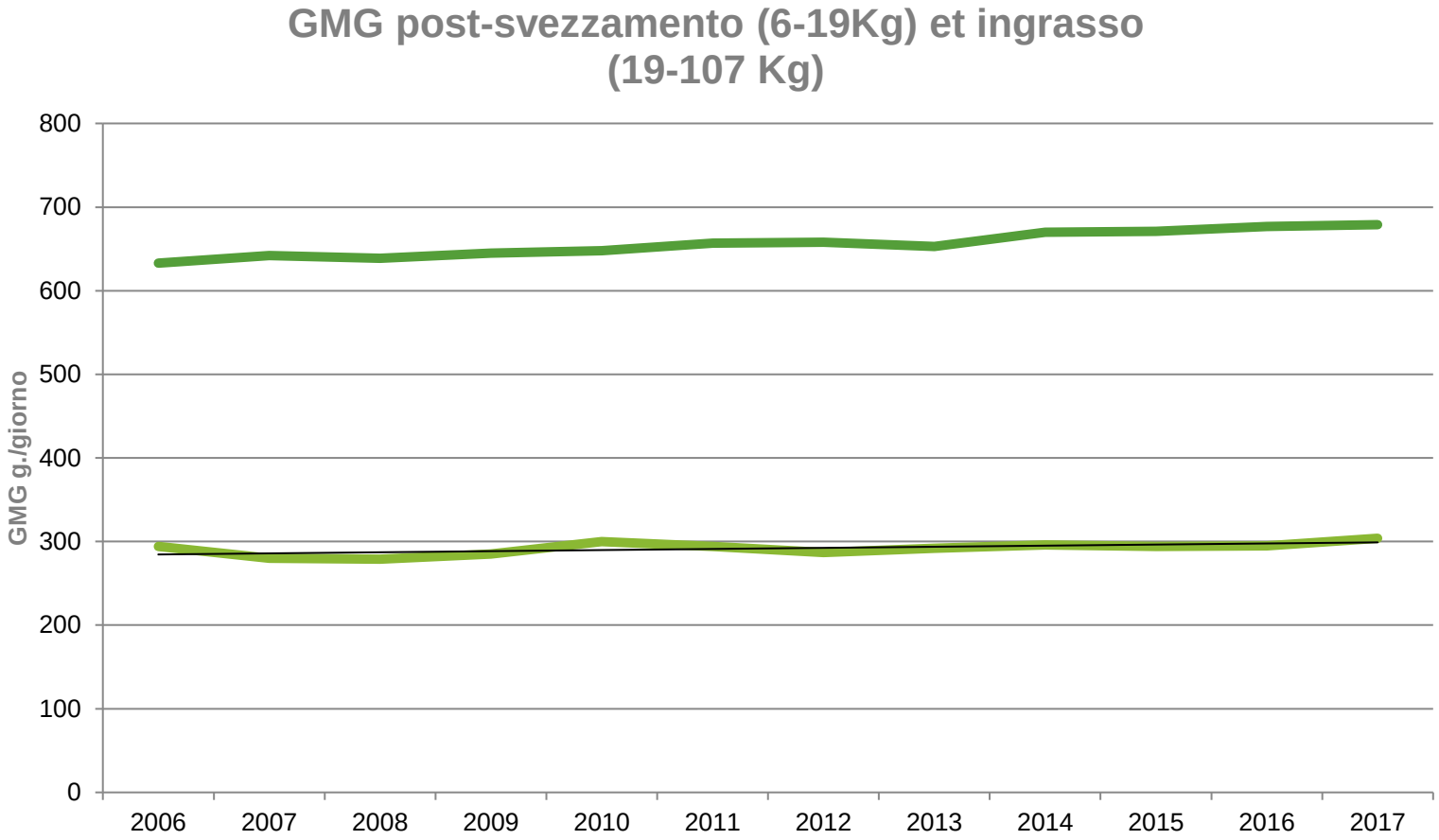
INTEGRITÀ INTESTINALE DEI SUINETTI, COME PRESERVARLA?

E. Marco

Marco vetgrup; SLP

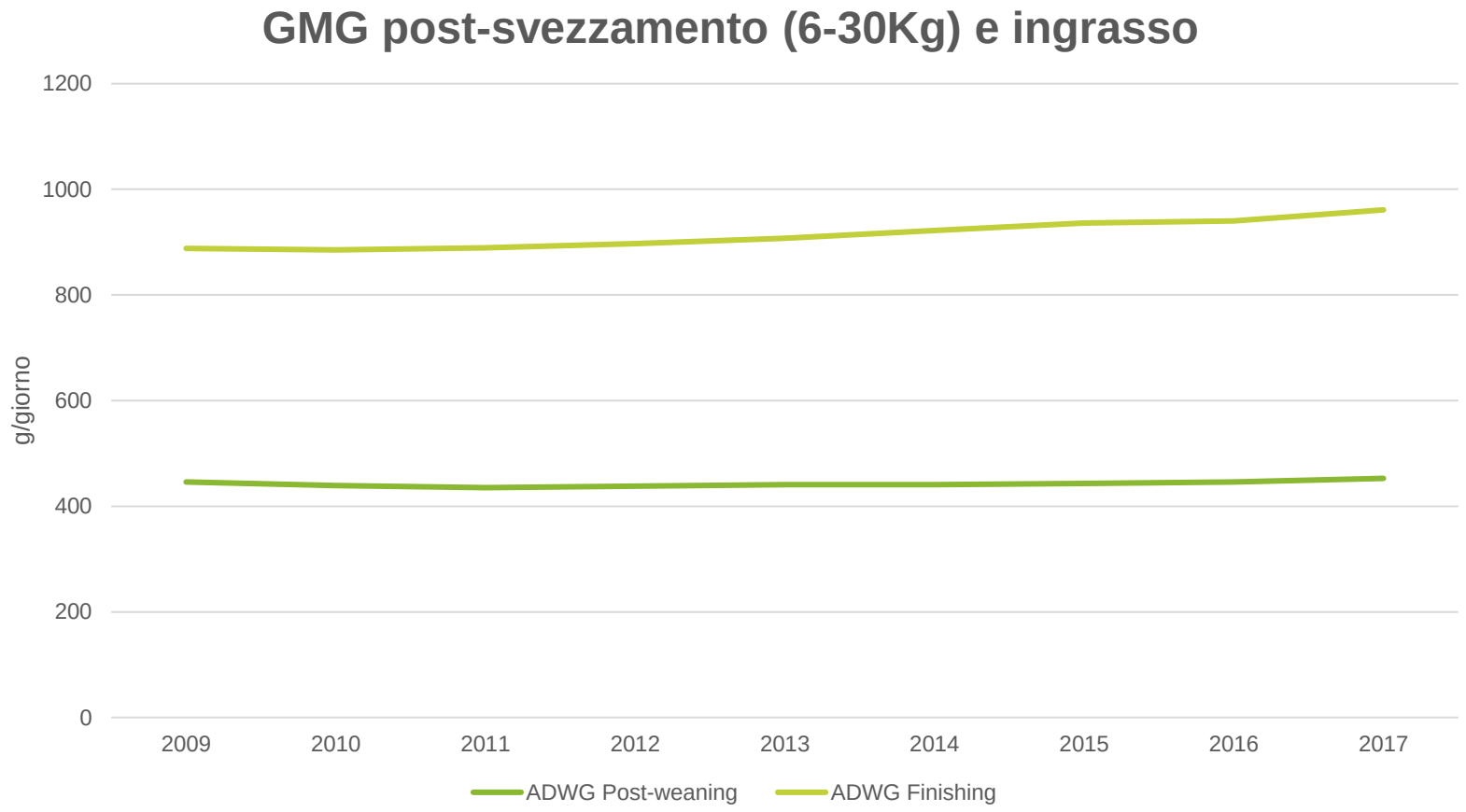
EM-IT-21-0095

Evoluzione del GMG in Spagna



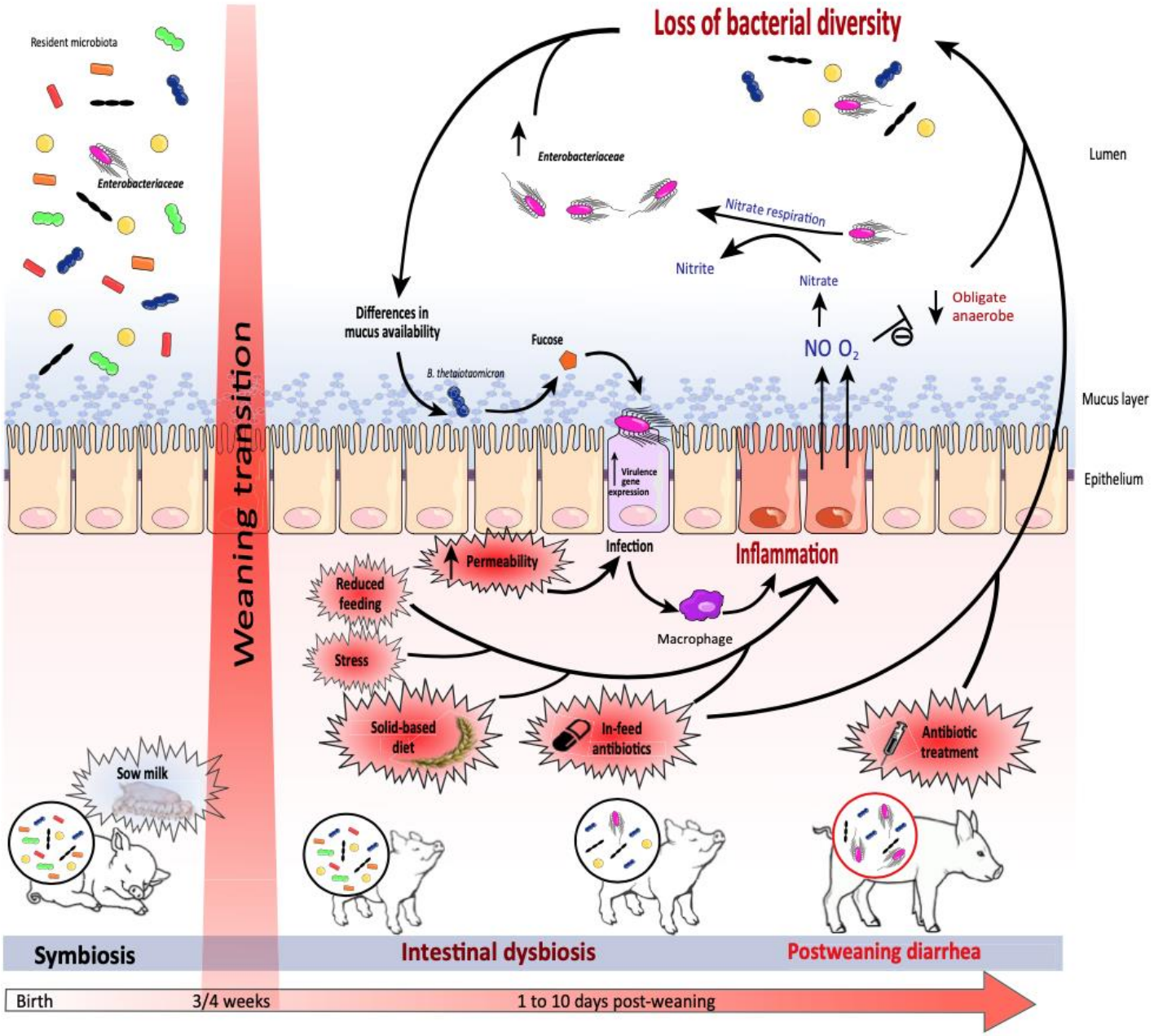
Data: SIP consultors 2014 and Grup de Gestió Porcina UdL. Informe Annual: 2009-2017

Evoluzione del GMG in Danimarca



Seges, NATIONAL AVERAGE PRODUCTIVITY OF DANISH PIG FARMS 2017

Problemi intestinali



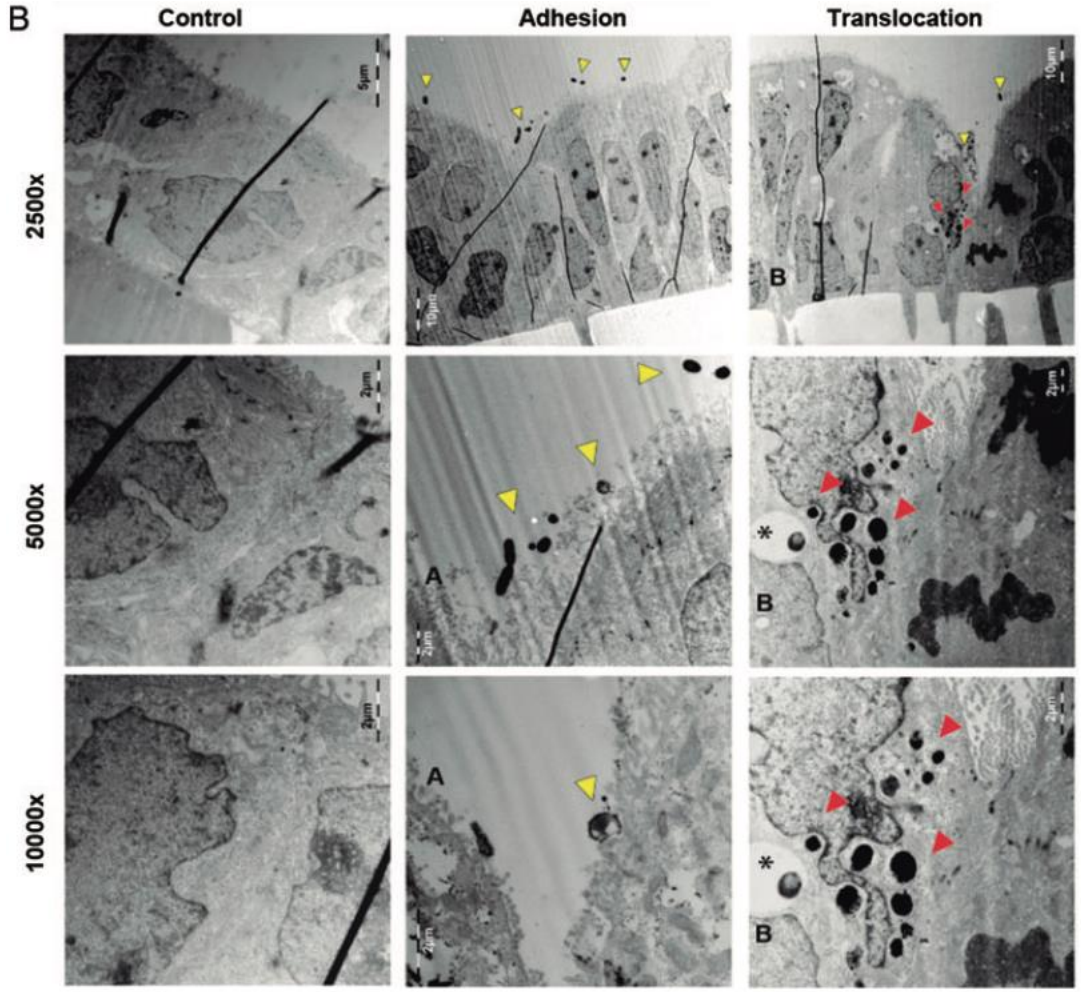
Gresse, R. *et al.* 2017. *Gut Microbiota Dysbiosis in Postweaning Piglets: Understanding the Keys to Health.* TIMI 1461 No. of Pages 23

Integrità intestinale

- Il microbiota associato alla mucosa agisce come difensore di prima linea contro i patogeni mediante l'esclusione competitiva e la modulazione dello stato immunitario.
- La produzione di immunoglobuline A (IgA) indotta dal microbiota modula la colonizzazione batterica, prevenendo la traslocazione dei batteri attraverso lo strato epiteliale.
- Il microbiota potrebbe metabolizzare alcune tossine presenti nei mangimi e può sintetizzare alcune vitamine che possono essere utilizzate dall'epitelio intestinale dell'ospite.
- È stato dimostrato che il microbiota intestinale supporta la maturazione delle cellule epiteliali intestinali e le loro funzioni di barriera, promuovendo l'omeostasi del sistema immunitario intestinale.

Duarte ME, Kim SW, Intestinal microbiota and its interaction to intestinal health in nursery pigs, Animal Nutrition Journal, https://doi.org/10.1016/j.aninu.2021.05.001.

S. suis: traslocazione intestinale



Ferrando, ML, *et al.* 2015. Host-pathogen Interaction at the Intestinal Mucosa Correlates With Zoonotic Potential of Streptococcus suis. The Journal of Infectious Diseases® 2015;212:95–105

Integrità intestinale

- Il microbiota intestinale può influire sulla crescita e sull'efficienza alimentare nei suini.

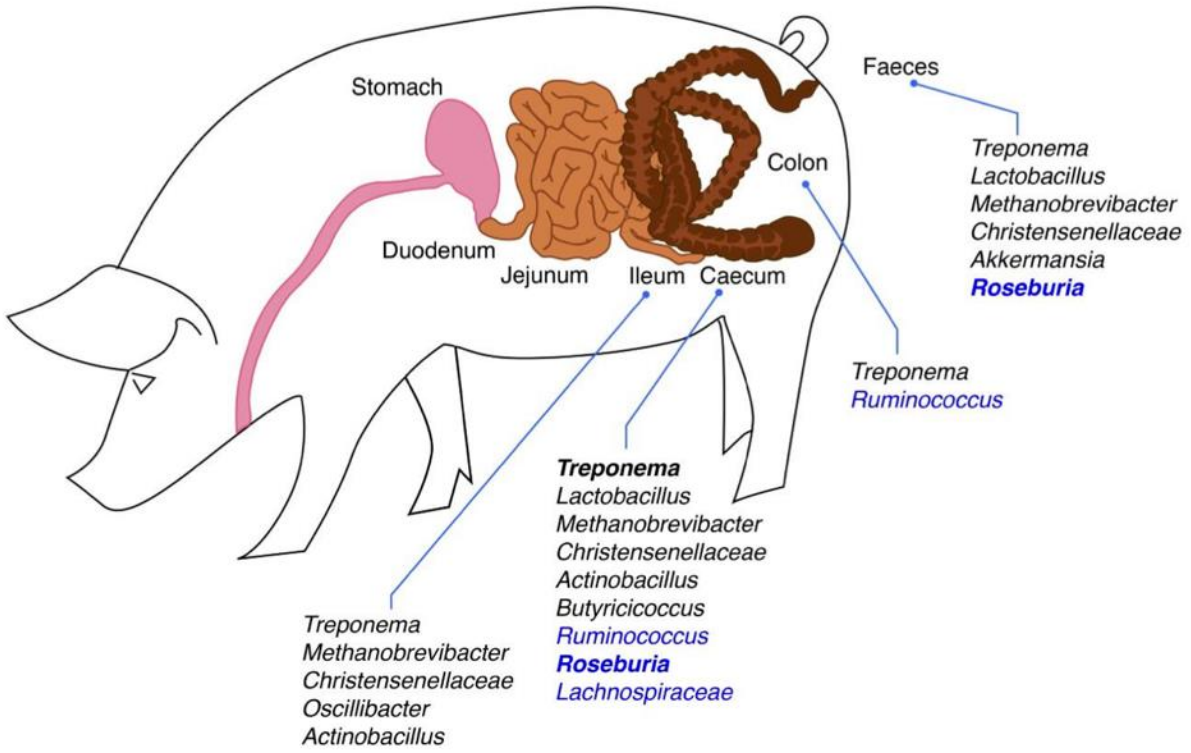


Figure 1. Summary of feed efficiency-associated bacterial taxa in pigs. There are some conflicting data for the taxa in blue, and the taxa in bold are also associated with increased body weight and/or leanness.

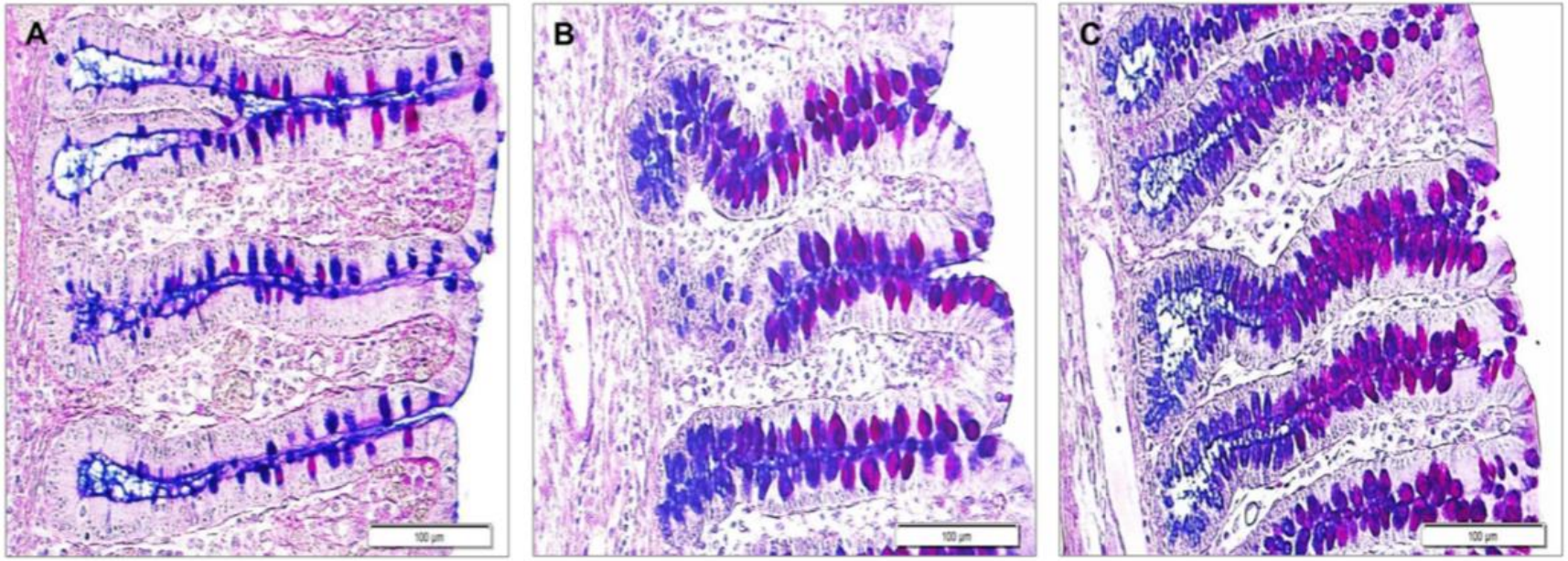
Gardiner, GE *et al.* Impact of Intestinal Microbiota on Growth and Feed Efficiency in Pigs: A Review. *Microorganisms* 2020, *8*, 1886; doi:10.3390/microorganisms8121886

Integrità intestinale

- *Treponema* nell'intestino tenue e crasso, che era più abbondante nei suini più magri ed è costantemente associato a una migliore FE;
- Metanogeni come *Methanobrevibacter* nell'intestino tenue e crasso; e *Lactobacillus* nell'intestino crasso, entrambi i quali sono anche comunemente associati a una migliore FE.
- *Treponema* e soprattutto *Lactobacillus* possono essere considerati parte del cosiddetto "microbiota" dei suini sani.
- Altri taxa che sembrano promettenti come biomarcatori per la crescita e/o FE, come *Ruminococcus, Roseburia* e *Prevotella*, sono anche membri fondamentali del microbioma intestinale dei maiali commerciali [16], ma per loro sono stati ottenuti dati contrastanti.

Gardiner, GE *et al.* Impact of Intestinal Microbiota on Growth and Feed Efficiency in Pigs: A Review. *Microorganisms* 2020, *8*, 1886; doi:10.3390/microorganisms8121886

Ossido di zinco: il suo utilizzo sarà vietato da luglio 2022



A. Basso livello di ossido di zinco : 57 mg/kg
B. Livello medio di ossido di zinco : 164 mg/Kg
C. Alto livello di ossido di zinco: 2425 mg/kg

Liu P, Pieper R, Rieger J, Vahjen W, Davin R, et al. (2014) Effect of Dietary Zinc Oxide on Morphological Characteristics, Mucin Composition and Gene Expression in the Colon of Weaned Piglets. PLoS ONE 9(3): e91091. doi:10.1371/journal.pone.0091091

Fattori che influenzano la salute dell'intestino

- Genetica
- Microbiota madre e suinetto
- Periodo di allattamento
- Digiuno dopo lo svezzamento
- Fattori specifici dopo-svezzamento
  - Management
  - Dieta
  - Atmosfera
  - Altre malattie

GENETICA

Genetica e microbiota

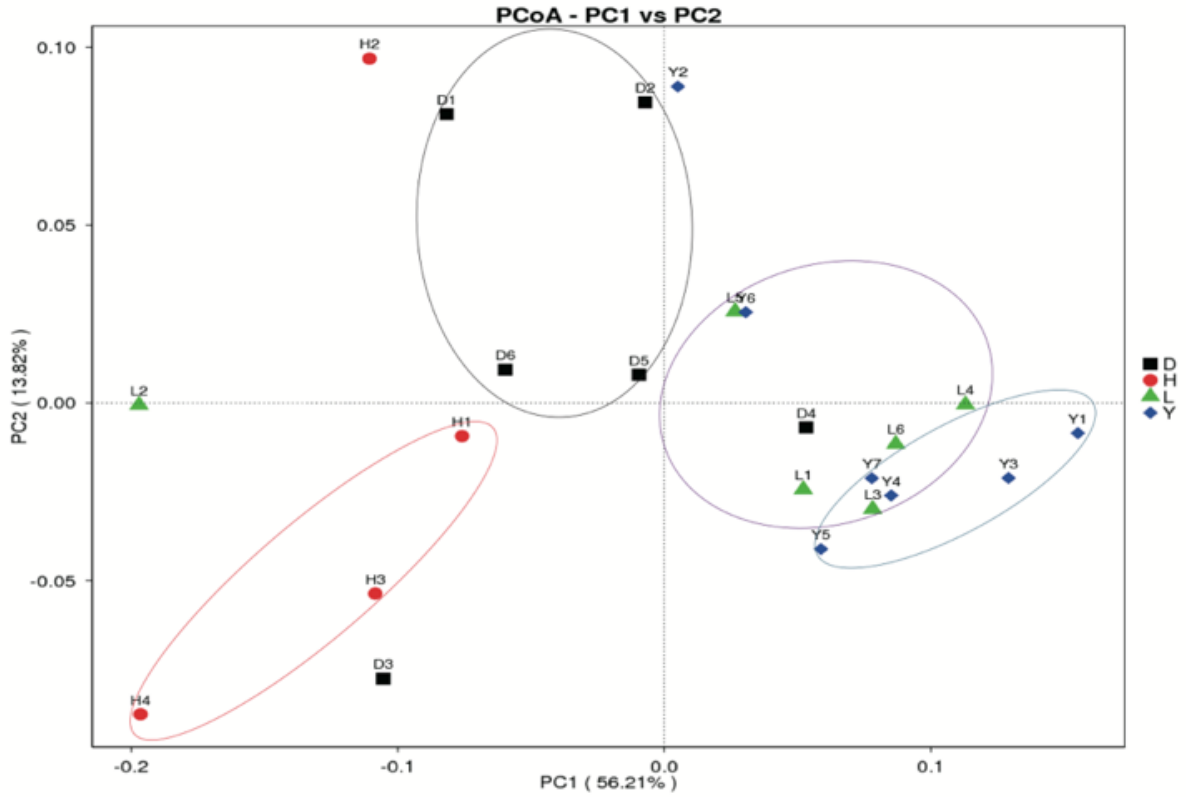


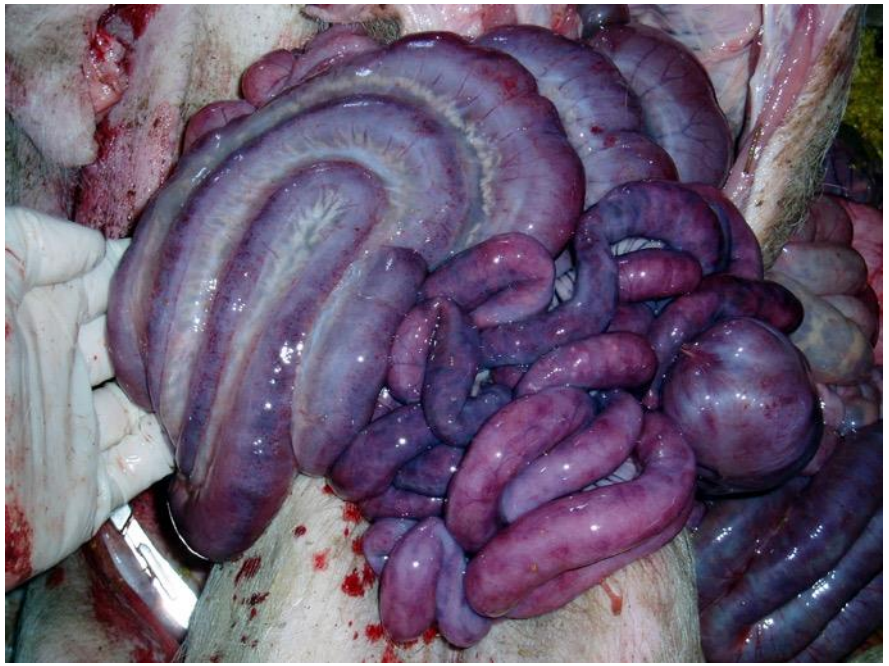
Figure 7. PCoA analysis based on Weighted UniFrac distance. Each point represents a sample. The first principal component is plotted on the X-axis, and the second principal component is plotted on the Y-axis. The colors indicate different breeds. The percentage on each axis indicates the contribution to the discrepancy among samples. PCoA, principal coordinate analysis; D, Duroc; H, Hampshire; L, Landrace; Y, Yorkshire.

Yingping Xiao et al. 2017. The fecal microbiota composition of boar Duroc, Yorkshire, Landrace and Hampshire. Asian-Australas J Anim Sci. Vol. 30, No. 10:1456-1463 October 2017 https://doi.org/10.5713/ajas.16.0746 pISSN 1011-2367 eISSN 1976-5517

Genetica

E. coli F18 ETEC+ (malattia degli edemi)

Bertschinger, *et al.* (1993): I suinetti con recettori per la fimbria di *E.coli* F18 sono suscettibili alla malattia degli edemi



Bertschinger, *et al.* 1993. Inheritance of resistance to oedema disease in the pig: Experiments with an *Escherichia coli* strain expressing fimbriae 107. *Vet Microbiol.* 1993 May; 35(1): 79–89.

Genetica

Vet Microbiol. 2017 Apr;202:58-63. doi: 10.1016/j.vetmic.2016.09.008. Epub 2016 Sep 18.

New perspectives to the enterotoxigenic E. coli F4 porcine infection model: Susceptibility genotypes in relation to performance, diarrhoea and bacterial shedding.

Roubos-van den Hil PJ[1], Litjens R[2], Oudshoorn AK[2], Resink JW[3], Smits CHM[2].

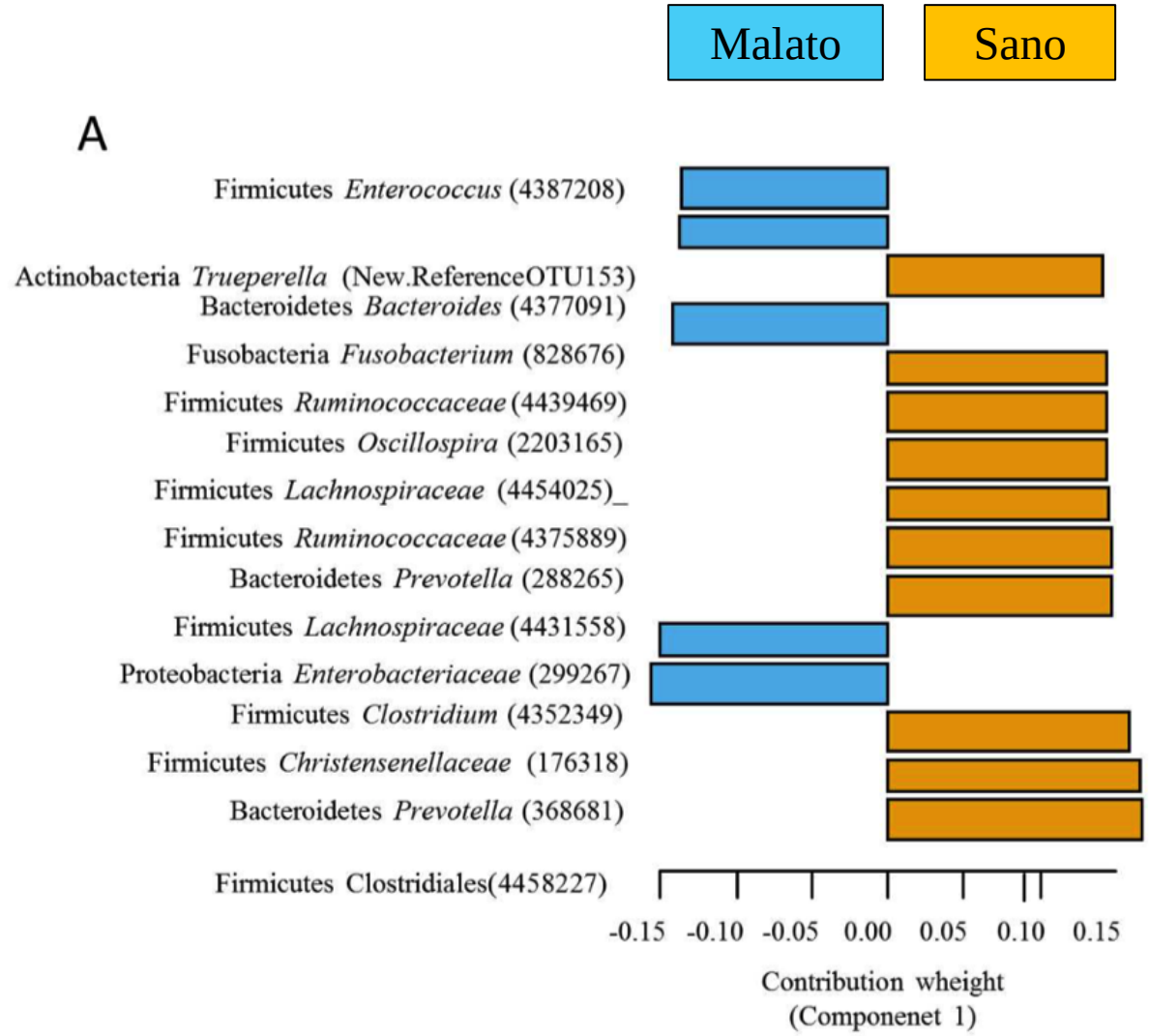
Author information

Abstract

Enterotoxigenic E. coli (ETEC), causing post-weaning diarrhoea, is a major problem in weaned piglets. Individual animal responses to ETEC infection show high variability in animal experiments. Two studies were designed to optimize the ETEC F4ac infection model in piglets by combining the genotype susceptibility with performance, diarrhoea incidence and bacterial shedding. The studies were performed with respectively 120 and 80 male piglets that were tested for susceptibility or resistance towards ETEC O149:F4ac by a DNA marker based test. Three different genotypes were observed; resistant (RR), susceptible heterozygote (RS) and susceptible homozygote (SS). Piglets, were orally infected with an inoculum suspension (containing 1.5E8 CFU/ml ETEC F4ac) at day 0, 1 and 2 of the study. Performance, diarrhoea incidence and bacterial shedding were followed for 21days. In the first week after challenge a difference in average daily gain was observed between resistant and susceptible piglets in both studies. For the complete study period no significant differences were observed. Diarrhoea incidence was significantly higher in susceptible pigs compared to the resistant pigs in the first week after challenge. Bacterial shedding was much higher in the susceptible pigs and ETEC excretion lasted longer. ETEC was hardly detected in the faecal material of the resistant pigs. In conclusion, susceptible pigs showed higher diarrhoea incidence and higher numbers of faecal ETEC shedding in the first week after challenge compared to resistant pigs. The DNA marker based test can be used to select pigs that are susceptible for ETEC for inclusion in ETEC infection model, resulting in less animals needed to perform infection studies.

MICROBIOTA MADRE E SUINETTO

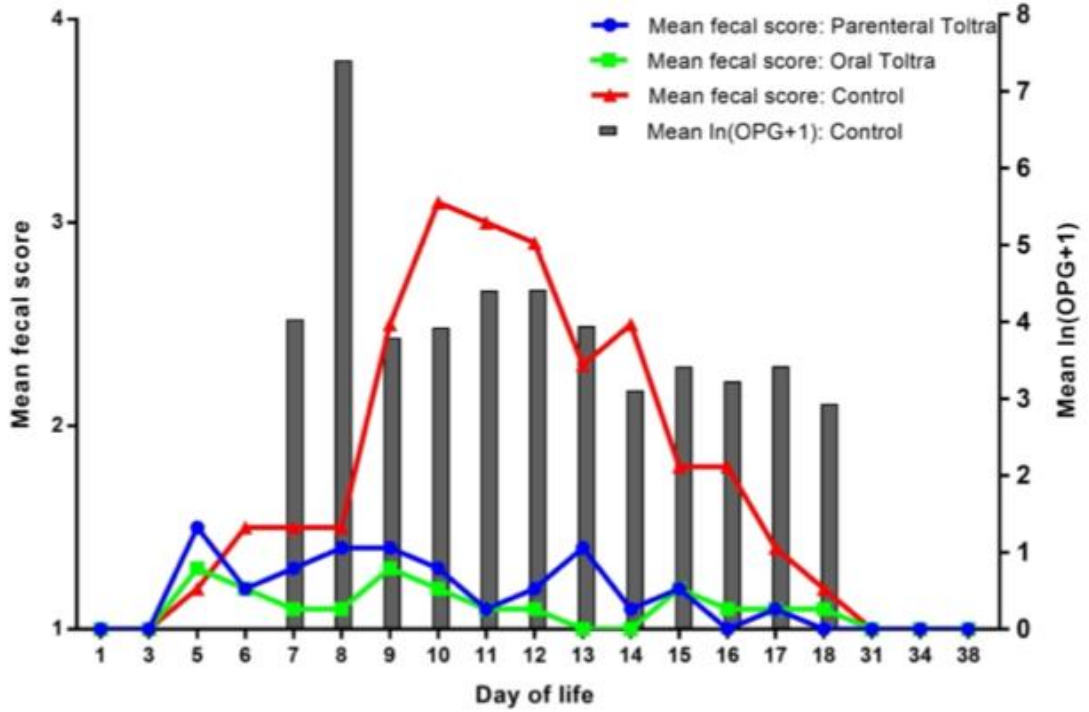
Microbiota



Dou S, Gadonna-Widehem P, Rome V, Hamoudi D, Rhazi L, Lakhal L, et al. (2017) Characterisation of Early-Life Fecal Microbiota in Susceptible and Healthy Pigs to Post-Weaning Diarrhoea. PLoS ONE 12(1): e0169851. doi:10.1371/journal.pone.0169851

PERIODO DI ALLATTAMENTO

Effetto della malattia sul microbiota: Coccidiosi



Shrestha, A. *et al. 2020*. The fecal microbiota evolves differently in piglets experimentally infected with *Cystoisospora suis* that are treated with toltrazuril. Posted Research Square

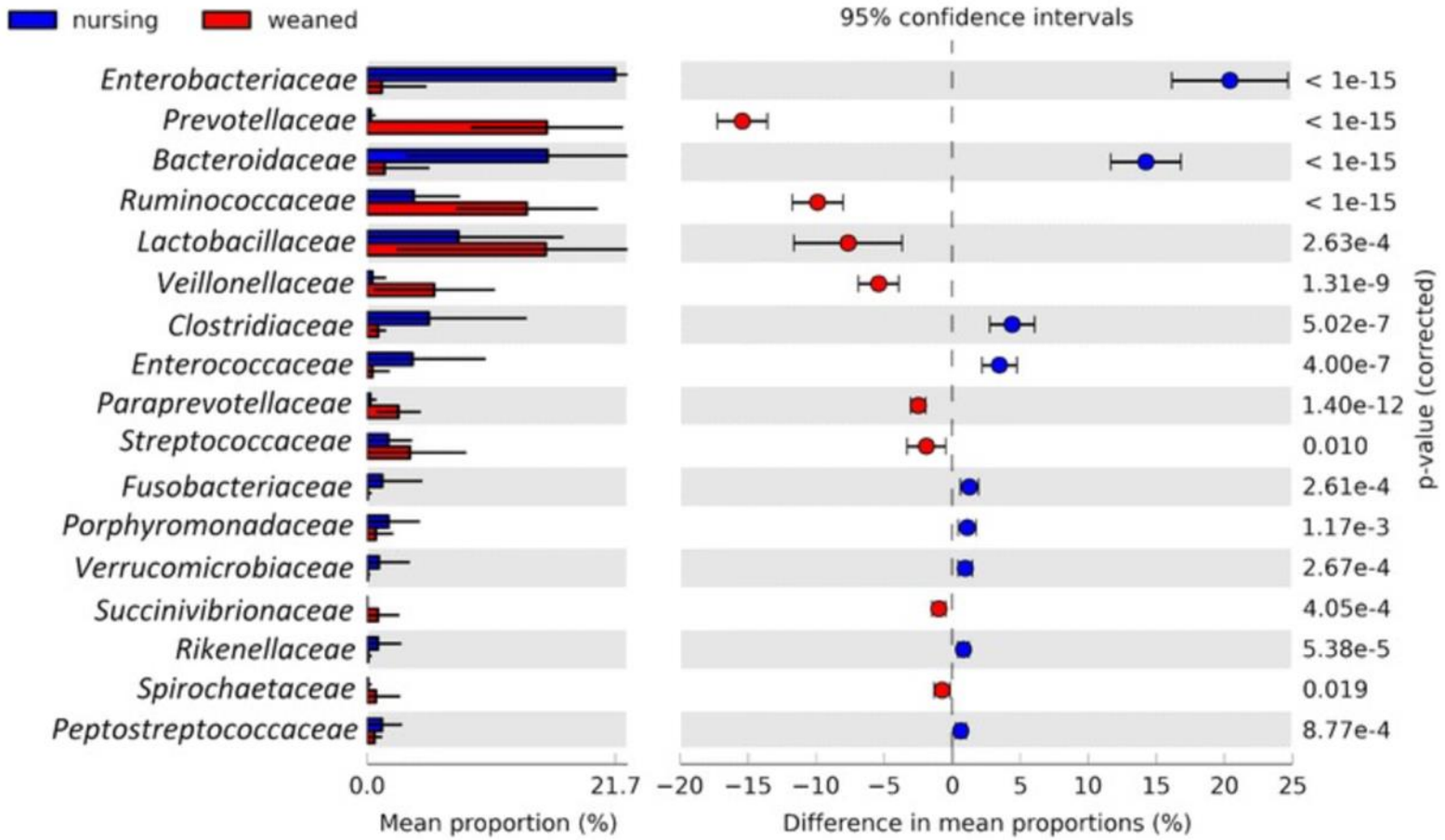
Effetto della malattia sul microbiota: Coccidiosi

Coccidiosi

- Entrambi i trattamenti con toltrazuril hanno prevenuto la perdita di specie batteriche e diversità rispetto ai suinetti nel gruppo di controllo, che ha mostrato segni clinici tipici dell'infezione da *C. suis*

Shrestha, A. *et al. 2020*. The fecal microbiota evolves differently in piglets experimentally infected with *Cystoisospora suis* that are treated with toltrazuril. Posted Research Square

Il microbiota cambia con il cambio di dieta



Frese SA, Parker K, Calvert CC, Mills DA. Diet shapes the gut microbiome of pigs during nursing and weaning. Microbiome. 2015;3:28.

Il microbiota cambia con il cambio di dieta

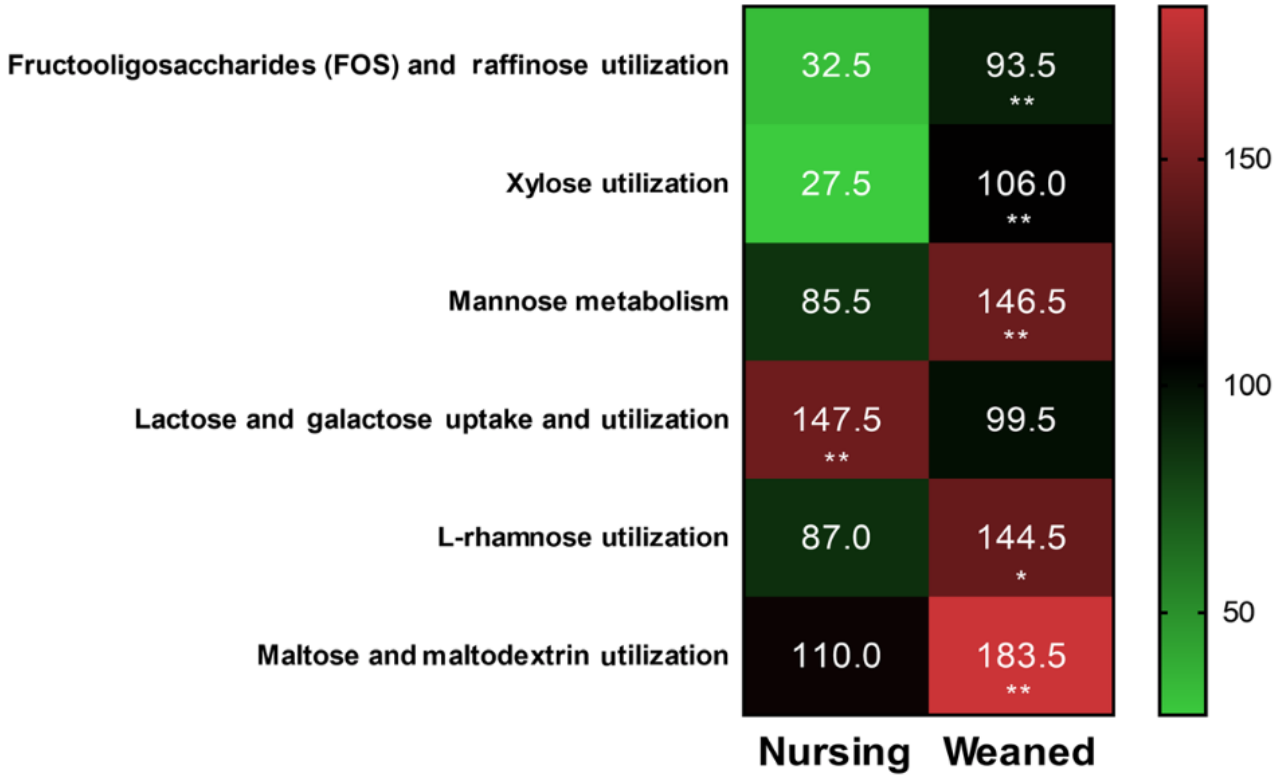
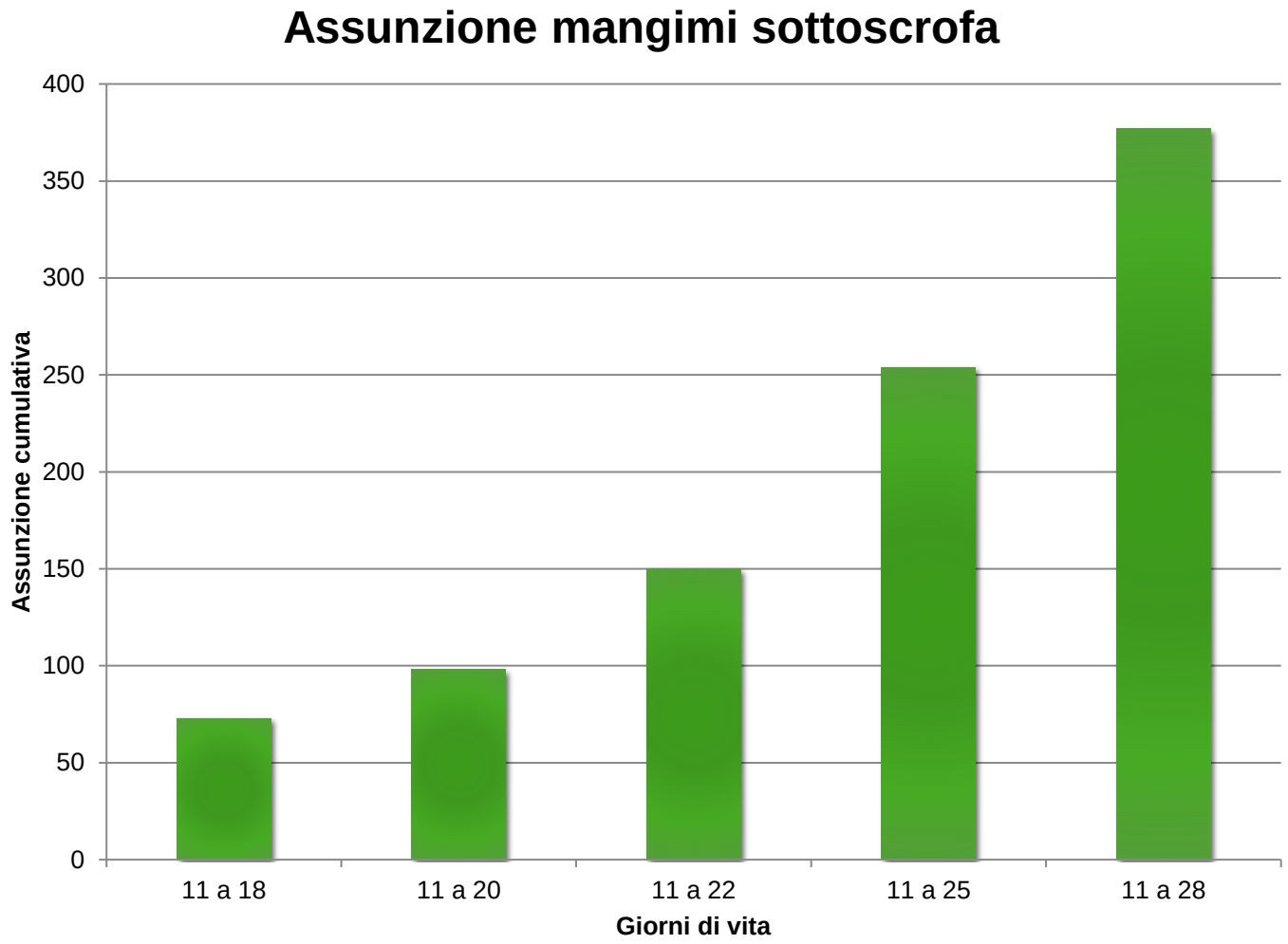


Fig. 3 The functional capacities of the microbiome between nursing and weaned piglets in association with carbohydrate metabolism as revealed by whole metagenome shotgun sequencing. The scale bar indicates normalized abundance of the level 3 SEED subsystem classified reads associated with carbohydrate metabolism. The [$P < 0.001$], [$P < 0.01$] and [$P < 0.05$] were indicated as [***], [**] and [*], respectively

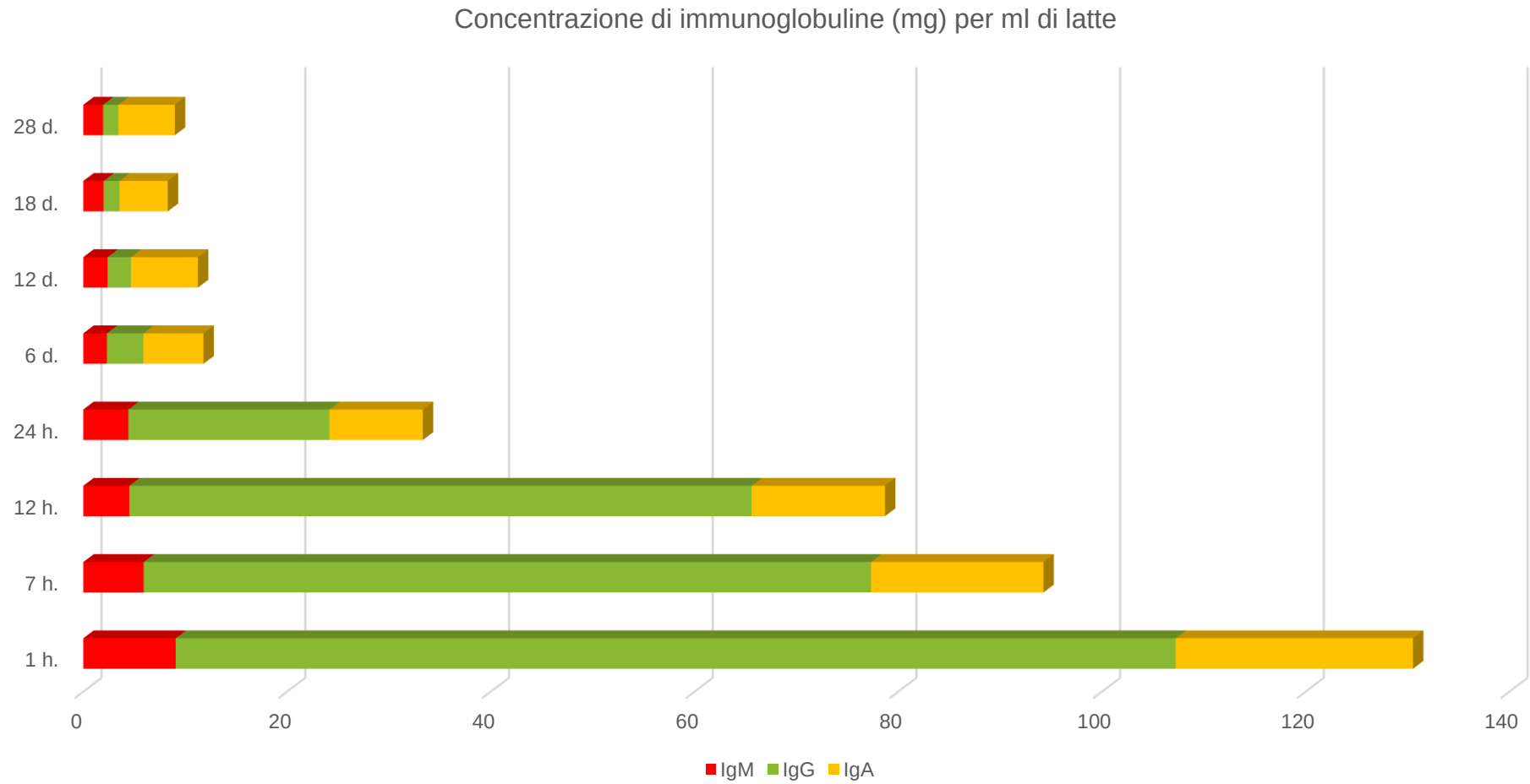
Guevarra et al. *Piglet gut microbial shifts early in life: causes and effects.* Journal of Animal Science and Biotechnology (2019) 10:1

Assunzione di dieta solida



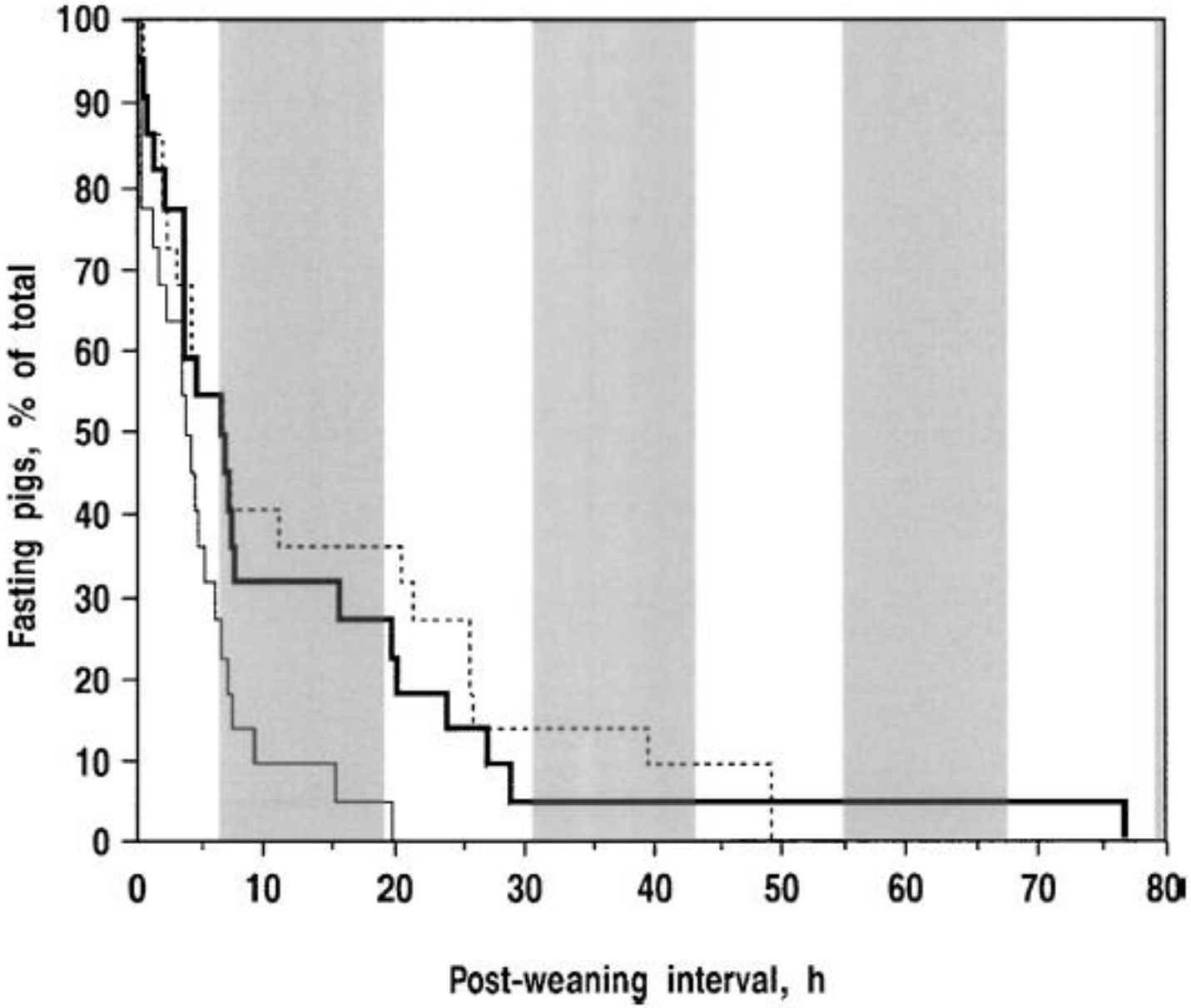
Brunix, et al. *Effect of creep-feed consumption on individual feed intake characteristics and performance of group housed weanling pigs*. J. Anim. Sci. 2002, 80: 1413-1418

Immunità



Iwona Markowska-Daniel and Malgorzata Pomorska-Mól. 2010. Shifts in immunoglobulins levels in the porcine mammary secretions during whole lactation period. Bull Vet Inst Pulawy 54, 345-349 .

DIGIUNO DOPO LO SVEZZAMENTO



Pre-starter eaters
Pre-starter non eaters
Not offered

Brunix, et al. *Effect of creep-feed consumption on individual feed intake characteristics and performance of group housed weanling pigs*. J. Anim. Sci. 2002, 80: 1413-1418

Relazione tra assunzione di mangime il primo giorno dopo lo svezzamento e diarrea

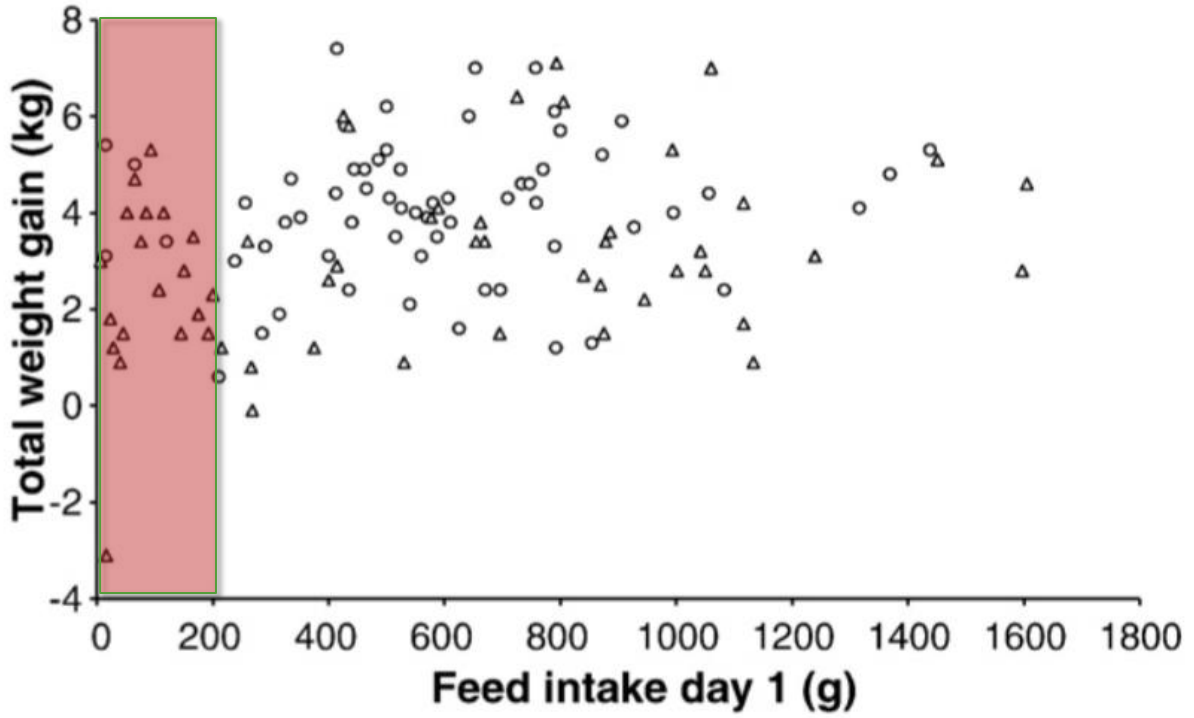
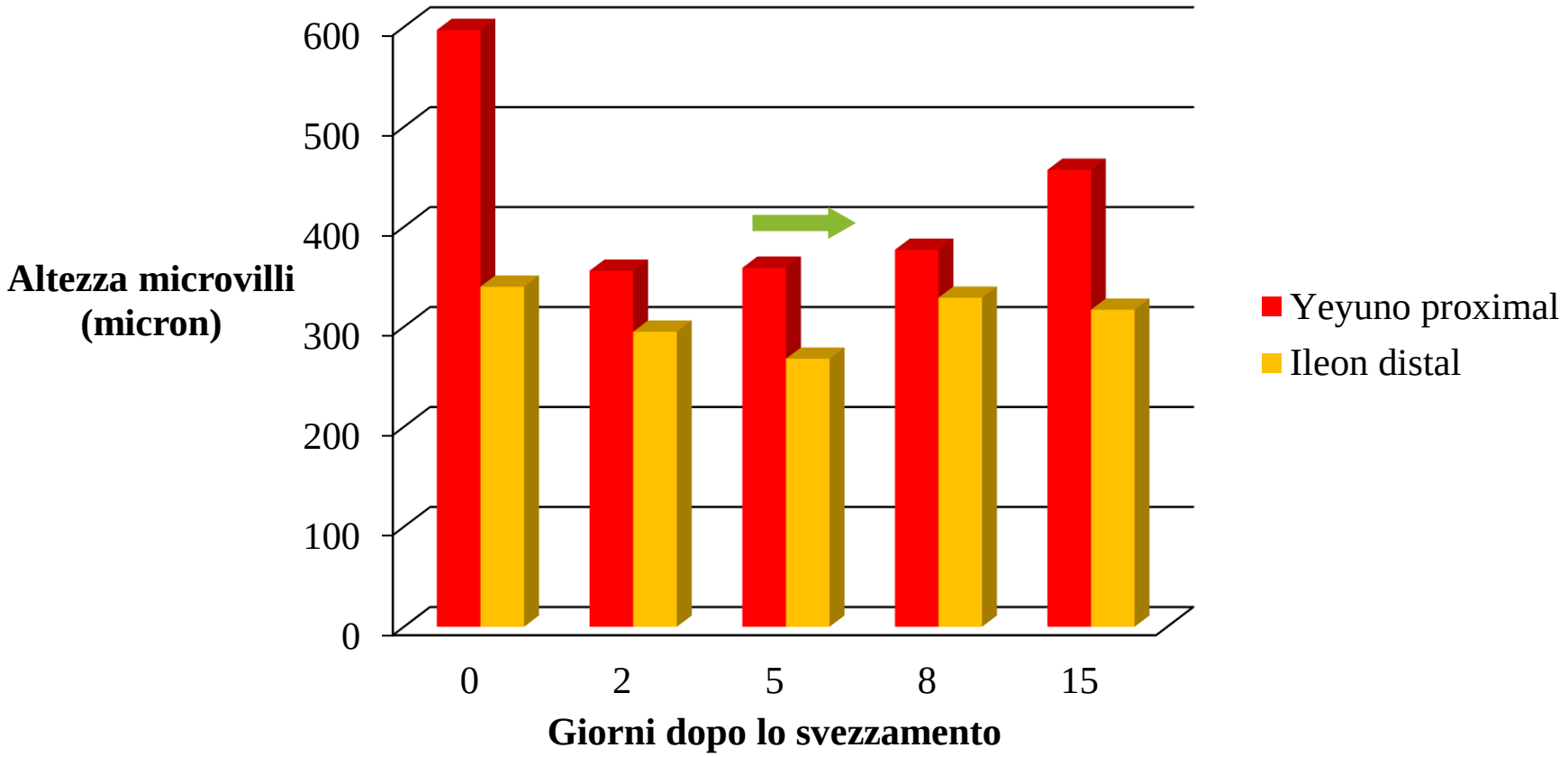


Fig. 3. Total weight gain during the 10-day experimental period as a function of feed intake during the first day after weaning in two clusters of piglets, i.e. piglets developing a diarrhoea-like condition (triangles) and piglets with only a slight increase in faecal score (circles) (see text for details). All piglets were included regardless of dietary treatment and inoculation.

M.T. Sørensen et al. / Livestock Science 123 (2009) 314–321

Effetto dello svezzamento sui microvilli



Gae¨ lle Boudry, *et al.* 2004. Weaning Induces Both Transient and Long-Lasting Modifications of Absorptive, Secretory, and Barrier Properties of Piglet Intestine. The Journal of Nutrition 134:2256-2262

Digiuno dopo lo svezzamento

- La mancanza di nutrienti ha portato ad una maggiore abbondanza di Prevotellaceae ed Escherichia-Shigella e ad una diminuzione delle Bacteroidiaceae.
- Lo stress da privazione del mangime ha indotto modifiche della produzione di metaboliti microbici come una diminuzione dell'acetato e un aumento della produzione proporzionale di valerato, isovalerato e isobutirrato.

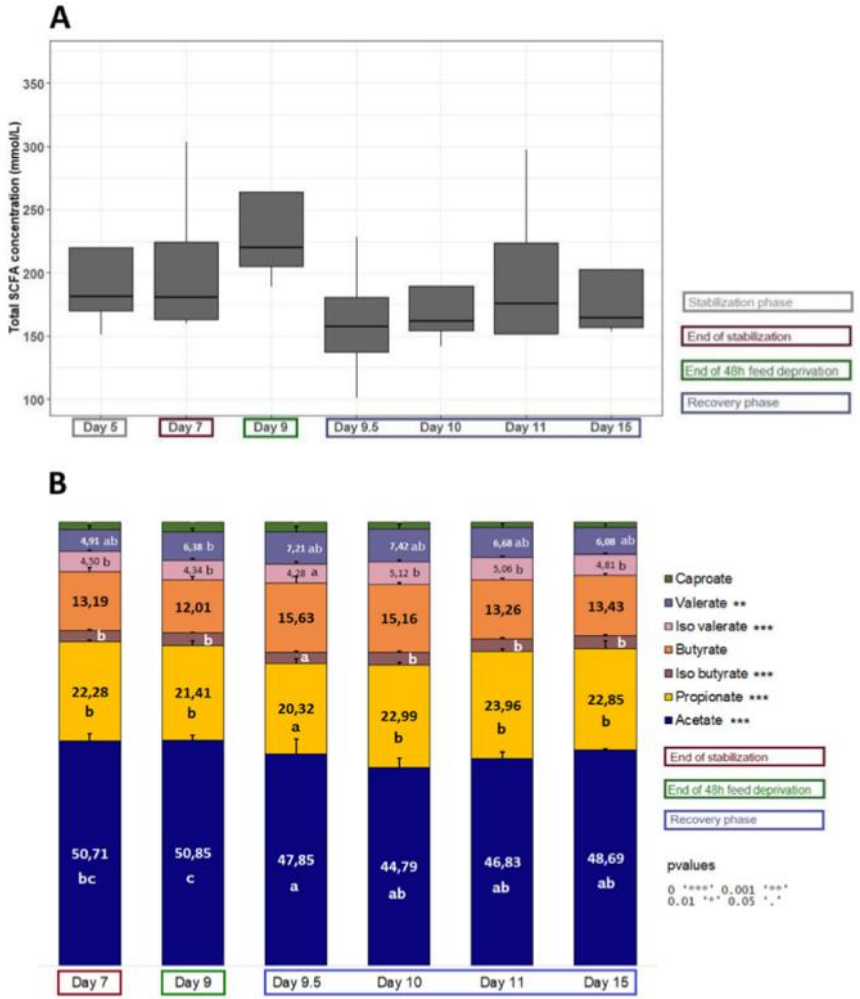


Fig. 10 Evolution of the mean total concentration (**a**) and of the relation abundance (**b**) of SCFAs during the fermentation #6, 7, 8 and 9 which were subjected to a feed deprivation stress of 48 h ($n = 4$ for each time point)

Gresse et al. Weaning-associated feed deprivation stress causes microbiota disruptions in a novel mucin-containing in vitro model of the piglet colon (MPigut-IVM). *Journal of Animal Science and Biotechnology* (2021) 12:75

FATTORI SPECIFICI DOPO-SVEZZAMENTO

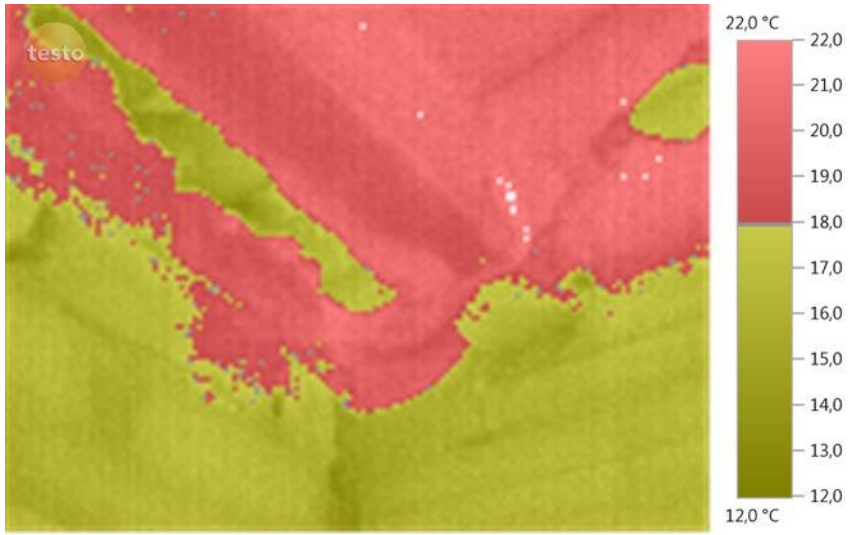

Mancanza di mangiatoia

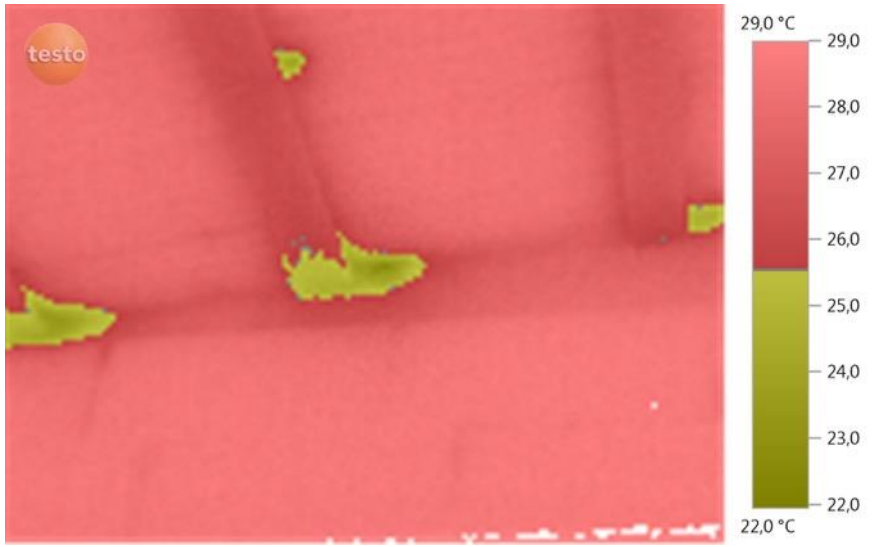

Mangime razionato


Freddo

Pre-riscaldamento imprescindibile

Condicione	Cambiamento Tª effettiva
Differenza Tª aire-parete	
13 °C	- 7 °C
3 °C	- 1,5 °C
1 °C	- 0,5 °C





Mancanza di pre-riscaldamento

Igiene

Igiene giornaliera

Amass SF, Halbur PG, Byrne BA, et al. Mechanical transmission of enterotoxigenic *Escherichia coli* to weaned pigs by people, and biosecurity procedures that prevented such transmission. *J Swine Health Prod.* 2003;11(2):61-68.

Table 4: Cumulative percentage of weaned pigs[1] from which *Escherichia coli* strain M1823B (challenge strain) was isolated during sample collection periods on Day 0 (prior to exposure), and Days 2, 4, 7, and 11 after initial exposure by inoculation (Inoculated Pigs) or direct (Pen Sentinels) or indirect exposure to the Inoculated Pigs.[2]

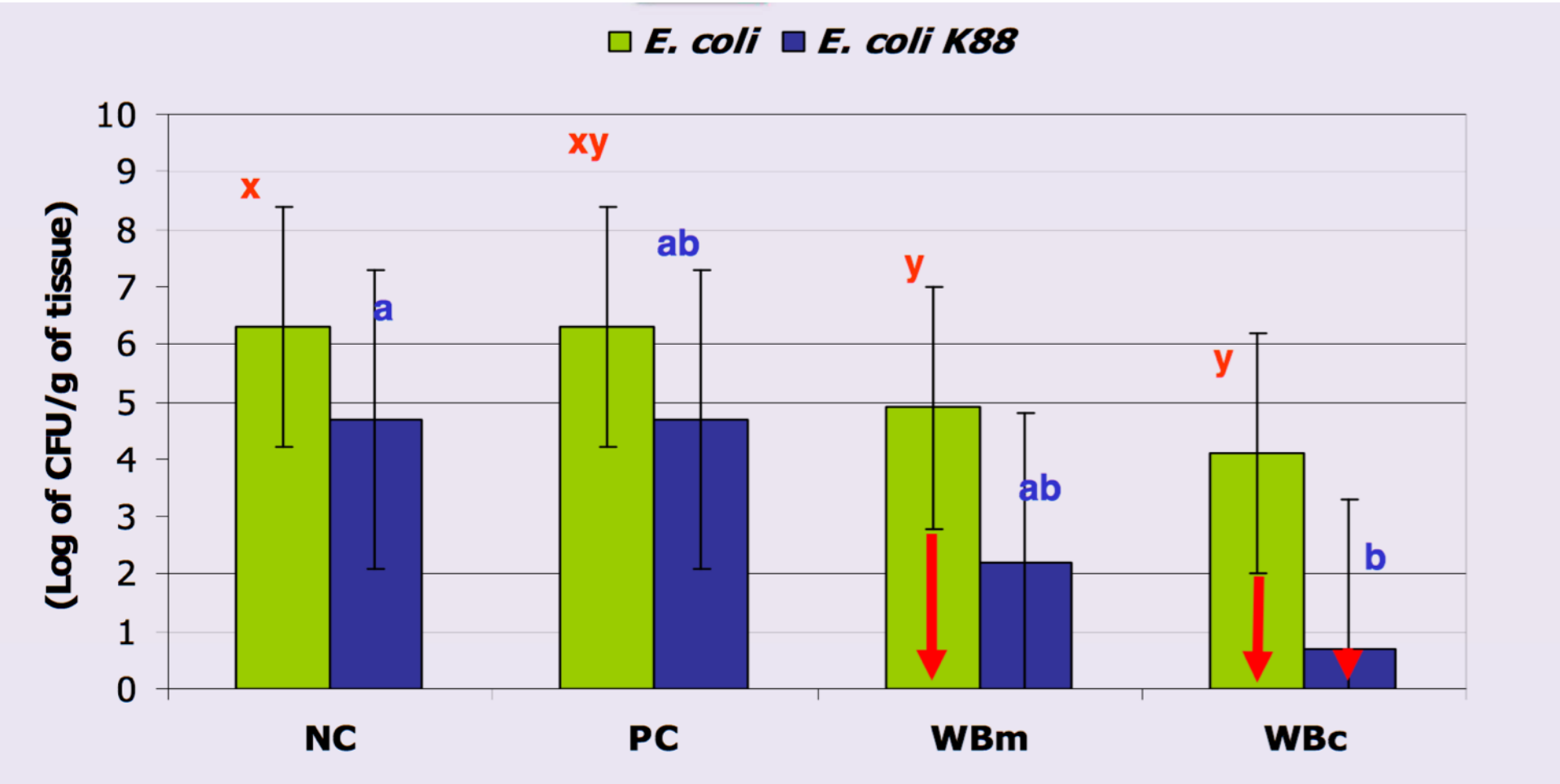
Treatment Group	n	No. of pigs (%) from which *E coli* strain M1823B was isolated[3]				
		Day 0 (prior to exposure)	Day 2	Day 4	Day 7	Day 11
Inoculated Pigs	20	0 (0)	18 (90)	19 (95)	20 (100)	20 (100)
Pen Sentinels	5	0 (0)	2 (40)	5 (100)	5 (100)	5 (100)
Direct Sentinels	25	0 (0)	0 (0)	12 (48)	17 (68)	20 (80)
Hand-wash Sentinels	25	0 (0)	0 (0)	0 (0)	13 (52)	23 (92)
Shower Sentinels	25	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Non-exposed Pigs (negative controls)	25	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

1 Inoculated Pigs were orally inoculated Days 0 and 2, and Pen Sentinels were housed with them except during inoculation procedures. On Days 1 through 10, Direct, Hand-wash, and Shower Sentinel groups (Table 1) were contacted according to the schedule in Table 2. When diarrhea was observed (except in Inoculated Pigs), affected pigs were immediately euthanized for cultural and histological examination. Pigs determined to be positive on a designated sample collection day or on the day of euthanasia were counted as positive for all subsequent sample collection periods.

2 Inoculated Pigs were individually offered 1.36 to 8.92 × 10^{10} colony forming units of *E coli* M1823B in liquid strawberry gelatin.

3 Strain M1823B was identified on the basis of antimicrobial sensitivity.

Dieta



Molist Gasa, et al. 2009. Effect of wheat bran on the health and performance of weaned pigs challenged with Escherichia coli K88+. Livestock Science 133(1):214-217. DOI:10.1016/j.livsci.2010.06.067

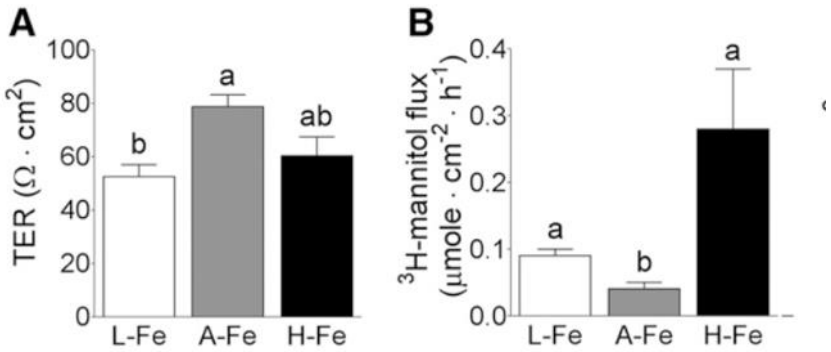
COSA SI PUÒ FARE PER PRESERVARE LA SALUTE DELL'INTESTINO?

Dalla nascita allo svezzamento

- Colostrare il suinetto correttamente.
- Non usare antibiotici a meno che non sia strettamente necessario.
  - Quando si usano meglio che siano di breve durata.
- Effettuare una corretta profilassi della coccidiosi e dell'anemia.
  - *La carenza di ferro e l'eccesso di ferro inducono infiammazione intestinale e aumentano la permeabilità intestinale* (*).

Intestinal permeability assessed as TER (A) 3H-mannitol permeability (B) in the duodenum of pigs fed diets for 32 d. :

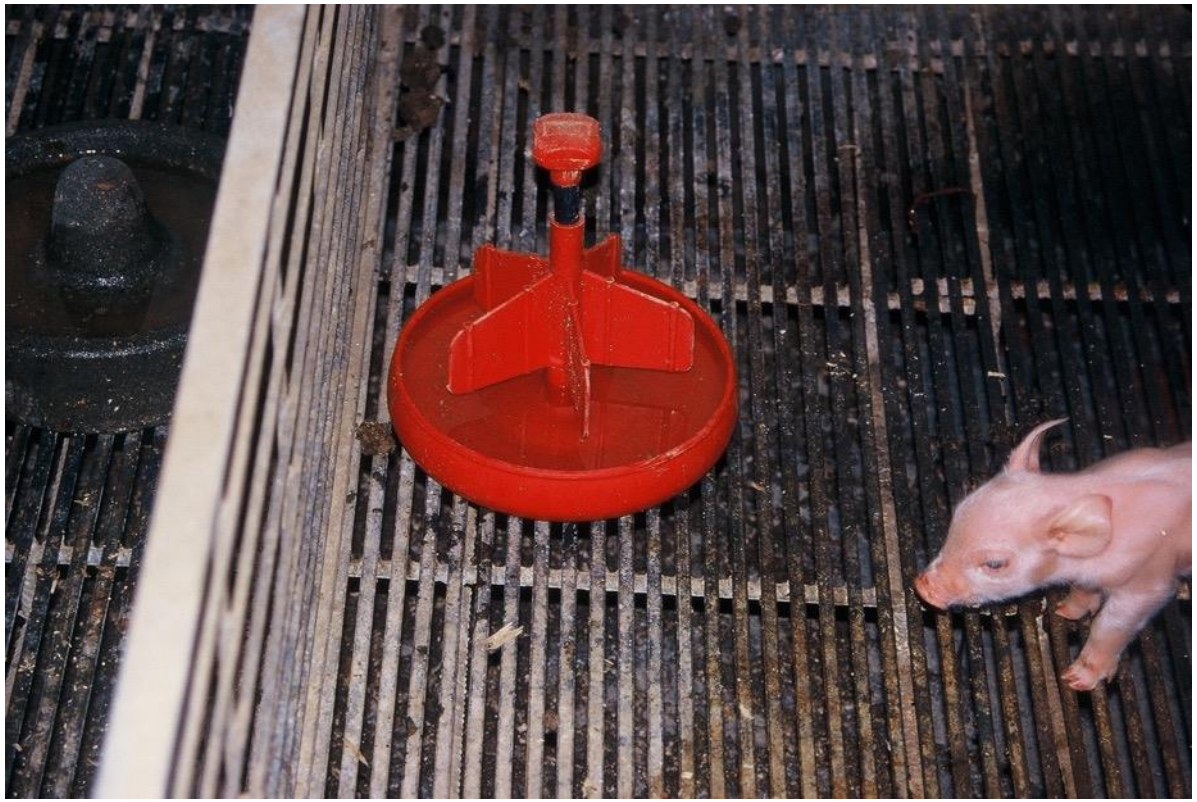
- L-Fe (20 mg Fe/kg DM)
- A-Fe (120 mg Fe/kg DM)
- H-Fe (520 mg Fe/kg DM)

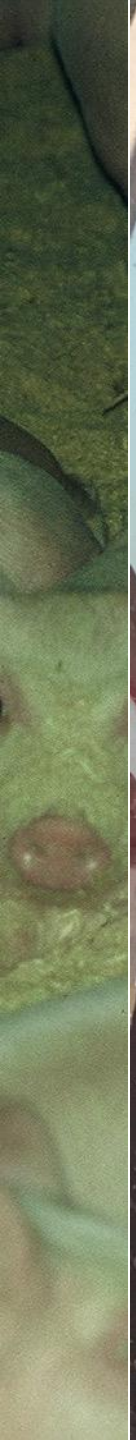


(*) Li, Y, *et al.* Dietary Iron Deficiency and Oversupplementation Increase Intestinal Permeability, Ion Transport, and Inflammation in Pigs1–3. J Nutr 2016;146:1499–505.

Dalla nascita allo svezzamento

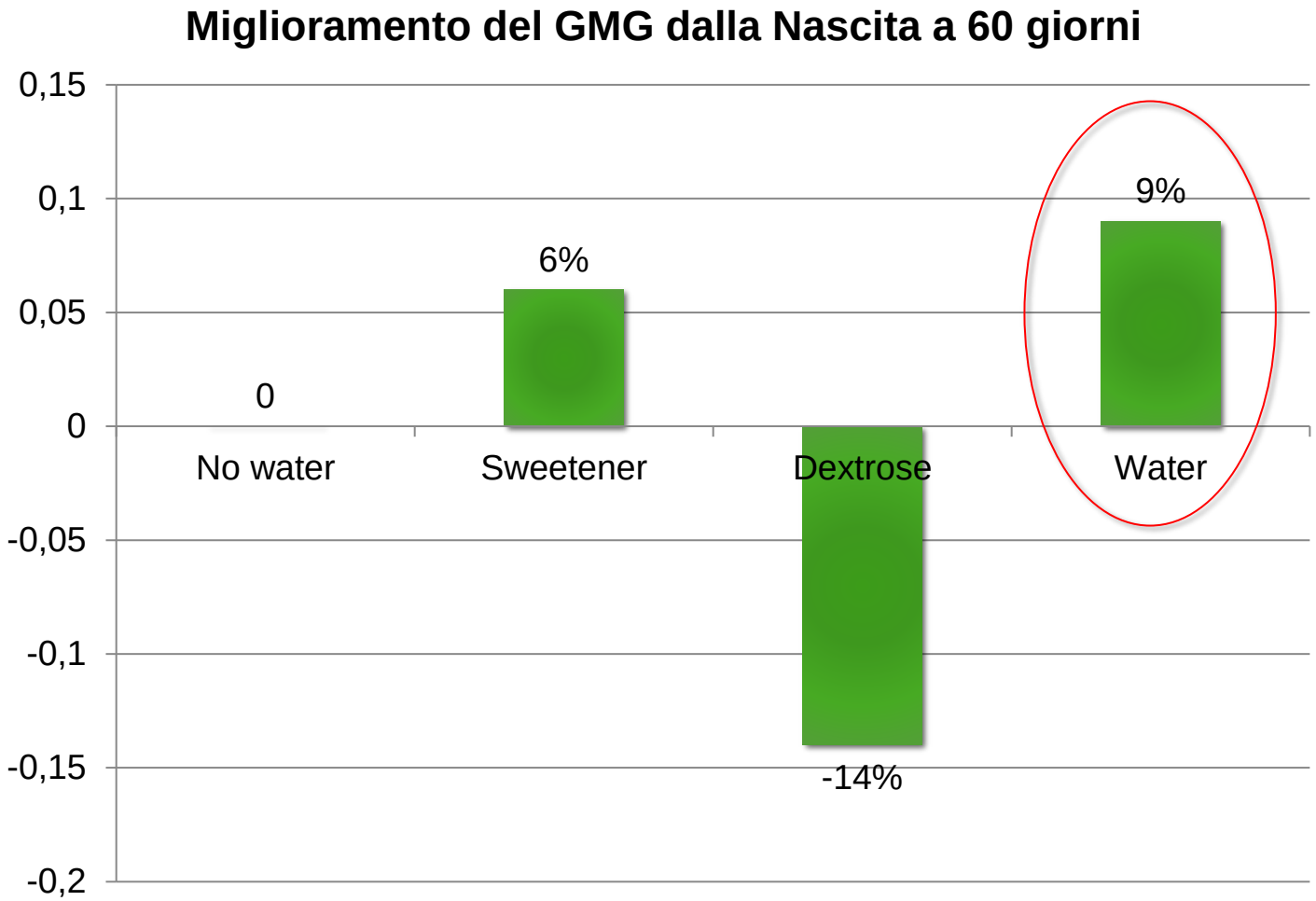
- Mettere a disposizione ai suinetto acqua e dieta solida il prima possibile.





Dalla nascita allo svezzamento

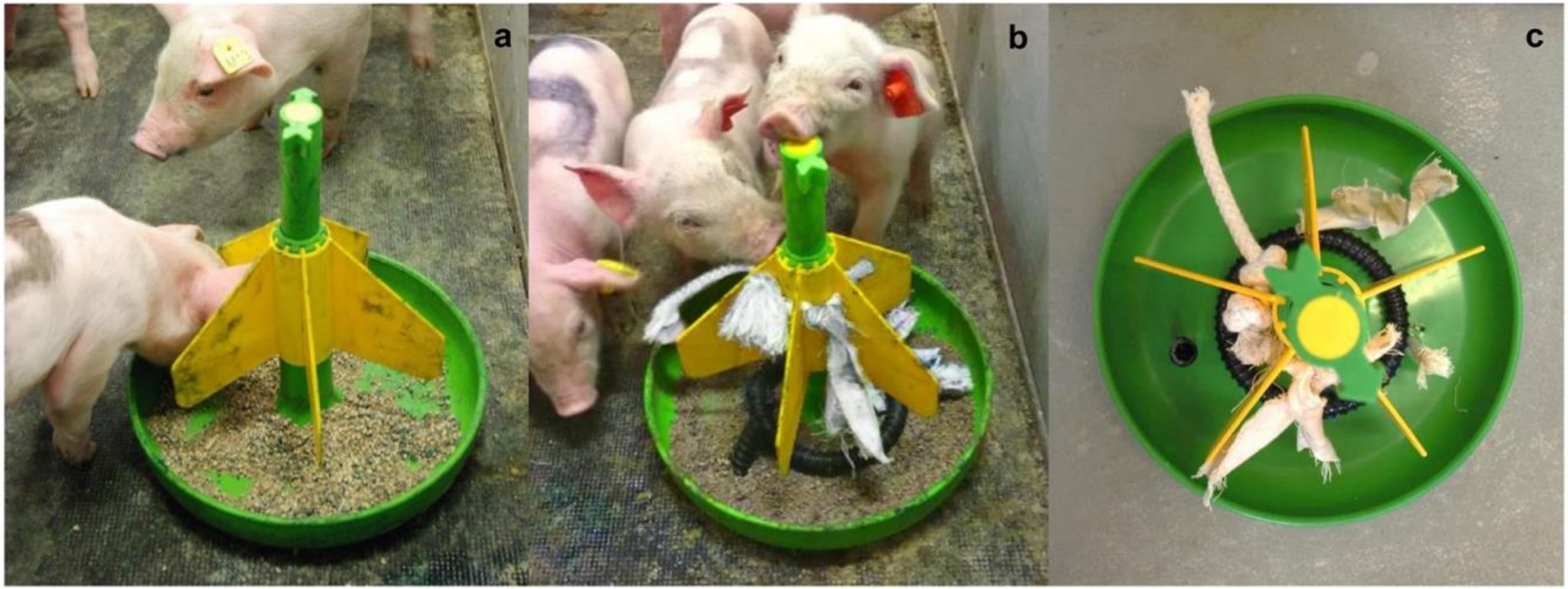
L'acqua extra li aiuta a mangiare



MA Juvero et al. 2017. "Nuevas estrategias de alimentación en maternidad para conseguir una mejor sanidad intestinal y un mayor crecimiento de los lechones en fase post-destete".

Dalla nascita allo svezzamento

Come stimolare l'assunzione di una dieta solida



Middelkoop, A. *et al. Feed intake of the sow and playful creep feeding of piglets influence piglet behaviour and performance before and after weaning.* Nature Research-Scientifics Reports, (2019) 9:16140.

Dalla nascita allo svezzamento

Vaccino bivalente (F4/F18) orale *E.coli*

Livestock Science 241 (2020) 104247

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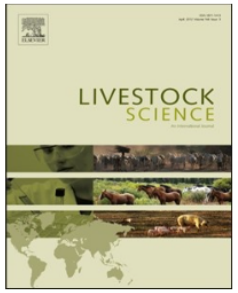

Effects of *E. coli* bivalent vaccine and of host genetic susceptibility to *E. coli* on the growth performance and faecal microbial profile of weaned pigs

Diana Luise, Elisa Spinelli, Federico Correa, Chiara Salvarani, Paolo Bosi, Paolo Trevisi*

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Dopo svezzamento

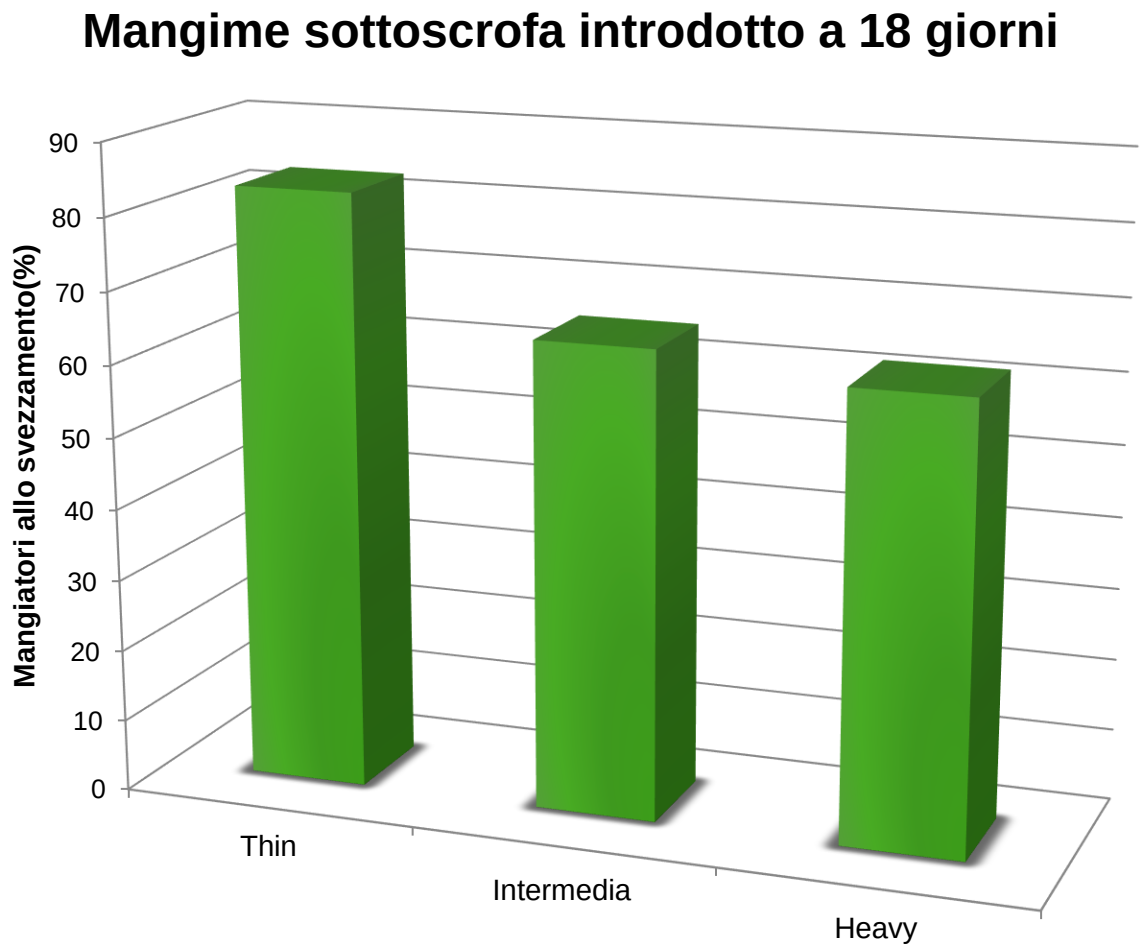
La prima settimana è la più importante

Aiutare a trovare acqua e mangime

Aiutare a trovare acqua e mangime

Dopo lo svezzamento

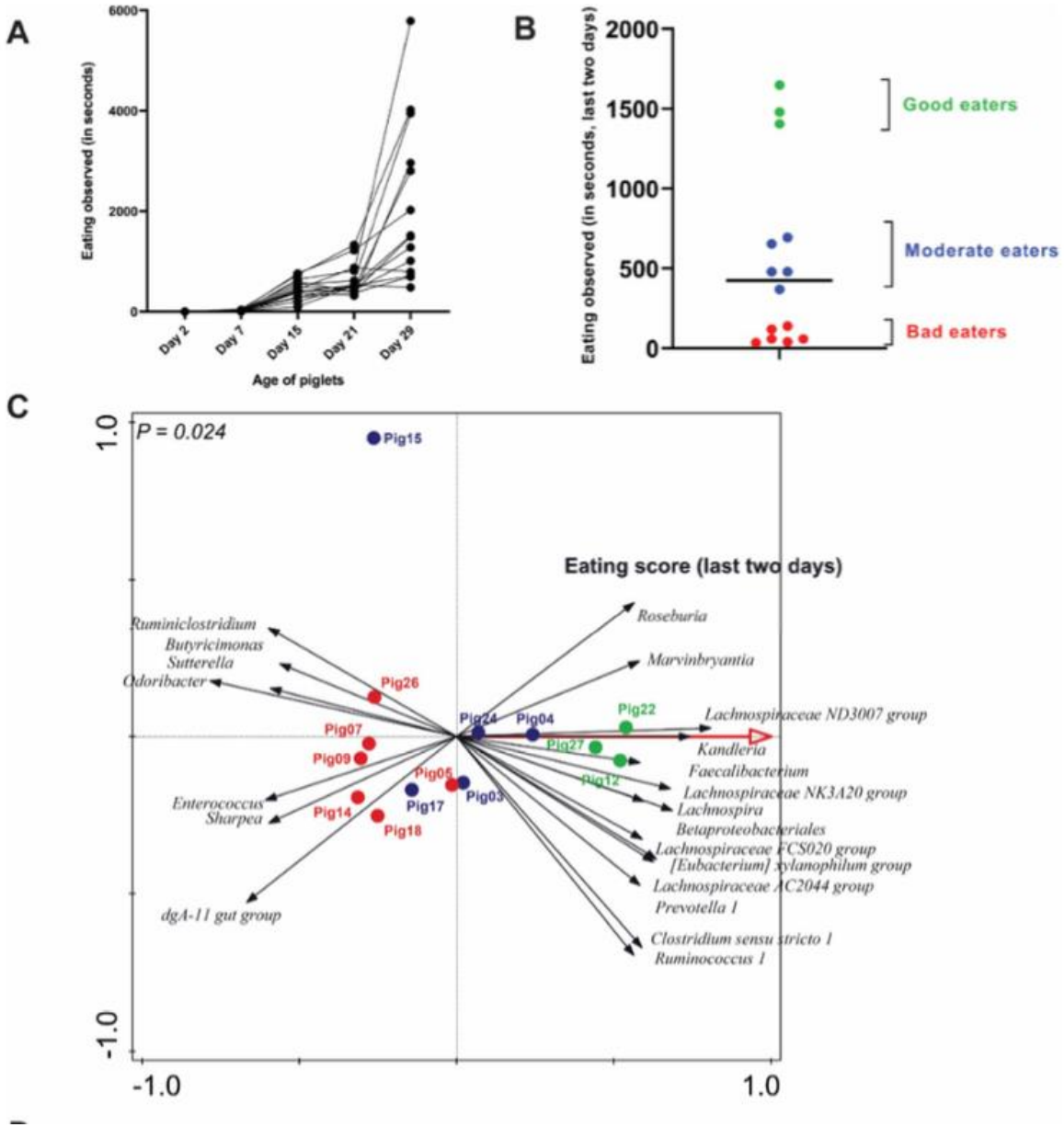
I suinetti affamati mangiano di più



Sulabo *et al.* 2009

Dopo lo svezzamento

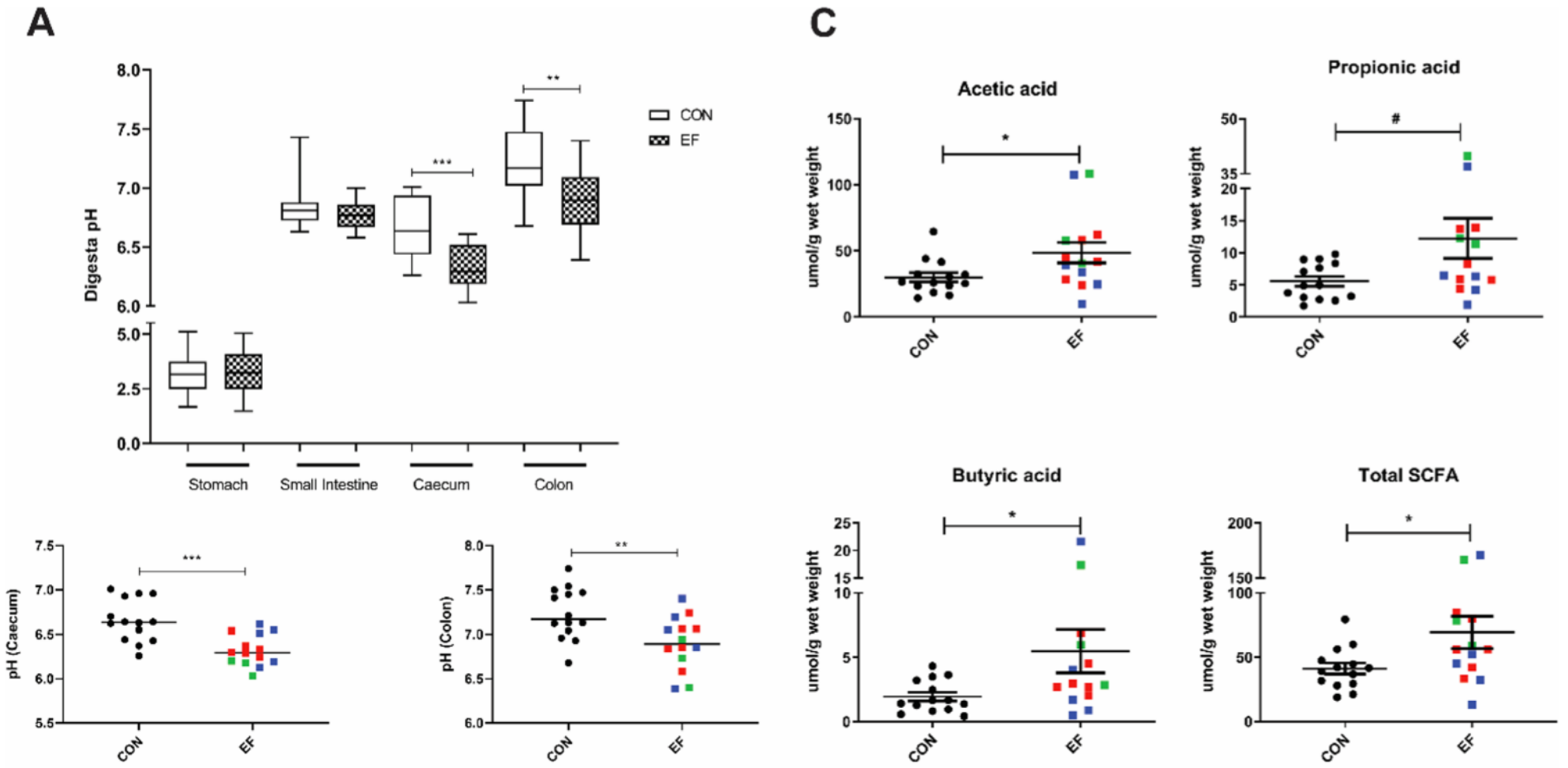
Più mangiano più è differenziato il microbiota



Choudhury, R. *et al.* Impact of early-life feeding on local intestinal microbiota and digestive system development in piglets. Scientific Reports (2021) 11:4213. https://doi.org/10.1038/s41598-021-83756-2

Dopo lo svezzamento

Più mangiano più è differenziato il microbiota



Choudhury, R. *et al.* Impact of early-life feeding on local intestinal microbiota and digestive system development in piglets. Scientific Reports (2021)11:4213. https://doi.org/10.1038/s41598-021-83756-2

Disinfezione

Table 7. Evaluation of the bacteriocidal activity of seven chemical disinfectants against *E.coli* (Abbotstown strain) and E.coli NCTC 10418 (Type strain) using British Standard Method BSEN 1656:2000 (phase 2 /step 1). Results are given as the lowest effective concentration of product giving at least 10^5 reduction in viable bacterial count under the stated test conditions.

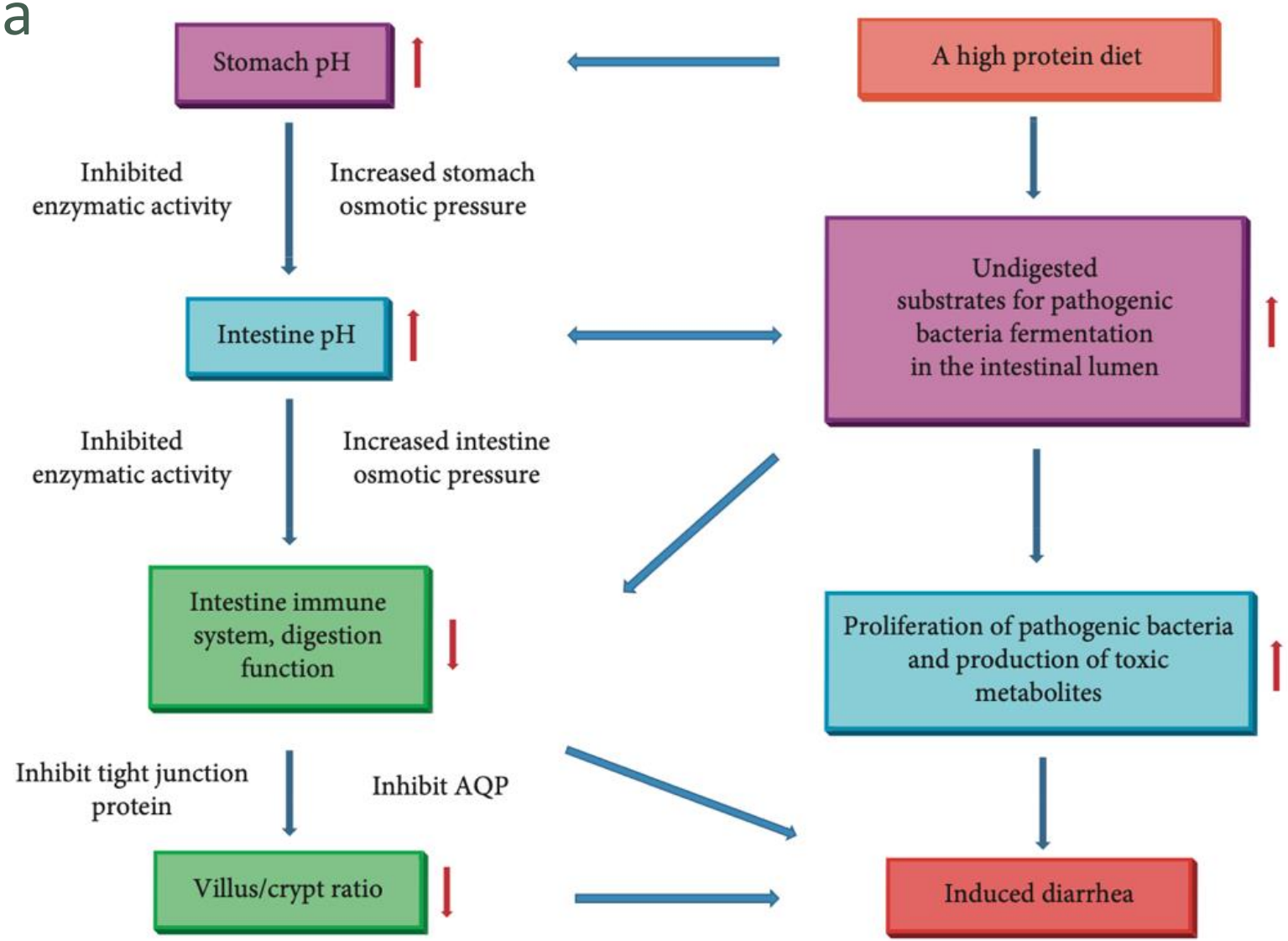
Bacteria	Disinfect ~	Test conditions											
		Low organic matter						High organic matter					
		4° C		10° C		20° C		4° C		10° C		20° C	
		30 min	60min	30 min	60min	30 min	60min	30 min	60min	30 min	60min	30 min	60min
EC (A)^	A	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100
	B	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100
	C	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100
	D	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100
	E	1/200	1/200	1/200	1/200	1/100	1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100
	F	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100
	G	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100
EC (T)*	A	1/400	1/400	1/400	1/400	1/400	1/400	1/100	1/100	1/100	1/100	1/100	1/100
	B	1/800	1/800	1/800	1/800	1/800	1/800	1/200	1/200	1/200	1/200	1/200	1/200
	C	1/1000	1/1000	1/1000	1/1000	1/1000	1/1000	1/200	1/200	1/200	1/200	1/200	1/200
	D	1/200	1/400	1/200	1/400	1/400	1/400	NE 1/100	NE 1/100	NE 1/100	NE 1/100	1/100	1/100
	E	1/400	1/800	1/800	1/800	1/1000	1/1000	1/400	1/400	1/400	1/400	1/400	1/400
	F	1/800	1/800	1/800	1/800	1/1000	1/1000	1/100	1/100	1/100	1/200	1/200	1/200
	G	NE 1/100	1/100	1/100	1/100	1/100	1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100	NE 1/100

^ *E.coli* (Abbotstown strain) - field isolate P5297/06. Isolated from porcine intestine (diarrhoea outbreak)
* *E.coli* NCTC 10418 (Type strain)
~ The key for the disinfectant compounds is given in Table 2
NE 1/100 = Not effective at the highest concentration tested (1/100)

Key	Active compound	Recommended dilution range
A	Iodine (acidic based)	1:125 – 1:600
B	Glutaraldehyde plus quaternary ammonium	1:50 – 1:190 (SVD 1:250)
C	Peracetic acid plus hydrogen peroxide	1:100 – 1:200
D	Iodine	1:200
E	Quaternary ammonium plus hydrogen peroxide	1:100 – 1:200
F	Quaternary ammonium	1:50 – 1:100
G	Peroxygen	1:100 – 1:200

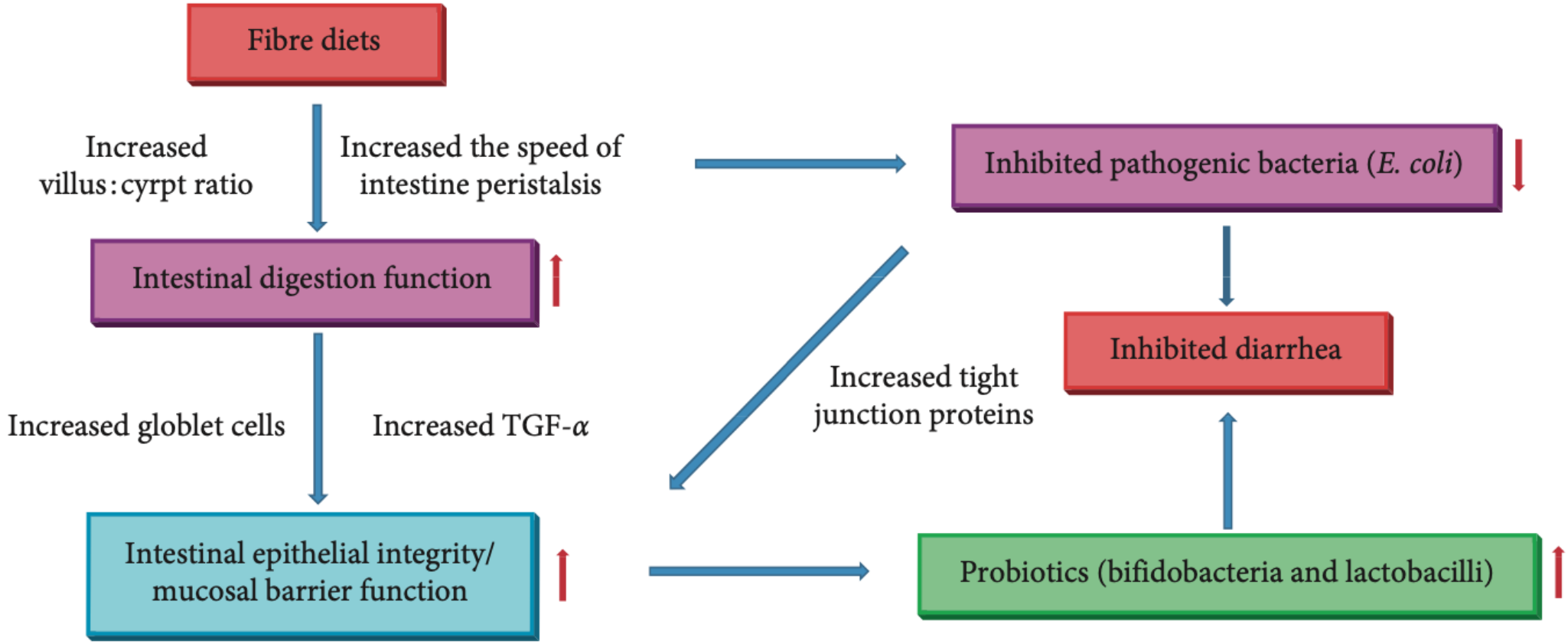
Jill R. Thomson, Nichola A. Bell, Meighan Rafferty. 2007. *Efficacy of some Disinfectant compounds against porcine bacterial pathogens.* Pig Journal, 40, 28-37. Source. . 2007.

Dieta: proteina



Jing Gao, *et al*. What Is the Impact of Diet on Nutritional Diarrhea Associated with Gut Microbiota in Weaning Piglets: A System Review. Biomed Res Int. 2019; 2019: 6916189.

Dieta: fibre



Jing Gao, *et al.* What Is the Impact of Diet on Nutritional Diarrhea Associated with Gut Microbiota in Weaning Piglets: A System Review. Biomed Res Int. 2019; 2019: 6916189.

Aiuti per la salute intestinale

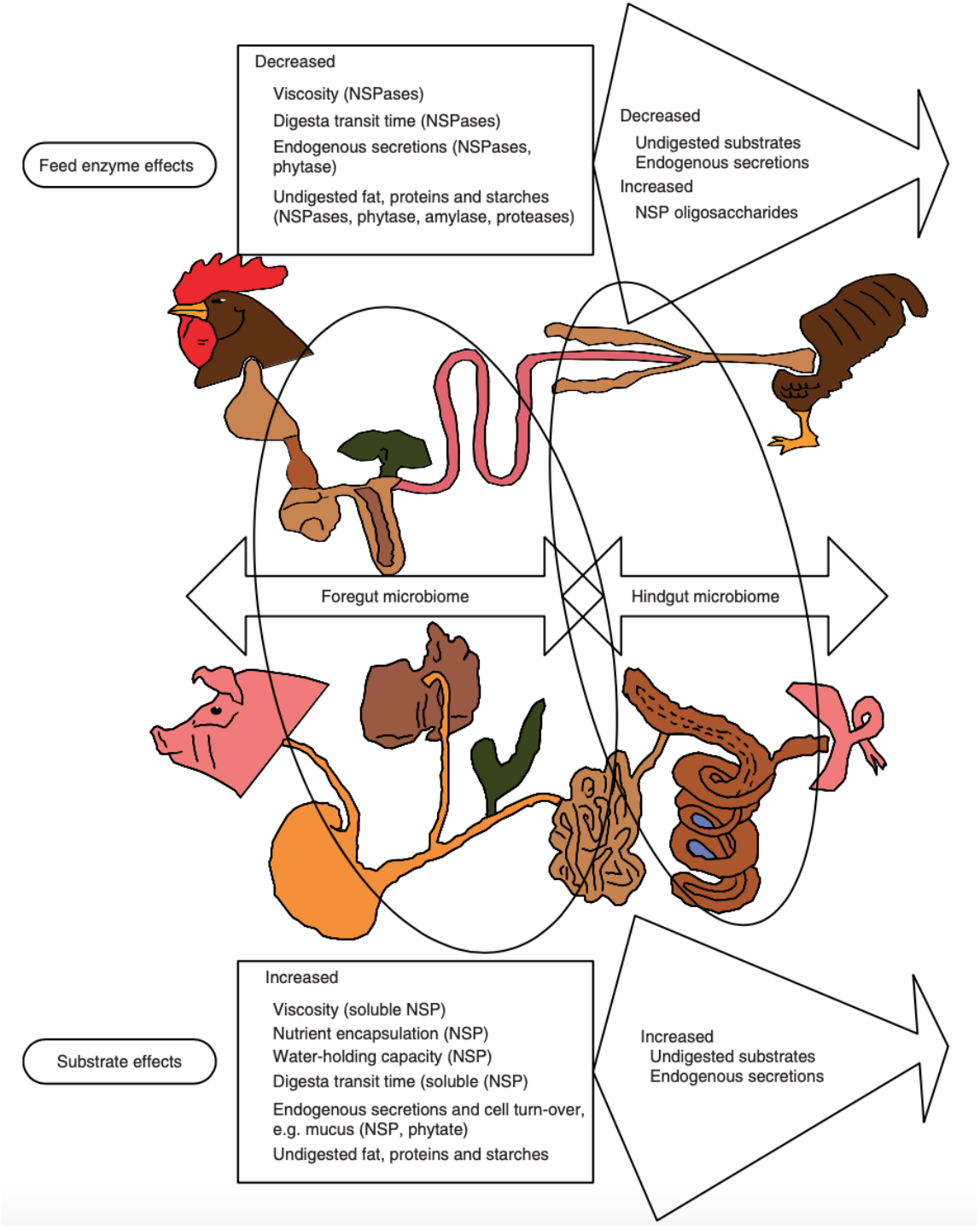
Pluske, J. Journal of Animal Science and Biotechnology 2013, 4:1

Alternative feed additives	Efficacy*	Potential for developement*
Antibiotics	+++++	0
Zinc Oxide	++++	0
Copper sulphate	+++	0
Organic acids	+	0
Enzymes	+++	+++
Pre-fermentation and inoculation	?	+
Probiotics	+	+
Fermentable substrates (Prebiotics)	++	+++
Lactose	++	0
Zeolites and clay minerals	?	0
Nutraceuticals (e.g. gingseng, oregano)	?	+
Soya isolates	+	+
Immunoglobulins	++	?
Epidermal growth factors	?	?
Colostrally drived growth factors	?	?
Husbandry/management techniques	**Efficacy**	**Potential for development**
All-in-all production	++++	++++
Hygiene	++++	+++
Later weaning	?	+
Outdoor production	+	0
Colostrum quality and intake	++	++
Immunisation	+++	++
Drinking water quality and provision	++	+++
Education - owner and stockperson	++++	+++++

* - Efficacy and development based on a subjective score 0 (zero) to ++++ (very high), or ? (unknown)

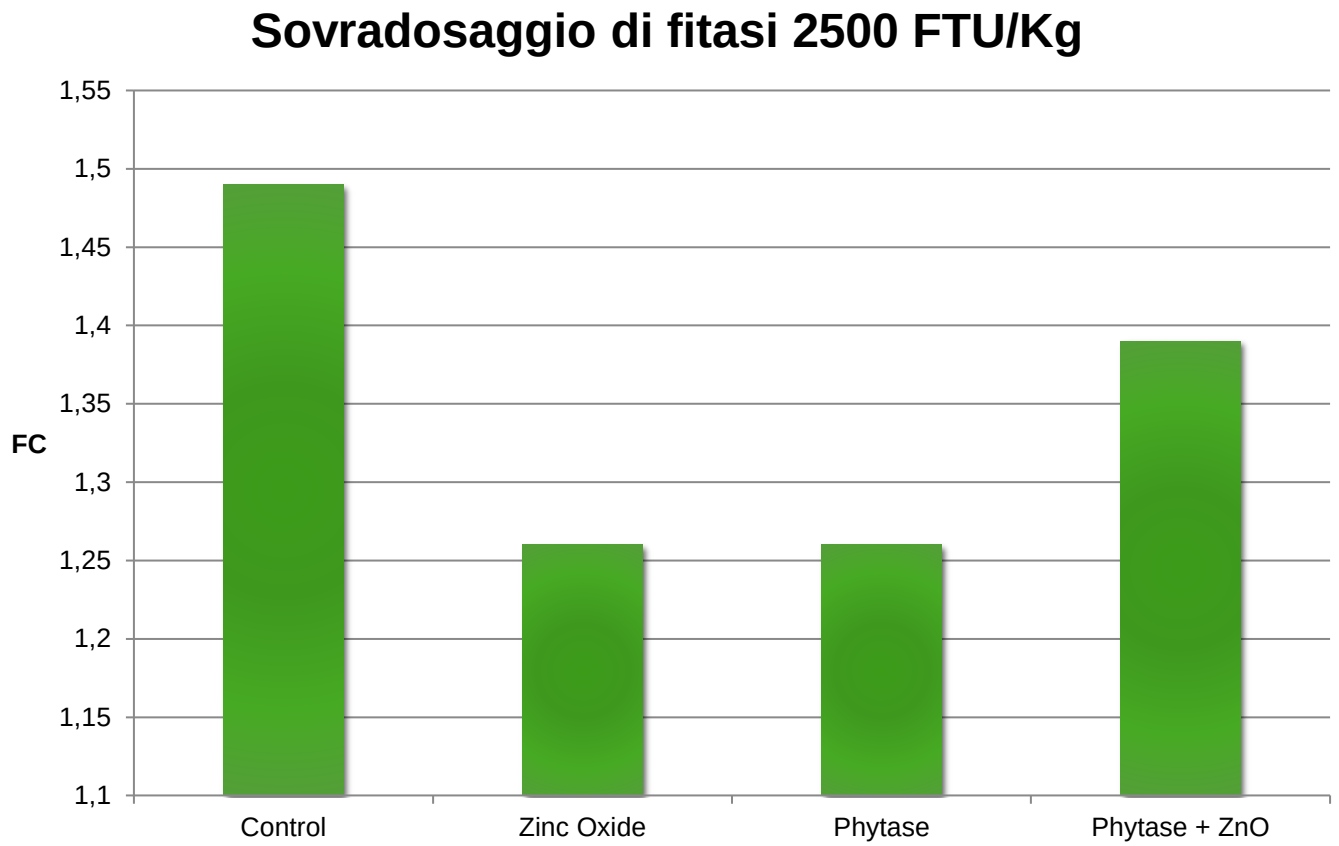
Enzimi

Kiarie, E. *ert al*. The role of added feed enzymes in promoting gut health in swine and poultry. Nutrition Research Reviews (2013), 26, 71–88. doi:10.1017/S0954422413000048



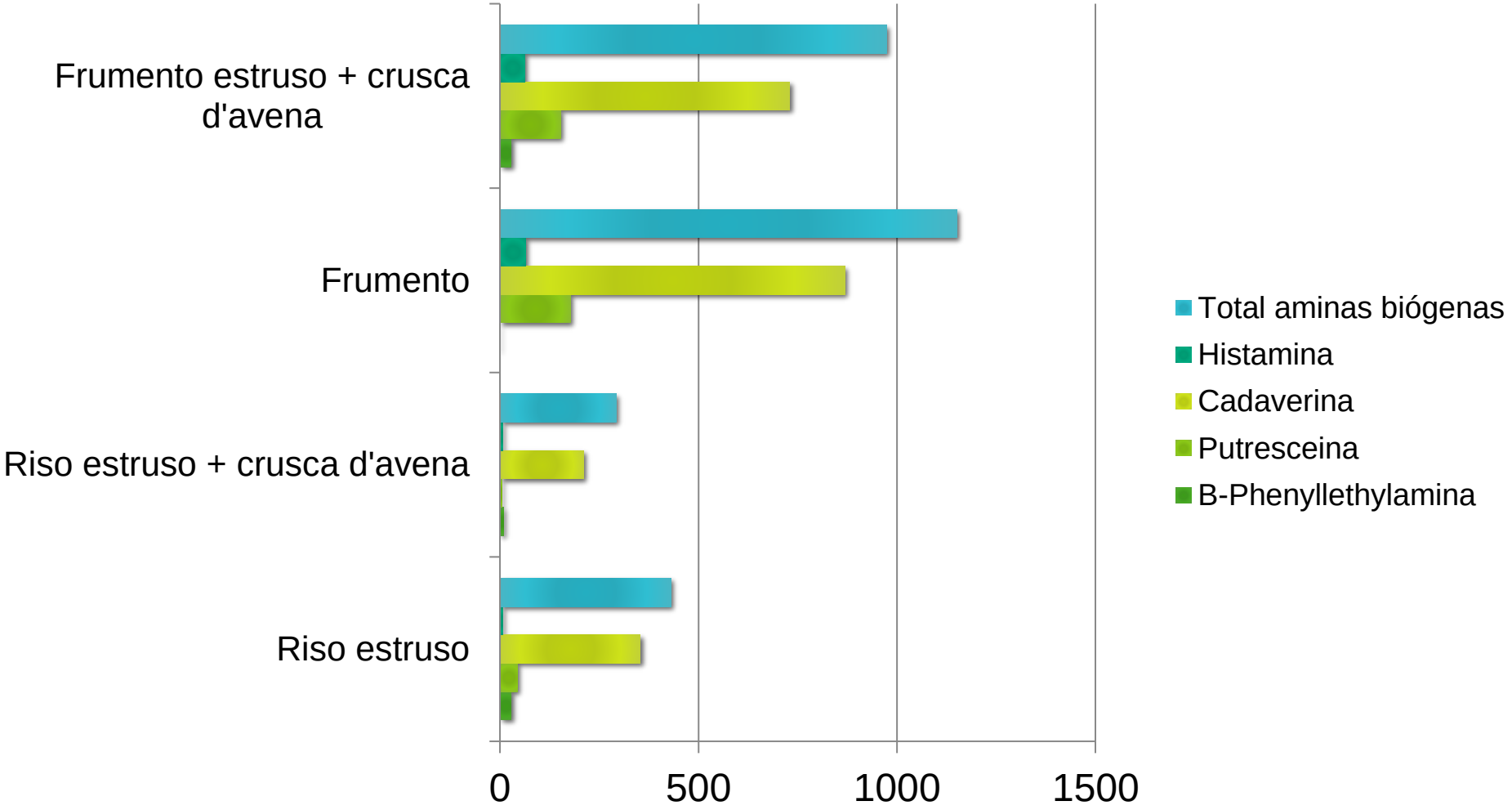
Enzimi

- Fitasi apporta fosforo e calcio per i maiale e per il microbiota



S C Mansbridge, et al. *The effects of dietary digestible phosphorous, phytase and zinc oxide on the growth performance of weaner pigs*. Conference Paper. April 2015 DOI: 10.1017/S2040470015000035

Digeribilità dell'amido



John Pluske and Professor David Hampson. Rice-based Diets in Pigs–*for protection against intestinal bacterial infections.* A report for the Rural Industries Research and Development Corporation . 200. RIRDC Publication No 05/143

Enzimi: xylanase, cellulases and mannanase

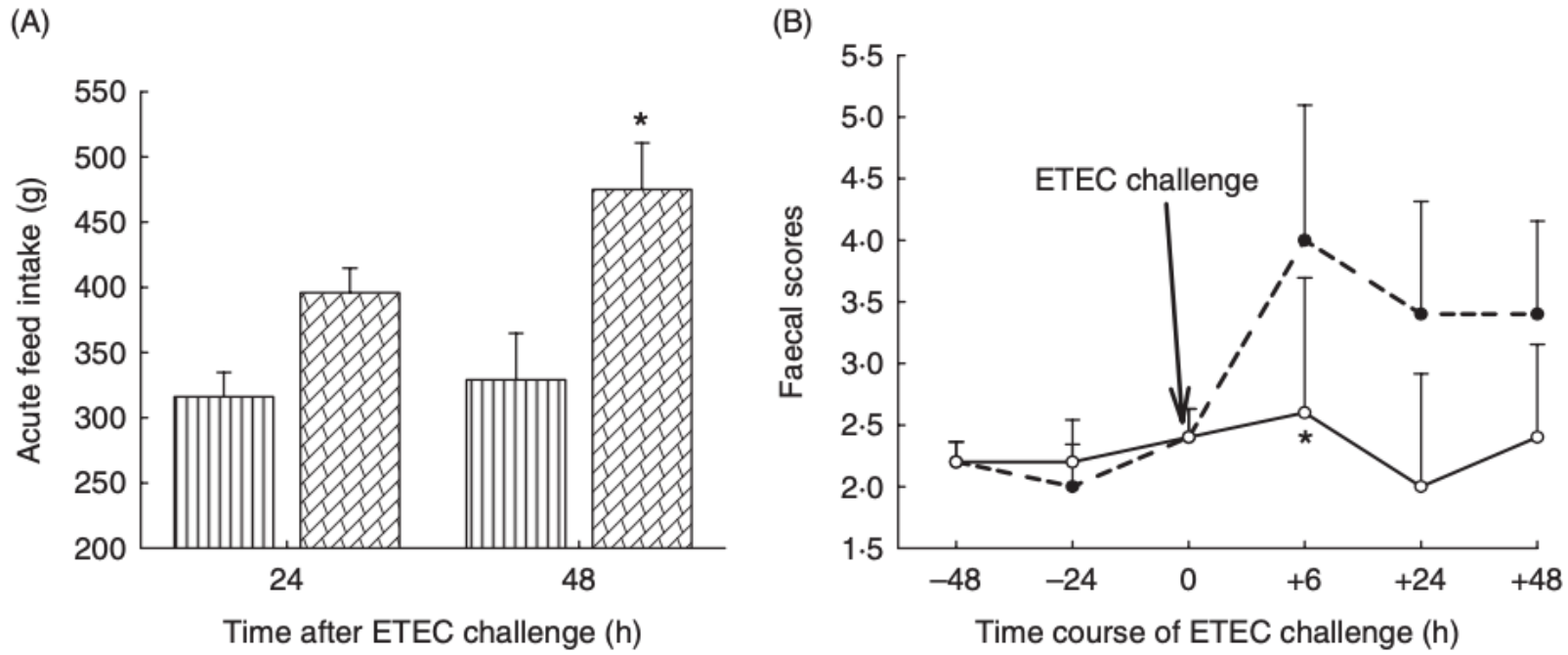


Fig. 3. Acute feed intake of piglets fed enzyme hydrolysis products (▨) or a control diet (▥) and challenged with enterotoxigenic *Escherichia coli* (ETEC) (A) and incidence and severity of diarrhoea (faecal scores) in piglets fed enzyme hydrolysis products (–○–) or a control diet (–●-) upon challenge with ETEC (B). Values are means, with standard errors represented by vertical bars. * Mean value was significantly different from that of the control ($P<0·05$). Adapted from Kiarie *et al.*[122,123].

Kiarie, E. *ert al*. The role of added feed enzymes in promoting gut health in swine and poultry. Nutrition Research Reviews (2013), 26, 71–88. doi:10.1017/S0954422413000048

Enzimi: proteasi

T L Mynott, R K JLuke, D S Chandler. *Oral administration of protease inhibits enterotoxigenic Escherichia coli receptor activity in piglet small intestine.* Gut 1996;38:28-32

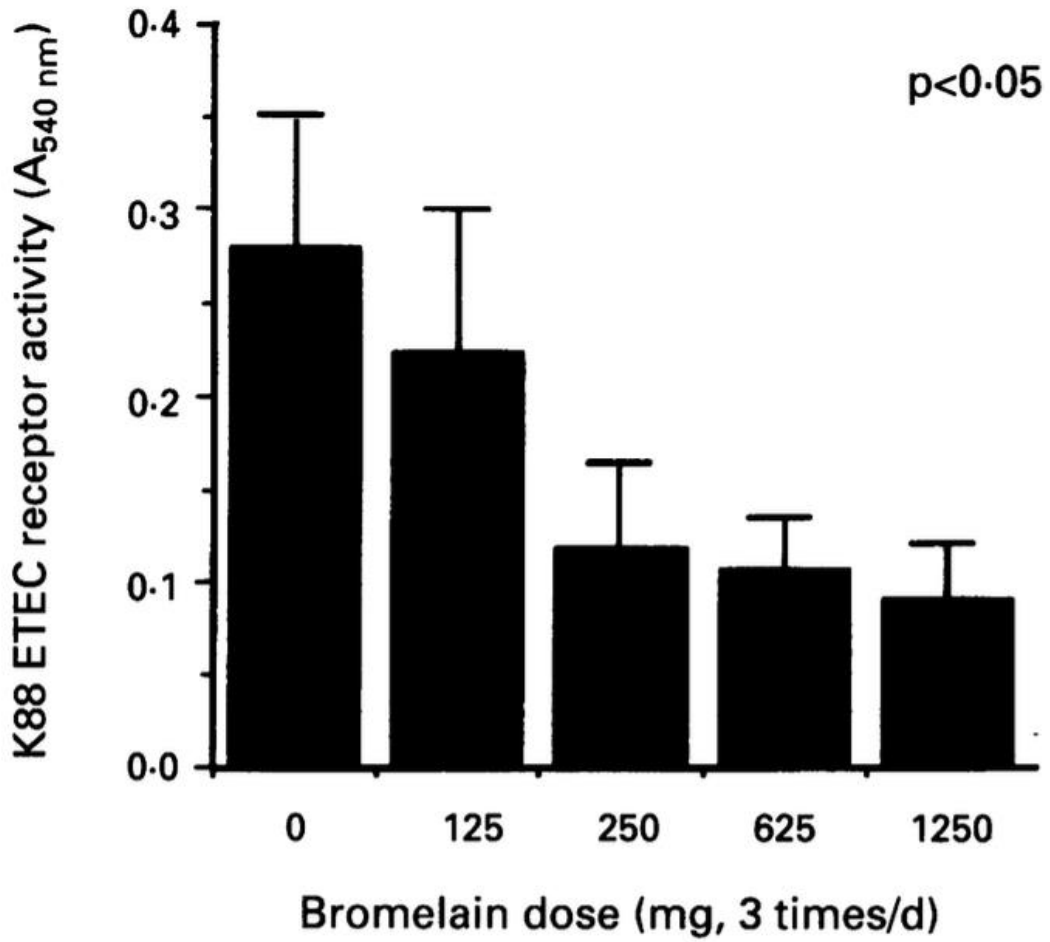


Figure 2: K88⁺ enterotoxigenic Escherichia coli *ETEC receptor activity of small intestine samples of pigs treated with bromelain or untreated. Columns with bars represent the mean (SEM) $A_{540\ nm}$ values of 19 samples taken from each pig (n=7 pigs per group). The reduction in enzyme immunoassay activity was significant (p<0·05).*

POSSIAMO MISURARE LA SALUTE INTESTINALE?

Come misurare la salute dell'intestino

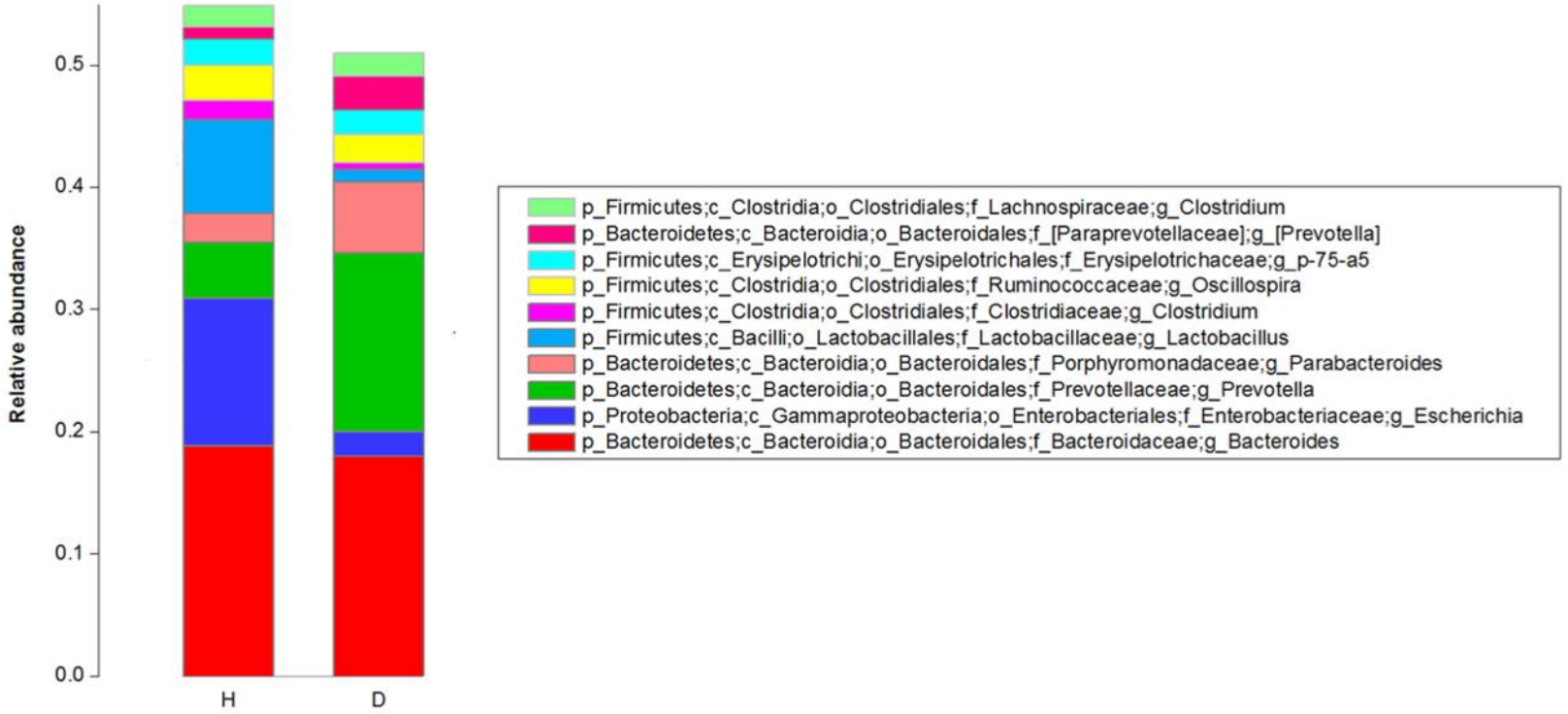
Bischoff, S.C. 2011. «“Gut health”: A new objective in medicine?» BMC Medicine 9-24.

Bischoff propone 5 criteri per misurare la salute intestinale:

- Digestione e assorbimento efficaci di nutrienti, acqua e minerali.
- Assenza di malattie nel tratto gastrointestinale, senza malattie dello stomaco. Alcuni esempi potrebbero essere ulcerazioni, intolleranze ai carboidrati o carenze enzimatiche.
- Flora microbica normale e stabile, senza crescita abnorme di alcune specie batteriche su altre e senza diarrea associata a infezioni o parassiti.
- Uno stato immunitario efficace, con un'efficace funzione della barriera gastrointestinale.
- Uno stato di benessere. Sebbene difficile da identificare negli animali da produzione, può essere misurato con livelli normali di serotonina e in assenza di marcatori di stress.

Microbiota

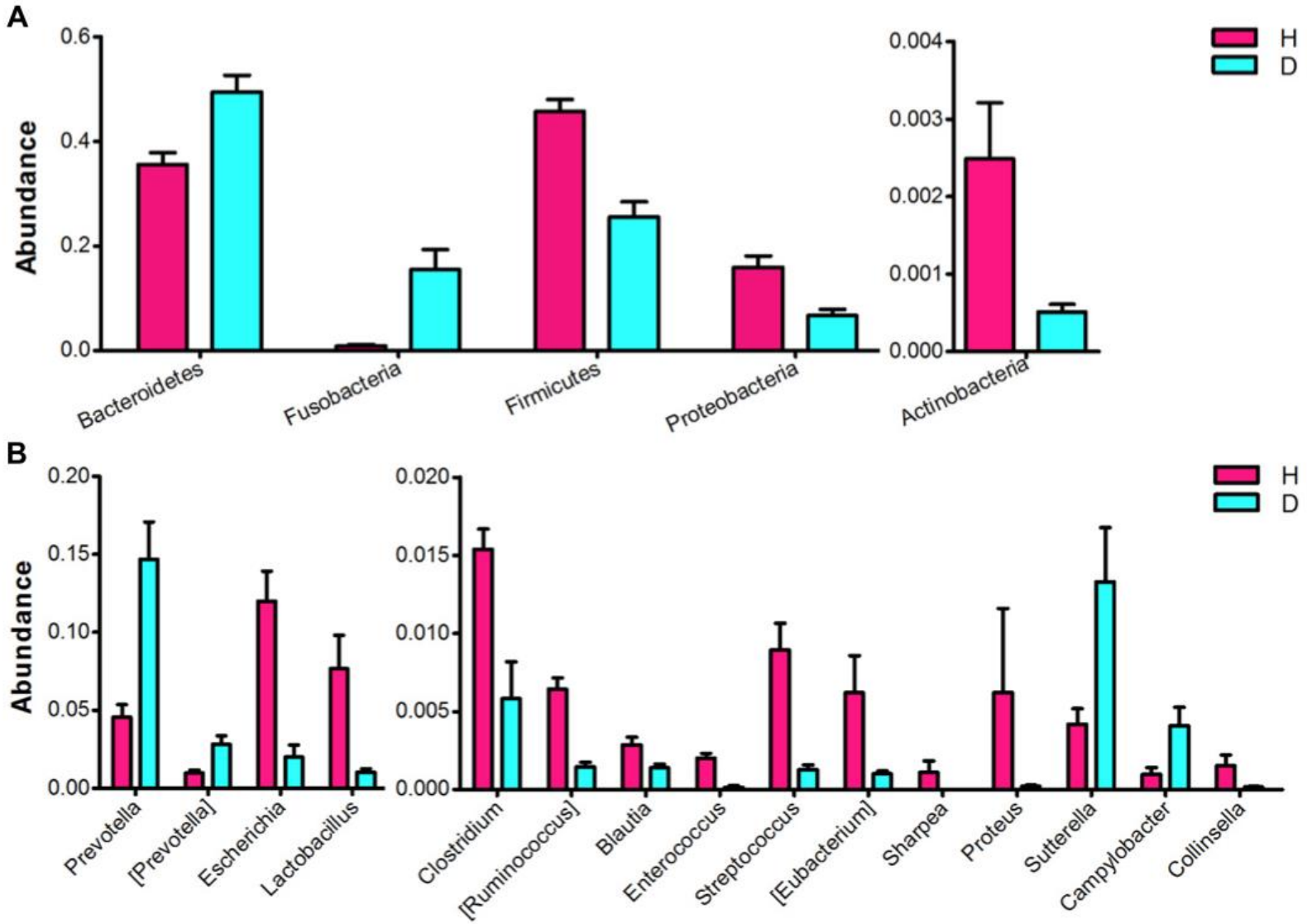
Taxonomic profiles of the fecal bacteria in diarrheic and healthy piglets from 16S rRNA gene sequencing. The relative abundance of the top 10 phylum (A) and the top 10 genus (B) of fecal bacteria present in both diarrheic and healthy piglets



Yang QL, *et al.* 2017. Structure and Function of the Fecal Microbiota in Diarrheic Neonatal Piglets. Front. Microbiol. 8:502. doi: 10.3389/fmicb.2017.00502

Microbiota

Comparison of the fecal microbial community of healthy and diarrheic neonatal piglets. The bacterial phyla **(A)** and genera **(B)** differed between the diarrheic and healthy piglets.



Yang QL, *et al.* 2017. Structure and Function of the Fecal Microbiota in Diarrheic Neonatal Piglets. Front. Microbiol. 8:502. doi: 10.3389/fmicb.2017.00502

Biomarcatori

- I biomarcatori o marcatori biologici sono sostanze che possono essere utilizzate come indicatori biologici.
  - Devono poter essere misurati oggettivamente
  - Devono poter essere indicatori di
    - un normale processo biologico,
    - di uno stato patologico o
    - come risposta ad un trattamento farmacologico.
- La quantità di mRNA che codifica un dato marcatore viene misurata come metodo di analisi dell'espressione genica.

Biomarcatori

- Indicatori dello stato delle giunzioni strette e quindi dell'integrità intestinale.
  - **Zonulina** e **Occludina**
- Indicatori dell'attivazione immunitaria e del processo infiammatorio
  - **Calprotectina**, **IFN-γ** e **TGF-β**

Ramis, G. *et al.* 2021. Validation of mRNA quantification of tight junction proteins and cytokines in fecal samples as intestinal integrity biomarkers in swine: a preliminary experience. 2021 AASV, Poster 77: 340-341

Conclusioni

- Preservare la salute dell'intestino è essenziale
- Per preservarla:
  - Buon management dal primo giorno di vita
  - Correte prevenzione dell'anemia e della coccidiosi
  - Introduzione precoce della dieta solida
  - Mangime di qualità
    - Utilizzando aiuti come: acidi organici, enzimi, ecc.
- Lo studio del microbiota e/o dei biomarcatori può essere di grande aiuto nel suo controllo

GRAZIE

EM-IT-21-0095 La bibliografia è disponibile, su richiesta, presso il relatore