.9	58.8	60.1
CP (N × 6.25)	219.1	212.3	220.2	213.0
Ether extract	47.2	46.0	31.6	32.2
Starch	381.5	341.5	488.8	425.9
GE, MJ/kg	18.77	18.65	18.55	18.41
Crude fiber	32.5	48.9	35.8	63.9
NDF	109.6	112.5	122.3	153.2
ADF	34.6	50.1	39.3	69.0
ADL	2.1	8.6	3.9	9.9
Total dietary fiber	120.9	169.1	145.8	216.8
Water insoluble fiber	102.6	140.7	122.7	186.1

Montagne et al., 2012

2x2 Experimental design:

- **Level of F-CHO**: high and low
- **Sanitary conditions**: good and bad

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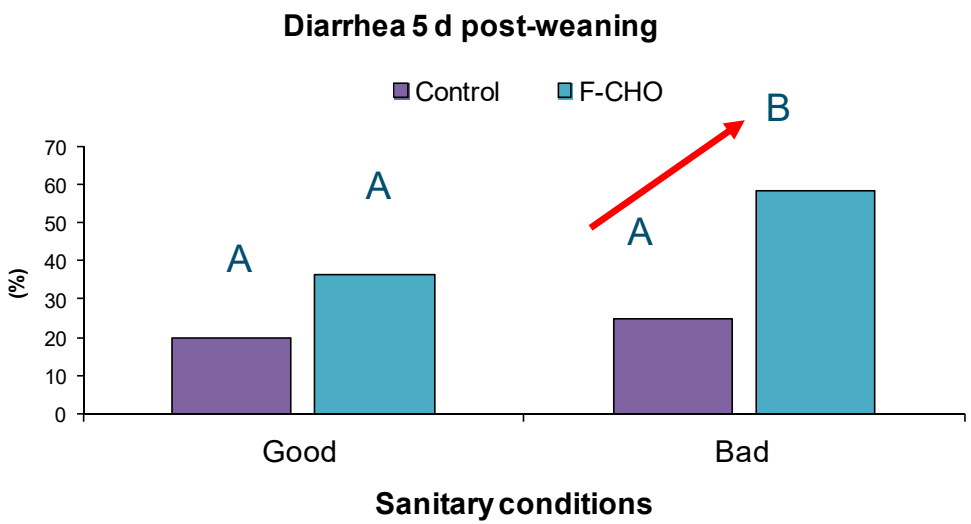
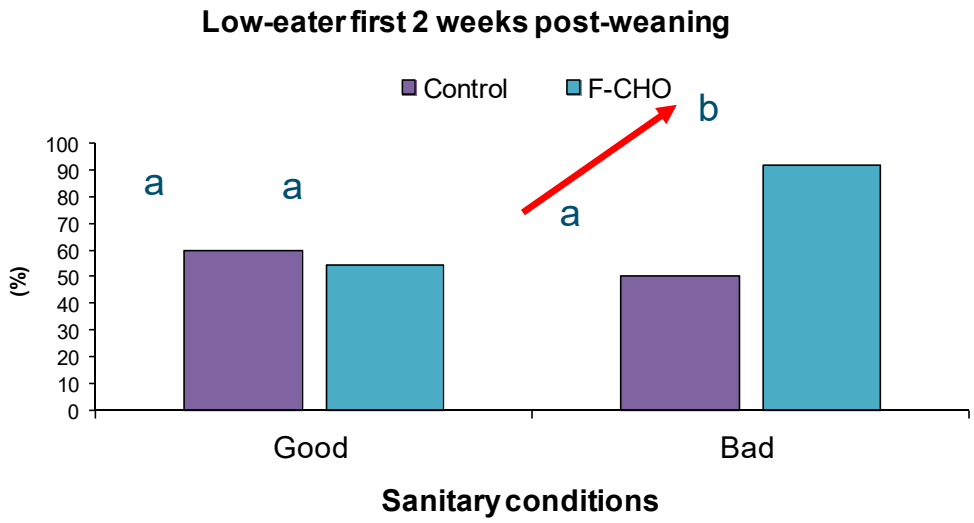
Interaction between F-CHO and health status of the animals



P diet x sanitary conditions = 0.07



P diet x sanitary conditions = 0.01

Montagne et al., 2012

In situations with bad sanitary conditions, the utilization of F-CHO sources in the first week post-weaning is an additional risk factor

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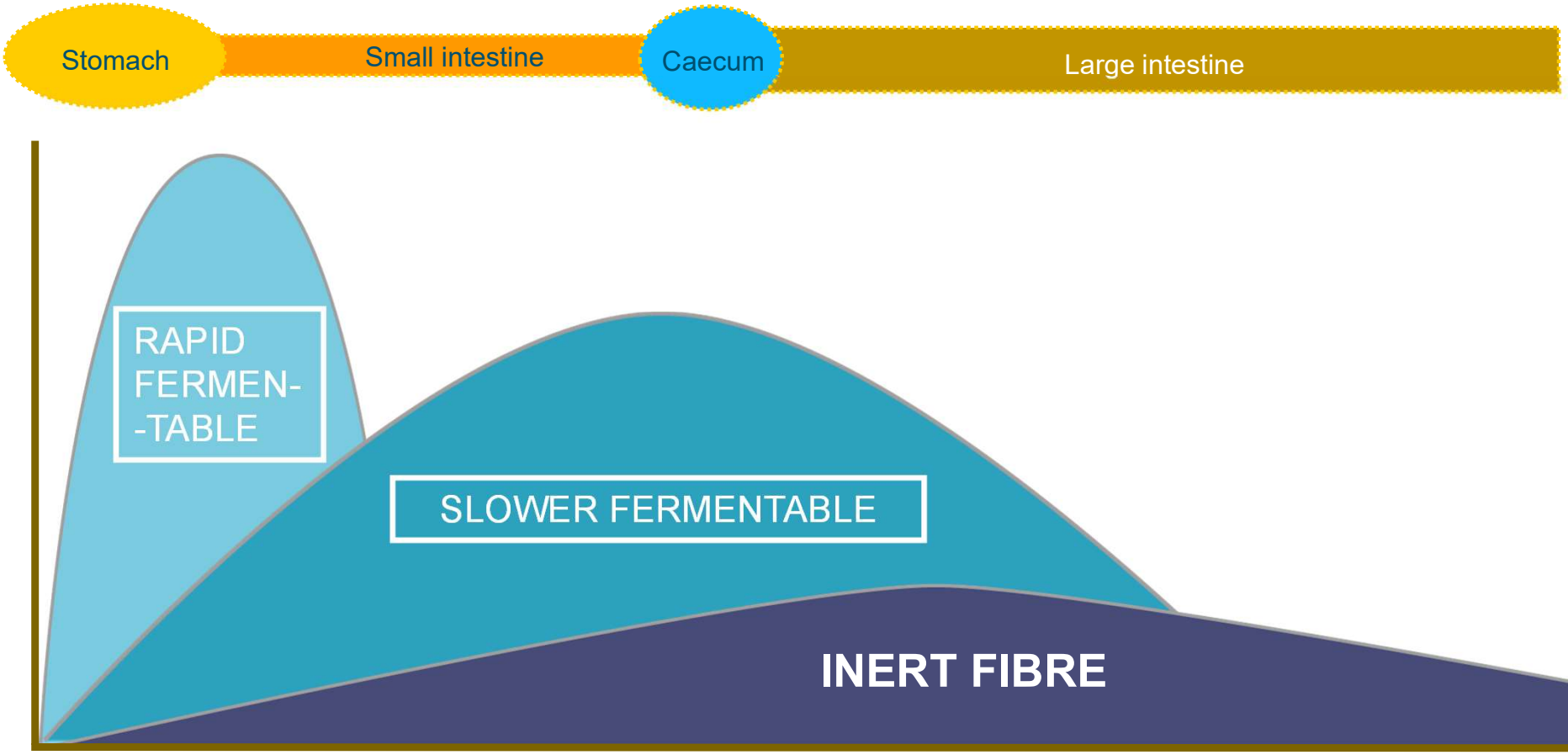
FERMENTATION KINETICS
Piglets need a fully developed GIT to ferment fibre ingredients



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Effect of diet dilution in the first 2 weeks PW on the piglet performance

	PC	NC	I-CHO	SEM	P-value
ADG, g	99.1^{ab}	114.5^{b}	131.3^{a}	4.66	0.008
ADFI, g	146.8^{b}	149.0^{b}	173.3^{a}	4.23	0.001
FS	5.2^{b}	5.3^{b}	5.5^{a}	0.06	0.005
G:F	0.68	0.77	0.76	0.04	0.103

Gerritsen et al., 2012

Diet dilution with inert fiber sources improves the ADFI, ADG and FS of the piglets compared to the NC and PC diets

SCHOTHORST FEED RESEARCH

Effect of diet dilution in the first 2 weeks PW on the piglet performance

	PC	NC	I-CHO	SEM	P-value
E. coli ileum, (log 10, g)	5.6^{b}	4.8^{ab}	3.8^{a}	4.66	0.008
E. coli colon, (log 10, g)	6.8^{b}	5.6^{b}	3.9^{a}	4.66	0.008
Amylase activity brush border (mmol/g protien)	0.030^{AB}	0.028^{B}	0.032^{A}	0.001	0.060
Stomach weight (%, BW)	0.78^{b}	0.76^{b}	0.89^{a}	0.04	0.103

Gerritsen et al., 2012

Dilution of the diet with iNSP results in a lower E. coli counts, higher activity of brush border enzymes and higher stomach weight, suggesting a better adaptation of the piglets to the PW diet

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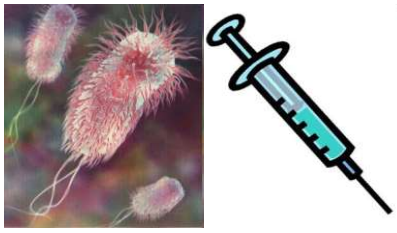
Experimental design

Is particle size of the inert fibre important?

NEGATIVE CONTROL:	Basal Diet	NC
POSITIVE CONTROL:	CT + 0.01% ab	PC
WB coarse:	CT + 4% WB (1088µm)	**WBc**
WB fine:	CT + 4% WB (445 µm)	WBm



***E.coli* k88**

Sacrifice all the animals

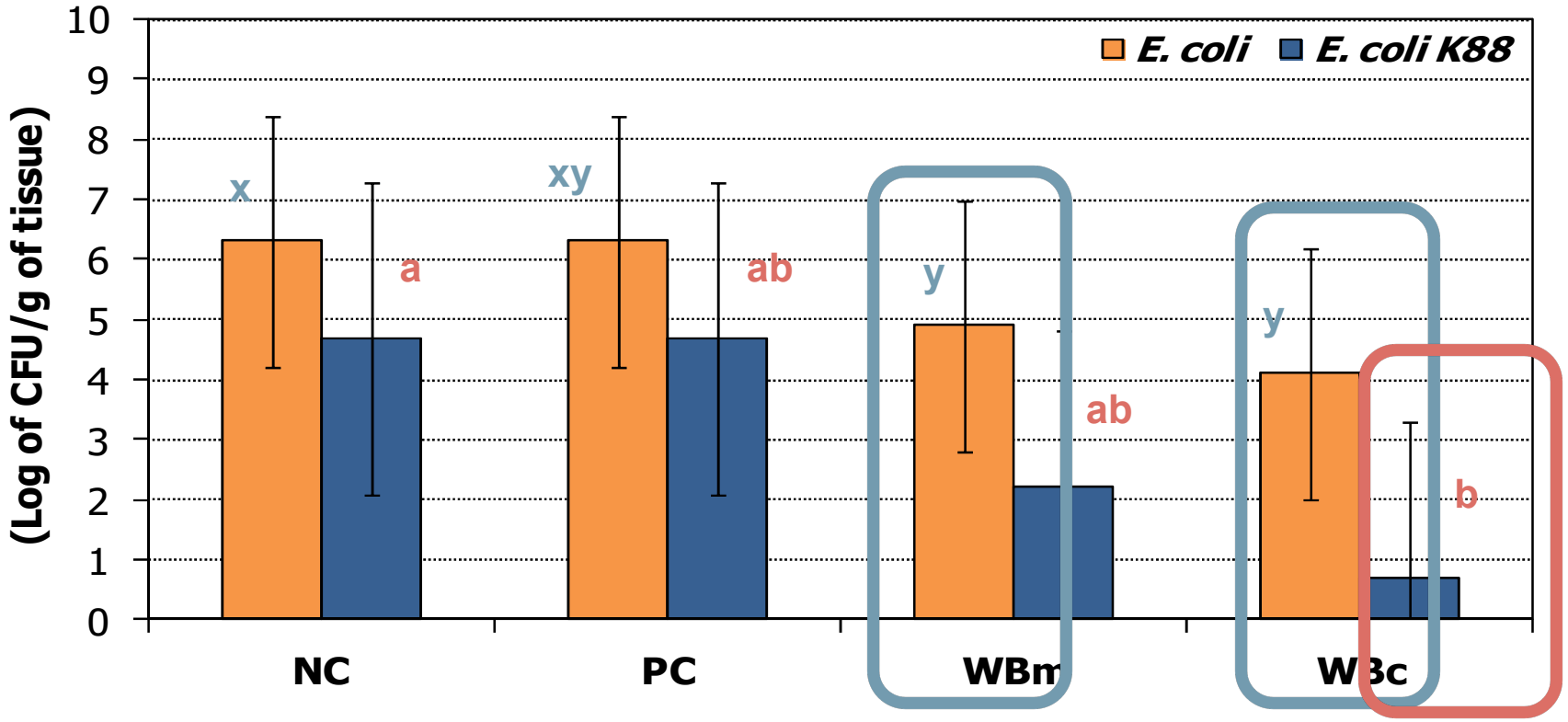
d0 — d9 — d16

BW — **BW, ADFI** — **BW, ADFI**

Molist et al., 2011

Physical effect

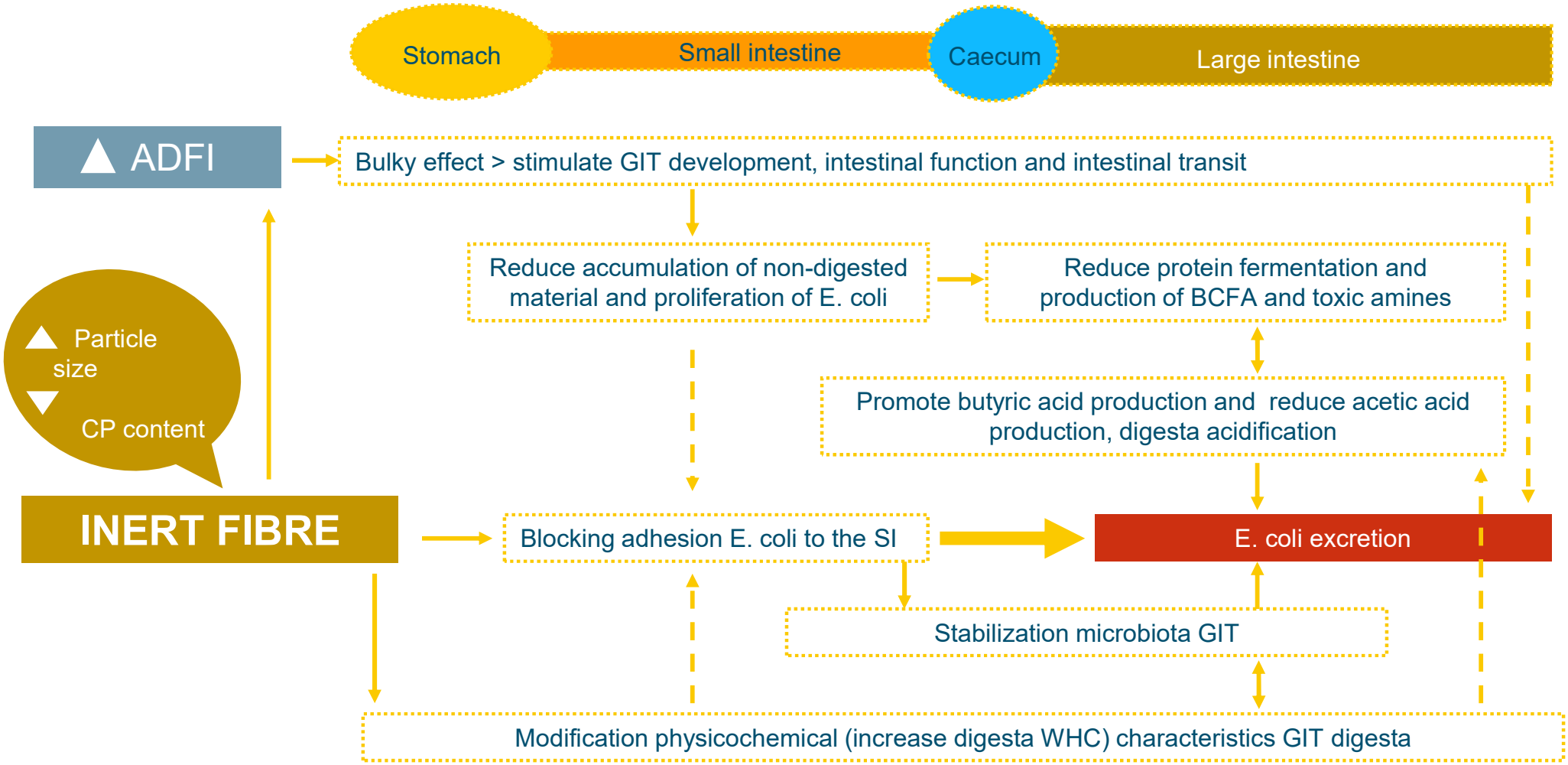
E.coli attached to ileum the mucosa



Molist et al., 2011

WB inclusion reduces the *E. coli* bacteria in the ileum digesta, and in coarse particle size also reduces the number of *E. coli* K88 adhered to the ileum mucosa

The complicated world of the fibre ingredients



DEGENERATIVE PHASE (5-10 d PW)

How we can help the piglets to have a good start?

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MODIFIERS OF THE MICROBIOTA OF THE GIT

- Acidifiers
- Prebiotics
- Probiotics
- Symbiotics
- Plant extracts
- Minerals: ZnO & Cu
- Dietary fibre
- Low CP diet
- Role of fat

PROMOTERS OF FOOD CONSUMPTION AND PRODUCTION ENHANCERS

- Palatable ingredients
- Digestible ingredients
- Flavours
- Synthetic amino acids

Protein

- Protein and AA necessary for piglet growth.
- Protein & minerals have a higher buffering capacity!.
- High protein level can negatively affect intestinal health.
- Protein rich diets: large amount of indigestible protein, enters the large intestine, fermentation.
- Amount of protein in the large intestine is influenced by:

  - Protein content of the diet
  - Digestibility of the protein
  - AA profile
  - Protein balance of the animal
  - Activity of the intestinal wall (endogenous protein production)

Protein source and age of piglet

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	Age of the piglets (wks)		
	3.5	**4.5**	**5.5**
Milkpowder	93	94	95
Soycomil	85	87	88
SBM	78	84	86
Fishmeal	86	89	91
Potato protein	87	-	91

(SFR trial)

The older the animal > the higher the protein digestibility
Digestibility vegetal protein sources is lower specially in case of ANF

Effect of protein source on performance

	Corn-soybean	15% Milk powder	8% Spray dried plasma
Day 1-7			
ADG	85	**134****	**140****
ADFI	133	170	163
FCR	1.55	1.26	1.15
Day 7-14			
ADG	243	274	244
ADFI	326	311	330
FCR	1.34	1.14	1.35
Day 14-28			
ADG	496	**535***	**549***
ADFI	805	**894***	**854***
FCR	1.62	1.67	1.56

Araujo et al., 2010

* : P < 0.05

** : P > 0.01

AA profile for different purposes

source	Baker1966, Baker& Allee (1970), Fuller et al (1989).	Fuller et al., 1989	Pettigrew, 1993	Pettigrew, 1993	NRC (1998) Dietary AA profile Boisen 1997
	maintenance	**protein accretion**	**milk synthesis**	**body tissue**	**25-120 kg pigs**
lys	**100**	**100**	**100**	**100**	**100**
met	28	27	26	27	26
met+cys	**123**	55	45	45	51
thr	**151**	60	58	58	64
trp	**26**	18	18	10	17
iso	75	54	55	50	57
leu	70	102	115	109	114
his	32	32	40	45	36
phe	50	60	55	60	57
phe+try	121	93	112	103	114
val	67	68	85	69	74

Protein sources

% CP	Feedstuff
60-80%	potato protein, (blood), fishmeal, AA
40-60%	(animal meal), soybean meal, maize gluten, milk proteins
20-40%	peas, lupins, beans, sunflower meal, rapeseed meal, coconut meal
10-20%	grains, palm kernel, maizegluten feed
0-10%	pulp, tapioca, molasses, fats

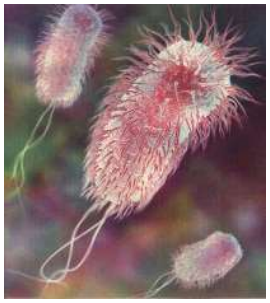
Fiber & CP fermentation

Level of protein

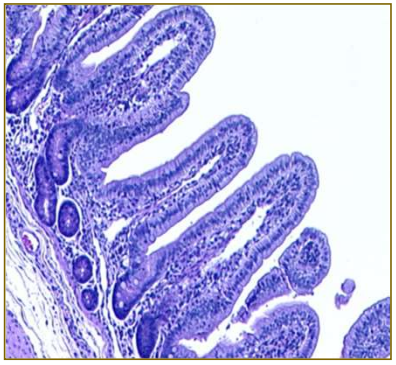
(15 %) → Performance → ¡ Importance! Essentials Aa (Iso, Val)

(19 %) + Fermentable Carbohydrates in pigs of 35 d old

(23 %) → Protein Fermentation → N-ammonia



\- gut integrity



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Protein Fermentation can be reduced:

First 2 wk PW

↓ Crude Protein ➔ AA supplementation

Le Bellego and Noblet (2002); Nyachoti et al. (2006)

ADVANTAGES

- ↓ BUFFERING CAPACITY
- ↓ AMMONIA ➔ ENVIROMENT

DISADVANTAGES

- AMINOACIDS BALANCE
- PRODUCTIVE PERFORMANCE

> 2 wk PW

↑ Dietary Fiber ➔ Sugar beet pulp, Inulin, Wheat bran

Awati et al., 2006; Bikker et al, 2006; Wellock et al., 2008

ADVANTAGES

- ↑ MICROBIAL FERMENTATION
- ↑ INTESTINAL TRANSIT
- GUT MATURATION

DISADVANTAGES

- ↓ ENERGETIC DENSITY
- ↓ FEED INTAKE
- PRODUCTIVE PERFORMANCE

How we can help the piglets to have a good start?

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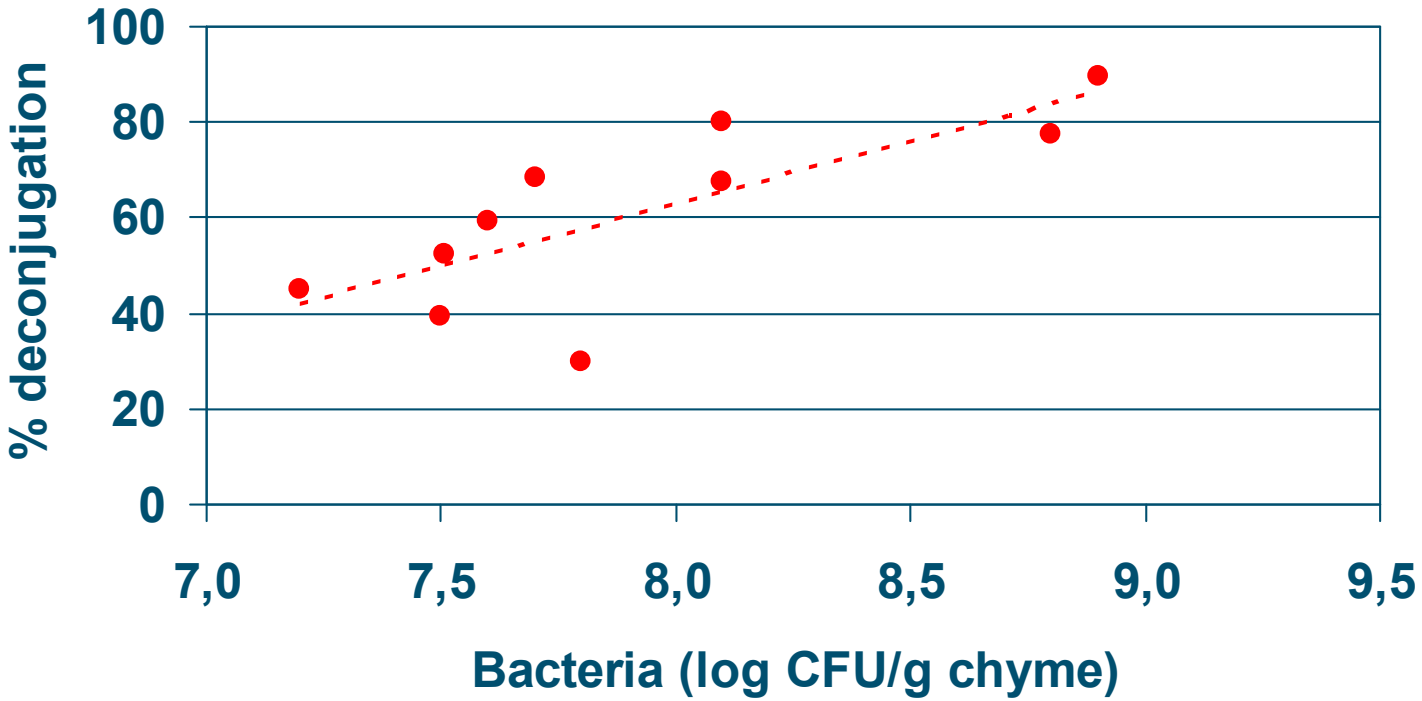
Fat

- The chemical and physical properties and therefore the nutritional value, differ widely between different fat sources.
- Fatty acids are major components of cell membranes, metabolic subtrates, cell-signiling molecules and play a critical role as immune modulators.
- Important to control the balance between optimal digestibility and product quality.
- When piglets face diarrhea long-chain fatty acids digestibility is drastically reduced.

Bacterial degradation of bile acids



Van der Klis, 1999

Over bacterial growth is linked to lower fat digestibility

MCFA's- Intestinal health

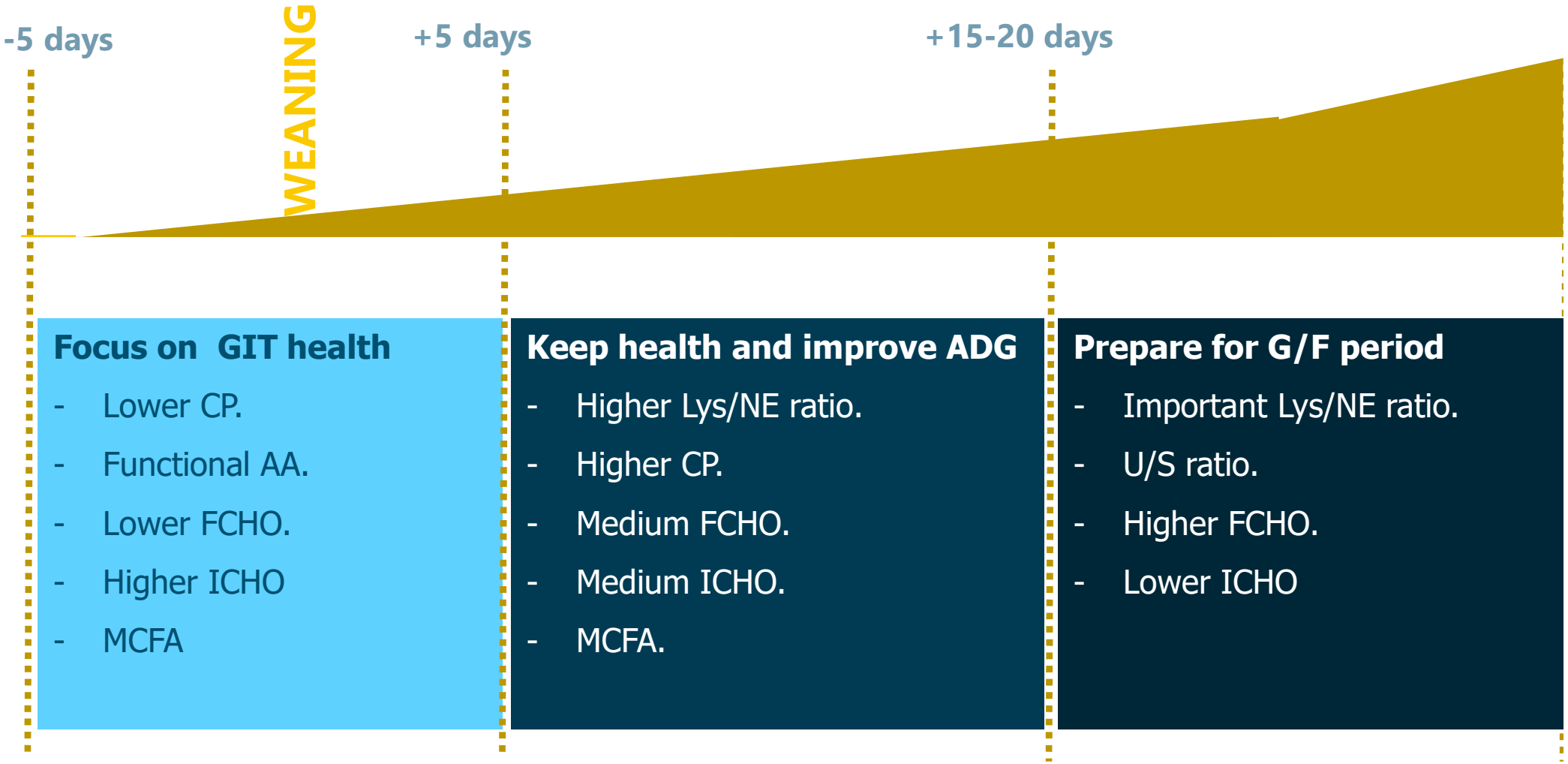
Treatment	Stomach				Duodenum			
	Total	*Lactobacilli*	*Streptococci*	*E. coli*	Total	*Lactobacilli*	*Streptococci*	*E. coli*
A	7.0^{a}	7.2^{ac}	4.2^{a}	4.6^{a}	6.4^{a}	6.9	1.6^{a}	4.9^{a}
B	7.0^{ac}	7.6^{a}	0.6^{b}	0.8^{bc}	6.1^{a}	6.8	0.0^{a}	4.8^{a}
C	5.9^{b}	6.6^{bc}	5.3^{a}	2.0^{b}	5.6^{b}	5.9	4.7^{b}	1.8^{b}
D	6.9^{ac}	7.3^{a}	5.1^{a}	0.0^{c}	5.9^{a}	6.4	4.7^{b}	1.8^{b}
S.E.M.	0.13	0.13	0.48	0.48	0.13	0.19	0.54	0.51

a,b,c: different superscripts in the same column denote significant differences at least $P < 0.05$.

Dierick et al., 2002

- A: control feed (incl. 2.5% soya oil)
- B: control feed + 2.5% MCFA - C8 and C10 (i.p.v. soya oil)
- C: feed B + lipase
- D: Control feed met 1.5% organic acids

Take home message…



Muito Obrigado!!

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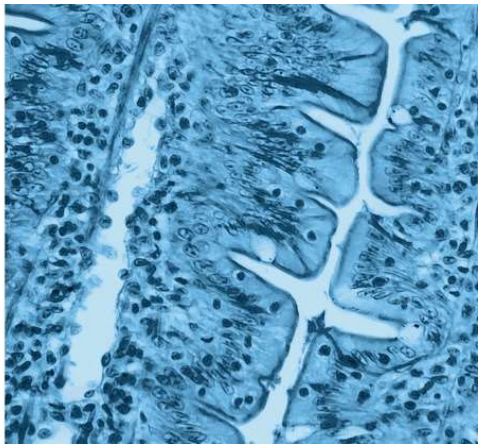
SCHOTHORST FEED RESEARCH

Knowhow to feed

SCHOTHORST FEED RESEARCH





Thank you for your attention

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