

## Post Weaning Diarrhea in pigs

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### Anamnesis (mail from vet)

- Farm with 250 sows
- Farmer mixes the feed by himself
- Experimentation with new feed
- Acute post weaning diarrhea
- Increased mortality (~13 kg)



### Feed composition

- Grain based (wheat, barley, triticale, **corn/soy**)
- **Low in protein**
- High in vitamins
- **Probiotics (low)**

Year	Yearling	Km	TS-Growth	Meaningful m	Percent gain	MLI
			Q 90 kg	€ (100 = 1000)		
1	Longhorn, MP1_030717	MP1	067	63.60	0.97	1
2	Longhorn, MP2_030717	MP2	078	46.46	0.85	1
3	Longhorn, MP3_030717	MP3	078	50.25	0.90	1
4	Longhorn, VM_030817	VM	070	34.30	0.62	1

Nr.	Füllmittel	Preis € je m³	Mischungsanteile in % FM					W
			MP1	MP2	MP3	VM	MuS	
2118	Kiesstein	10,00	10,00					92 (M 20)
2441	Leichtgewicht Leichtgewicht 2017	16,00	30,00	20,00	40,00	10,00		92 (M 20)
2503	Wintergewicht Leichtgewicht 2017	14,00	10,00	10,00	10,00	70,00		92 (M 20) (pH 7)
2510	Leichtgewicht Leichtgewicht 2017	11,00	10,00	10,00	20,00	60,00		92 (M 20)
2139	Regelst	8,00	1,00	1,00	1,00	97,00		92 (M 20)
2442	Regenwasser P1 2018	33,00	3,00	14,00	14,00	70,00		92 (M 20)
2447	12,5 % PS 600 P10	10,00	1,00	1,00	1,00	97,00		92 (M 20)
2420	8 % PS 600 P10 2,5	100,00	3,00	6,00	91,00			92 (M 20)
2485	Regenwasser P1 Kern mit 10% P (GVO frei)	14,00	40,00	20,00				100 (pH 7) pH 7 (pH 7)

18. August 2017

Full

5-8g/1-12/12-23

↓ ↓

Werte der Elektrolyte bei Na<sup>+</sup> und K<sup>+</sup>

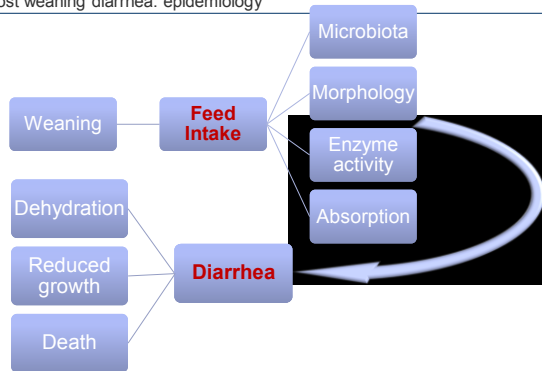
Na <sup>+</sup>	MPZ	MPZ 12	MPZ 12-23	MPZ
Na <sup>+</sup> (mmol/l)	136	136	136	136
K <sup>+</sup> (mmol/l)	4.0	4.0	4.0	4.0
Ca <sup>2+</sup> (mmol/l)	1.0	1.0	1.0	1.0
Mg <sup>2+</sup> (mmol/l)	0.8	0.8	0.8	0.8
Cl <sup>-</sup> (mmol/l)	102	102	102	102
HCO <sub>3</sub> <sup>-</sup> (mmol/l)	24	24	24	24
Urea (mmol/l)	5.0	5.0	5.0	5.0
Creatinine (mmol/l)	0.1	0.1	0.1	0.1
Glucose (mmol/l)	5.0	5.0	5.0	5.0
Lactate (mmol/l)	1.0	1.0	1.0	1.0
Ammonia (mmol/l)	0.1	0.1	0.1	0.1
Bilirubin (mmol/l)	0.1	0.1	0.1	0.1
Albumin (mmol/l)	3.5	3.5	3.5	3.5
Triglycerides (mmol/l)	0.5	0.5	0.5	0.5
Cholesterol (mmol/l)	2.0	2.0	2.0	2.0
Uric Acid (mmol/l)	0.4	0.4	0.4	0.4
Phosphate (mmol/l)	1.0	1.0	1.0	1.0
Iron (mmol/l)	0.1	0.1	0.1	0.1
Copper (mmol/l)	0.1	0.1	0.1	0.1
Zinc (mmol/l)	0.1	0.1	0.1	0.1
Selenium (mmol/l)	0.1	0.1	0.1	0.1
Manganese (mmol/l)	0.1	0.1	0.1	0.1
Cobalt (mmol/l)	0.1	0.1	0.1	0.1
Nickel (mmol/l)	0.1	0.1	0.1	0.1
Molybdenum (mmol/l)	0.1	0.1	0.1	0.1
Vanadium (mmol/l)	0.1	0.1	0.1	0.1
Chromium (mmol/l)	0.1	0.1	0.1	0.1
Silicon (mmol/l)	0.1	0.1	0.1	0.1
Boron (mmol/l)	0.1	0.1	0.1	0.1
Fluorine (mmol/l)	0.1	0.1	0.1	0.1
Iodine (mmol/l)	0.1	0.1	0.1	0.1
Sulfur (mmol/l)	0.1	0.1	0.1	0.1
Phosphorus (mmol/l)	0.1	0.1	0.1	0.1
Calcium (mmol/l)	0.1	0.1	0.1	0.1
Magnesium (mmol/l)	0.1	0.1	0.1	0.1
Potassium (mmol/l)	0.1	0.1	0.1	0.1
Sodium (mmol/l)	0.1	0.1	0.1	0.1
Chloride (mmol/l)	0.1	0.1	0.1	0.1
Bicarbonate (mmol/l)	0.1	0.1	0.1	0.1
Urea Nitrogen (mmol/l)	0.1	0.1	0.1	0.1
Creatinine (mmol/l)	0.1	0.1	0.1	0.1
Glucose (mmol/l)	0.1	0.1	0.1	0.1
Lactate (mmol/l)	0.1	0.1	0.1	0.1
Ammonia (mmol/l)	0.1	0.1	0.1	0.1
Bilirubin (mmol/l)	0.1	0.1	0.1	0.1
Albumin (mmol/l)	0.1	0.1	0.1	0.1
Triglycerides (mmol/l)	0.1	0.1	0.1	0.1
Cholesterol (mmol/l)	0.1	0.1	0.1	0.1
Uric Acid (mmol/l)	0.1	0.1	0.1	0.1
Phosphate (mmol/l)	0.1	0.1	0.1	0.1
Iron (mmol/l)	0.1	0.1	0.1	0.1
Copper (mmol/l)	0.1	0.1	0.1	0.1
Zinc (mmol/l)	0.1	0.1	0.1	0.1
Selenium (mmol/l)	0.1	0.1	0.1	0.1
Manganese (mmol/l)	0.1	0.1	0.1	0.1
Cobalt (mmol/l)	0.1	0.1	0.1	0.1
Nickel (mmol/l)	0.1	0.1	0.1	0.1
Molybdenum (mmol/l)	0.1	0.1	0.1	0.1
Vanadium (mmol/l)	0.1	0.1	0.1	0.1
Chromium (mmol/l)	0.1	0.1	0.1	0.1
Silicon (mmol/l)	0.1	0.1	0.1	0.1
Boron (mmol/l)	0.1	0.1	0.1	0.1
Fluorine (mmol/l)	0.1	0.1	0.1	0.1
Iodine (mmol/l)	0.1	0.1	0.1	0.1
Sulfur (mmol/l)	0.1	0.1	0.1	0.1
Phosphorus (mmol/l)	0.1	0.1	0.1	0.1
Calcium (mmol/l)	0.1	0.1	0.1	0.1
Magnesium (mmol/l)	0.1	0.1	0.1	0.1
Potassium (mmol/l)	0.1	0.1	0.1	0.1
Sodium (mmol/l)	0.1	0.1	0.1	0.1
Chloride (mmol/l)	0.1	0.1	0.1	0.1
Bicarbonate (mmol/l)	0.1	0.1	0.1	0.1
Urea Nitrogen (mmol/l)	0.1	0.1	0.1	0.1
Creatinine (mmol/l)	0.1	0.1	0.1	0.1
Glucose (mmol/l)	0.1	0.1	0.1	0.1
Lactate (mmol/l)	0.1	0.1	0.1	0.1
Ammonia (mmol/l)	0.1	0.1	0.1	0.1
Bilirubin (mmol/l)	0.1	0.1	0.1	0.1
Albumin (mmol/l)	0.1	0.1	0.1	0.1
Triglycerides (mmol/l)	0.1	0.1	0.1	0.1
Cholesterol (mmol/l)	0.1	0.1	0.1	0.1
Uric Acid (mmol/l)	0.1	0.1	0.1	0.1
Phosphate (mmol/l)	0.1	0.1	0.1	0.1
Iron (mmol/l)	0.1	0.1	0.1	0.1
Copper (mmol/l)	0.1	0.1	0.1	0.1
Zinc (mmol/l)	0.1	0.1	0.1	0.1
Selenium (mmol/l)	0.1	0.1	0.1	0.1
Manganese (mmol/l)	0.1	0.1	0.1	0.1
Cobalt (mmol/l)	0.1	0.1	0.1	0.1
Nickel (mmol/l)	0.1	0.1	0.1	0.1
Molybdenum (mmol/l)	0.1	0.1	0.1	0.1
Vanadium (mmol/l)	0.1	0.1	0.1	0.1
Chromium (mmol/l)	0.1	0.1	0.1	0.1
Silicon (mmol/l)	0.1	0.1	0.1	0.1
Boron (mmol/l)	0.1	0.1	0.1	0.1
Fluorine (mmol/l)	0.1	0.1	0.1	0.1
Iodine (mmol/l)	0.1	0.1	0.1	0.1
Sulfur (mmol/l)	0.1	0.1	0.1	0.1
Phosphorus (mmol/l)	0.1	0.1	0.1	0.1
Calcium (mmol/l)	0.1	0.1	0.1	0.1
Magnesium (mmol/l)	0.1	0.1	0.1	0.1
Potassium (mmol/l)	0.1	0.1	0.1	0.1
Sodium (mmol/l)	0.1	0.1	0.1	0.1
Chloride (mmol/l)	0.1	0.1	0.1	0.1
Bicarbonate (mmol/l)	0.1	0.1	0.1	0.1
Urea Nitrogen (mmol/l)	0.1	0.1	0.1	0.1
Creatinine (mmol/l)	0.1	0.1	0.1	0.1
Glucose (mmol/l)	0.1	0.1	0.1	0.1
Lactate (mmol/l)	0.1	0.1	0.1	0.1
Ammonia (mmol/l)	0.1	0.1	0.1	0.1
Bilirubin (mmol/l)	0.1	0.1	0.1	0.1
Albumin (mmol/l)	0.1	0.1	0.1	0.1
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Phosphate (mmol/l)	0.1	0.1	0.1	0.1
Iron (mmol/l)	0.1	0.1	0.1	0.1
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Albumin (mmol/l)	0.1	0.1	0.1	0.1
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Glucose (mmol/l)	0.1	0.1	0.1	0.1
Lactate (mmol/l)	0.1	0.1	0.1	0.1
Ammonia (mmol/l)	0.1	0.1	0.1	0.1
Bilirubin (mmol/l)	0.1	0.1	0.1	0.1
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Phosphate (mmol/l)	0.1	0.1	0.1	0.1
Iron (mmol/l)	0.1	0.1	0.1	0.1
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Sulfur (mmol/l)	0.1	0.1	0.1	0.1
Phosphorus (mmol/l)	0.1	0.1	0.1	0.1
Calcium (mmol/l)	0.1	0.1	0.1	0.1
Magnesium (mmol/l)	0.1	0.1	0.1	0.1
Potassium (mmol/l)	0.1	0.1	0.1	0.1
Sodium (mmol/l)	0.1	0.1	0.1	0.1
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Bicarbonate (mmol/l)	0.1	0.1	0.1	0.1
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Glucose (mmol/l)	0.1	0.1	0.1	0.1
Lactate (mmol/l)	0.1	0.1	0.1	0.1
Ammonia (mmol/l)	0.1	0.1	0.1	0.1
Bilirubin (mmol/l)	0.1	0.1	0.1	0.1
Albumin (mmol/l)	0.1	0.1	0.1	0.1
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Cholesterol (mmol/l)	0.1	0.1	0.1	0.1
Uric Acid (mmol/l)	0.1	0.1	0.1	0.1
Phosphate (mmol/l)	0.1	0.1	0.1	0.1
Iron (mmol/l)	0.1	0.1	0.1	0.1
Copper (mmol/l)	0.1	0.1	0.1	0.1
Zinc (mmol/l)	0.1	0.1	0.1	0.1
Selenium (mmol/l)	0.1	0.1	0.1	0.1
Manganese (mmol/l)	0.1	0.1	0.1	0.1
Cobalt (mmol/l)	0.1	0.1	0.1	

## PWD prophylaxis

- Clex met 12 drink:
  - Betain, Vitamin B12, minerals, methionine, propionic acid, citric acid, orthophosphoric acid and formic acid
- Post weaning: Colistin + zinc (Enteroxid), zinc (Tan-o-line)

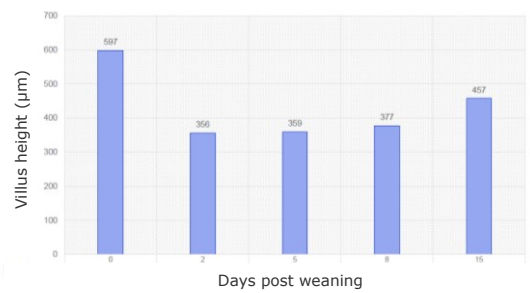
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## Post weaning diarrhea: epidemiology



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## Villus length post weaning



Montagne et al. (2007)

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Necropsy findings (13 kg)

- Oedema of nasal bridge
- Leptomeningitis
- Hyperemic mesenterial vessels
- Hyperplasia of mesenterial lymphatic nodes
  - *E. coli* O139:K82 (+++)
- Small intestines with mucosa
  - *E. coli* O139:K82 (+++)

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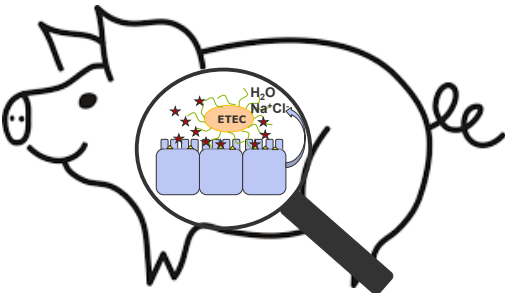
Post weaning diarrhea: pathogenesis

- *Escherichia coli*: ETEC
  - Virulence factors
    - Adhesins (F4, F18)
    - Enterotoxins (fluidity, water absorption)
  - Often resistant to wide range of antibiotics
  - $10^9 - 10^{10}$  cfu cause clinical symptoms
  - Protective immunoglobulins in colostrum and milk

Fimbrial adhesins	Serovariotypes
F4	O149:LT-STx:EASt-1
	O149:LT-STx:EASt-1
	O149:LT-STx
F18	O149:LT-STx:EASt-1
	O118:STx:STx
	O118:LT-STx:EASt-1:Stx2e
	O139:Stx2e(AIDA)
	O147:STx:STx-AIDA

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Post weaning diarrhea: pathogenesis



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Prophylaxis and therapy

• Antimicrobials

- Enrofloxacin, **apramycin**, cefitofur, **neomycin**,  
**gentamicin**, amoxicillin/clavulanic acid,  
**trimethoprim/sulfonamide**, **colistin**

27 July 2016  
EMA/CVMP/CHMP/231573/2016  
Committee for Medicinal Products for Veterinary Use (CVMP)  
Committee for Medicinal Products for Human Use (CHMP)

antibiotic resistance common

Updated advice on the use of **colistin** products in animals  
within the European Union: development of resistance  
and possible impact on human and animal health

Colistin, fluoroquinolones and 3rd- and 4th-generation cephalosporins should be reserved for those  
occasions when there are no effective alternative antimicrobials authorised for the respective target  
species and indication.

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Prophylaxis and therapy: nutrition

• Minerals

- Zinc (2400-3000 ppm)
  - epithelial barrier
  - Reduced cell damages by ETEC
  - Inflammatory cytokines
- Copper
  - Oxidative damage to bacteria

• Acidifier

- Solid feed increases stomach pH
- Organic acids

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Prophylaxis and therapy: nutrition

• Probiotics/Direct Fed Microbials (DFM)

- *Streptococcus*, *Bifidobacterium*, *Bacillus*, *Lactobacillus*,  
*Enterococcus*, yeast
- Strain dependent
- Multi strains, multi species

• Prebiotics

- Oligosaccharides, lactulose, inulin

• Phytobiotics

- Plant extracts and essential oils
- *Macleaya cordata*, garlic (allicin), clove, cinnamon,  
fenugreek, thyme, oregano, sanguinarine, Mexican  
pepper, *Acatia nilotica*, *Syzygium aromaticum*,  
Cinammon zeylanicum, mint, rosemary, *Macrocephala...*

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Prophylaxis and therapy

- Feed enzymes
- Clay minerals
- Milk products
- Antimicrobial peptides
- Nucleotides
  - Regulatory, structural and metabolic function
  - Immune system
  - Re-dox balance

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Prophylaxis and therapy

- Vaccines
  - i.m., F4
  - p.o., live attenuated/wild type
  - p.o., purified fimbriae
- Blood plasma
  - Antibodies
- Egg yolk antibodies
  - Laying hens immunized with fimbrial antigens
  - Before infection
- Bacteriophages
  - PP01, cocktail

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Recommendations: nutrition

- Water with glucose and electrolytes
- Creep feeding from 2 weeks of age, no feed restriction
- Consider to use corn instead of soy
- Consider to use dairy products in starter feed
- Weaning at 28 days or later
- Consequent application of organic acids
- Blood plasma
- Pre- and probiotics
- Consider lower zinc levels

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Further recommendations

- Susceptibility test *E. coli* isolates
- Adjustment of antibiotic treatment if necessary
- Vaccination
- Optimize rearing conditions

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Thank you



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References

Articles

1. Heo, J.M., Opapeju, F.O., Pluske, J.R., Kim, J.C., Hampson, D.J., Nycholi, C.M., 2013. Gastrointestinal health and function in weaned pigs: a review of feeding strategies to control post-weaning diarrhoea without using in-feed antimicrobial compounds. *J Anim Physiol Anim Nutr (Berl)* 97, 207-237.
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Post weaning diarrhea: predisposers

Stress	Creep feeding yes/no	Hygiene
<ul style="list-style-type: none"><li>• Nutritional</li><li>• Psychological</li><li>• Environmental</li><li>• Immune system</li><li>• Feed intake</li></ul>	<ul style="list-style-type: none"><li>• &lt; 2 weeks of age</li><li>• Frequent &amp; fresh</li><li>• Feeder space</li><li>• Feed additives</li><li>• Feed intake</li><li>• Adaptation</li></ul>	<ul style="list-style-type: none"><li>• Growth</li><li>• Immune response</li><li>• Inflammatory response</li><li>• Amino acid requirement</li><li>• Feed intake</li></ul>