Can feeding of prefermented rape seed and seaweed to weaners substitute medicinal zinc?

Without compromising piglet health and growth performance (pilot study)

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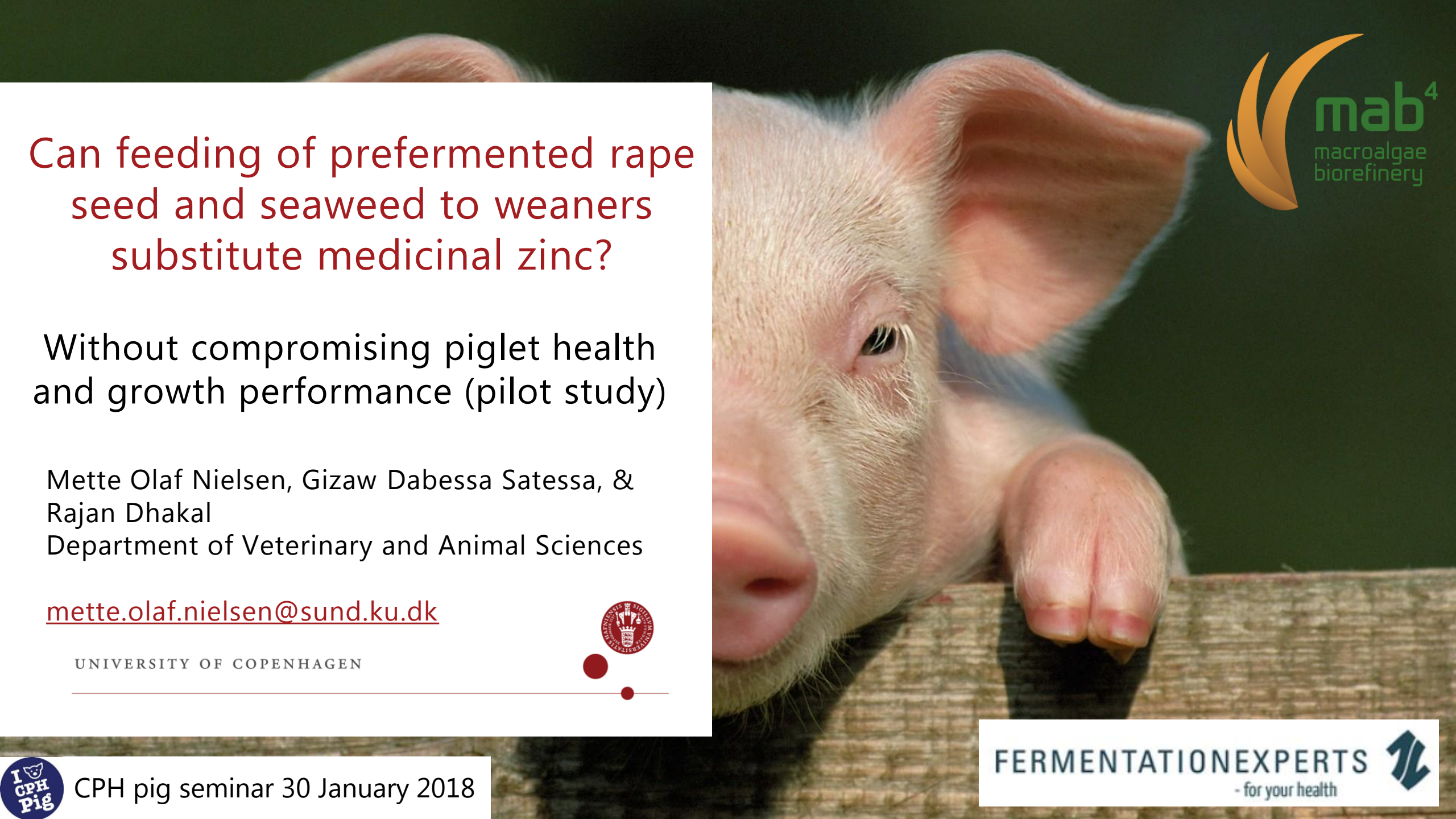

mab4 macroalgae biorefinery

FERMENTATIONEXPERTS - for your health

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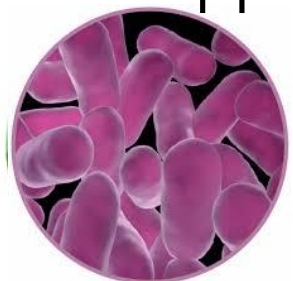
Background

- Use of medicinal zinc oxide in piglet diets must be phased out by 2020
- Creates a need to find alternative and effective strategies to promote gut health of weaner piglets in the future
- Lactic acid producing bacteria are used as probiotic supplements to promote gut health
  - Results not always convincing
  - It has been proposed that additional gut health benefits for weaner piglets may be achieved if lactic acid bacteria are used to preferment certain feeds
- Macroalgae, particularly brown algae species, contain different bioactive compounds, of which some appear to possess antimicrobial properties


Hypotheses of this pilot study:

- Inclusion of **lactobacillus prefermented rape seed cake** in piglet diets from 10 days before weaning until 91 days after weaning (33 kg liveweight):
  - Can substitute 2500 ppm zinc in diarrhea prevention
  - Without negative impact on feed intake and growth rate of pigs neither by 91 days of age (exit from weaner unit; appr. 33 kg) *nor when slaughtered*

- The preventive effect on diarrhea is more pronounced if the supplement in addition to prefermented rape seed cake also contains certain **brown macroalgae species**

Design of the pilot experiment:

- Conducted at private, commercial farm in Poland (120 km from Lublin)
  - 1350 sows (LY Danbred C22 line)
  - 33.5 weaned piglets ((LY)x(DP)) per sow annually (weaning: 28 days)
  - 440g/d average daily gain in weaner unit (exit weight: ~33 kg)
- Feeding trial with 9 different dietary treatment groups (TG; mash feed)
  - Litters standardized to 14 piglets per sow; fixed from day 14 post-partum
  - Differential feeding - start: 10 days before weaning (25.09.2017)
    - end: at exit from weaner unit (at 91 days of age)
  - Will be followed until slaughter (fixed date mid-March ~ 115 kg)
- No systemic or individual antibiotics treatment of experimental pigs
  - Piglets needing treatment (condition deteriorated): eliminated from the experiment (treatment elsewhere)
- D15 after weaning, 6 piglets/TG were slaughtered (blood, intestines)

Dietary treatments

- 9 different treatment groups (TG; 1 pen per treatment, 50 piglets per pen):

TG1: No supplementation	**0Zn**	(negative control)
TG2: 2500 ppm zinc oxide	**2500Zn**	(positive control)
TG3: 8% of DM as prefermented rape seed: EP100i	**8%EP100**	
TG4: 10% of DM as prefermented rape seed: EP100i	**10%EP100**	
TG5: - As TG4 + 0.6 % of DM brown algae product: EP900		**+0.6%BA**
TG6: - As TG4 + 1.0% of DM brown algae product: EP900		**+1.0%BA**
TG7: 12% of DM as prefermented rape seed: EP100i	**12%EP100**	
TG8: 15% of DM as prefermented rape seed: EP100i	**15%EP100**	
TG9: 25% of DM as prefermented rape seed: EP100i	**25%EP100**	

- Supplements were supplied by Fermentation Experts, Denmark, and mixed into the standard pre-weaner and starter diets
- Statistical analyses: all models included TG, gender and their interactions, start weight (linear and quadratic)

Results: Growth performance around weaning* for individual piglets (<50 observations per TG)

Parameter	0Zn	2500Zn	8%EP100	10%EP100	12%EP100	15%EP100	25%EP100	10%EP100	10%EP100 +0.6%BA	10%EP100 1.0%BA
BW age: D18 kg ± SEM	5.83 ± 0.88	5.28 ± 0.78	5.62 ± 0.83	4.92 ± 0.87	4.92 ± 0.83	4.92 ± 0.91	5.22 ± 0.75	4.92 ± 0.87	5.22 ± 0.99	5.21 ± 1.11
10 days before weaning until weaning (18 to 28 days of age) (corrected for BW D18 = start weight)										
ADG, g*	144^{a}	197^{bcd}	174^{ab}	180^{bc}	198^{bcd}	224^{d}	225^{d}	180^{bc}	206^{bcd}	214^{cd}
BW D28, kg	6.67^{a}	7.22^{bcd}	6.99^{abc}	6.94^{ab}	7.22^{bcd}	7.48^{d}	7.50^{d}	6.94^{ab}	7.29^{bcd}	7.36^{cd}
From weaning until 14 days after weaning (28-41 days of age) (corrected for start weight)										
ADG, g*	108^{ab}	98^{a}	153^{b}	103^{ab}	148^{ab}	99^{a}	116^{ab}	103^{ab}	124^{ab}	123^{ab}
BW D41, kg	7.78^{a}	8.34^{ab}	8.96^{bc}	8.31^{ab}	9.18^{c}	8.80^{bc}	9.01^{bc}	8.31^{ab}	8.91^{bc}	8.96^{bc}
From 10 days before weaning until 14 days after weaning (18-41 days of age) (corrected for start weight)										
ADG, g*	110^{a}	135^{ab}	162^{bc}	134^{ab}	171^{c}	154^{bc}	164^{bc}	134^{ab}	159^{bc}	162^{bc}

*ADG: Average Daily Weight Gain; BW: Body weight
Piglets eliminated included until time of elimination; P<0.0001 (ADG;W -> D14: 0.0032)

<0Zn and =2500Zn
<2500Zn

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ADG, g	110^{a}	135^{ab}	162^{bc}	134^{ab}	171^{c}	154^{bc}	164^{bc}	134^{ab}	159^{bc}	162^{bc}

- EP100i increased ADG pre-weaning to the same extent (at least) than 2500Zn

- Pre-weaning ADG and weight at weaning increased with increasing EP100i up to 15% in DM

- Slight further increase in weaning weight with BA

*Piglets eliminated included until time of elimination Treatment effect: P<0.0001 (ADG; W -> D14: 0.0032)

Results: Feed Conversion Rate (kg feed/kg body weight gain) (pen level; 1 observation per TG; raw data)

Parameter:	0Zn	2500Zn	8%EP	10%EP	12%EP	15%EP	25%EP	10%EP	+0.6%BA	+1.0%BA
Average daily weight gain after weaning (from average piglet weights at period start and end):										
D15-30	226	230	316	329	293	291	294	329	281	298
D31-64	625	633	594	651	558	647	612	651	540	599
Feed conversion rate after weaning (kg feed/kg liveweight gain):										
D1-14	2.10	2.30	1.55	1.80	1.55	1.77	1.72	1.80	1.60	1.73
D15-37	1.67	1.62	1.62	1.54	1.57	1.54	1.52	1.54	1.60	1.59
D38-65	1.55	1.45	1.64	1.56	1.56	1.53	1.56	1.56	1.61	1.58
Whole weaner unit period (D1-64):										
Exit D64 post-weaning	33.6	33.8	34.7	35.4	32.4	35.0	34.5	35.4	31.7	34.1
Daily weight gain	408	414	425	450	400	437	422	450	382	418
FCR	1.60	1.54	1.63	1.56	1.56	1.54	1.56	1.56	1.61	1.59

Better than 2500Zn

As good as 2500Zn

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FCR	1.60	1.54	1.63	1.56	1.56	1.54	1.56	1.56	1.61	1.59

Data from 1 pen only, but if anything – EP100i compared to 2500Zn:

- **Increased weight at exit from weaner unit (91 days of age)~1 kg**
- **Increased ADG D1-37 after weaning ~ 55-100g/d**
- **Improved FCR in weaner unit:**
  - **Overall from D1-37**
- **Same overall FCR from insertion to exit from weaner unit**

No additional beneficial effect of BA

Better than 2500Zn

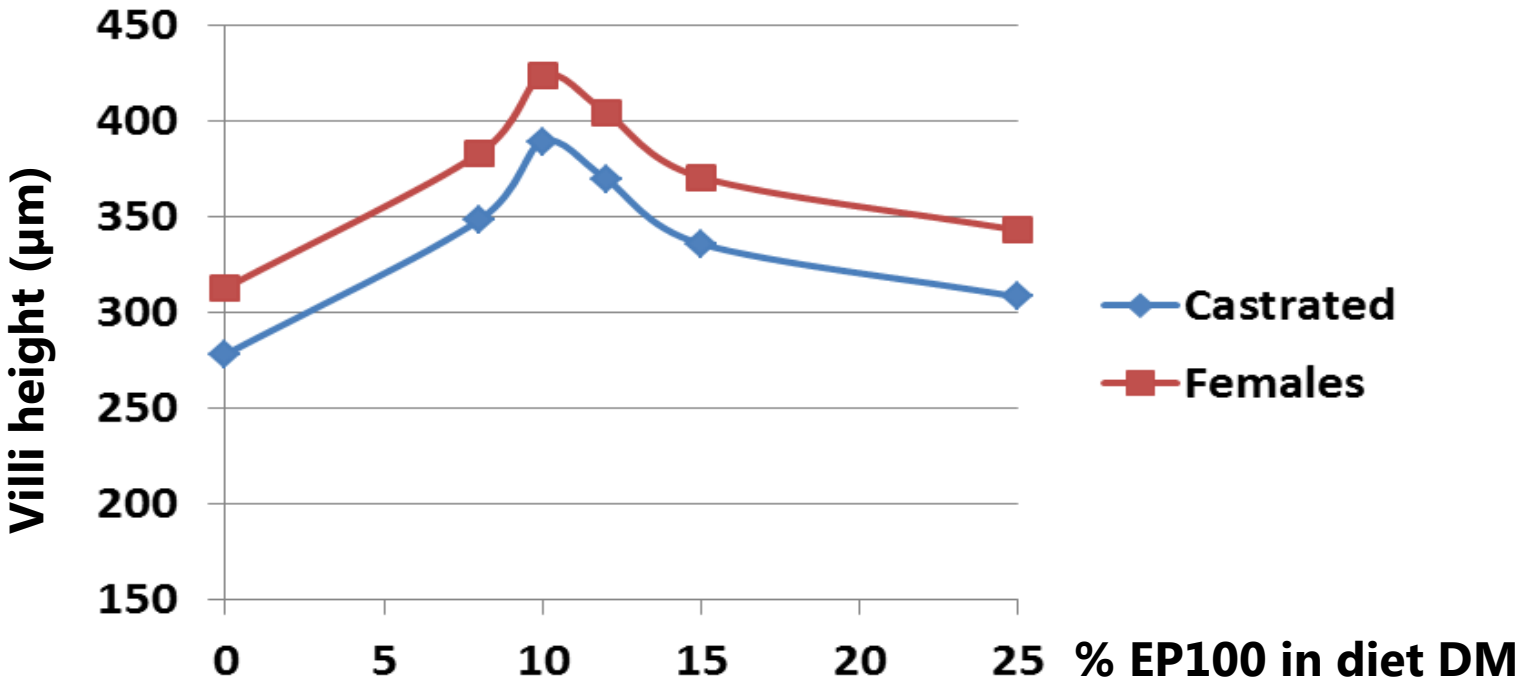
As good as 2500Zn

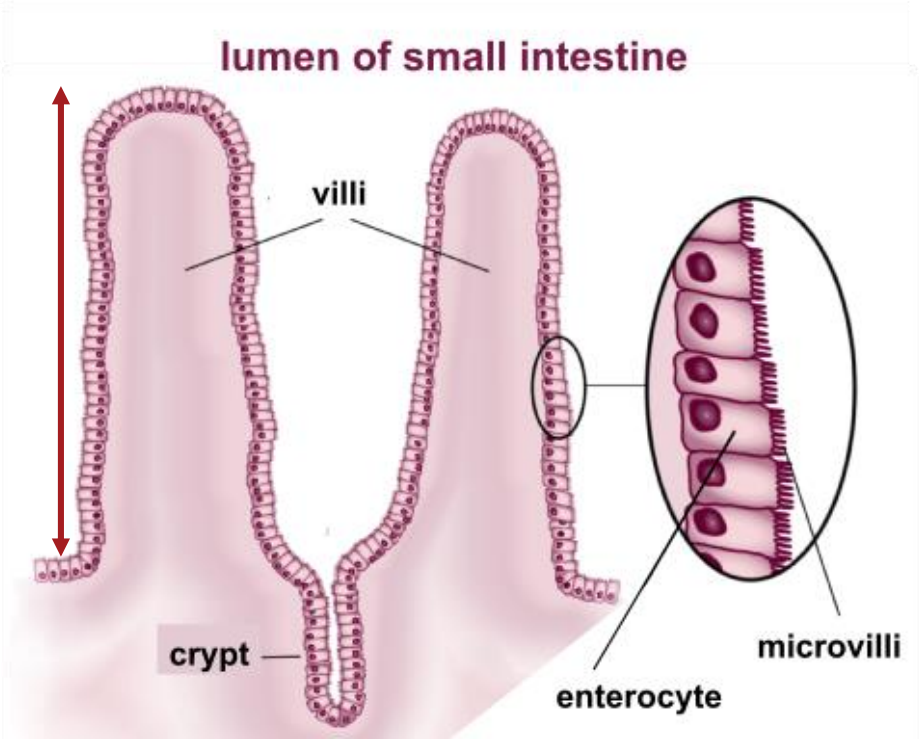
Results: Piglet diarrhea after weaning (pen level; 1 observation per TG)

No. of diarrhea cases:	0Zn	2500Zn	8%EP	10%EP	12%EP	15%EP	25%EP	10%EP	+0.6%BA	+1.0%BA
Until D14	6	1	0	4	0	2	2	4	2	0
D15-64	6	2	12	15	6	10	4	15	6	10
Duration per case (avg.)	1.41	1.0	1.83	1.55	1.33	2.08	1.33	1.55	1.69	1.77
Total diarrhea days	17	3	22	31	8	25	8	31	22	39
Piglets completing (%)	77	91	93	84	89	81	89	84	90	83

EP100:
- **Ensured piglet completion rates ~ 2500Zn**
- **Without preventing diarrhea symptoms**
- **Ie. diarrhea was less detrimental (survival, growth)**
  - **Reduced intestinal damage and immune cell infiltration**
  - **Feed induced osmotic diarrhea?**

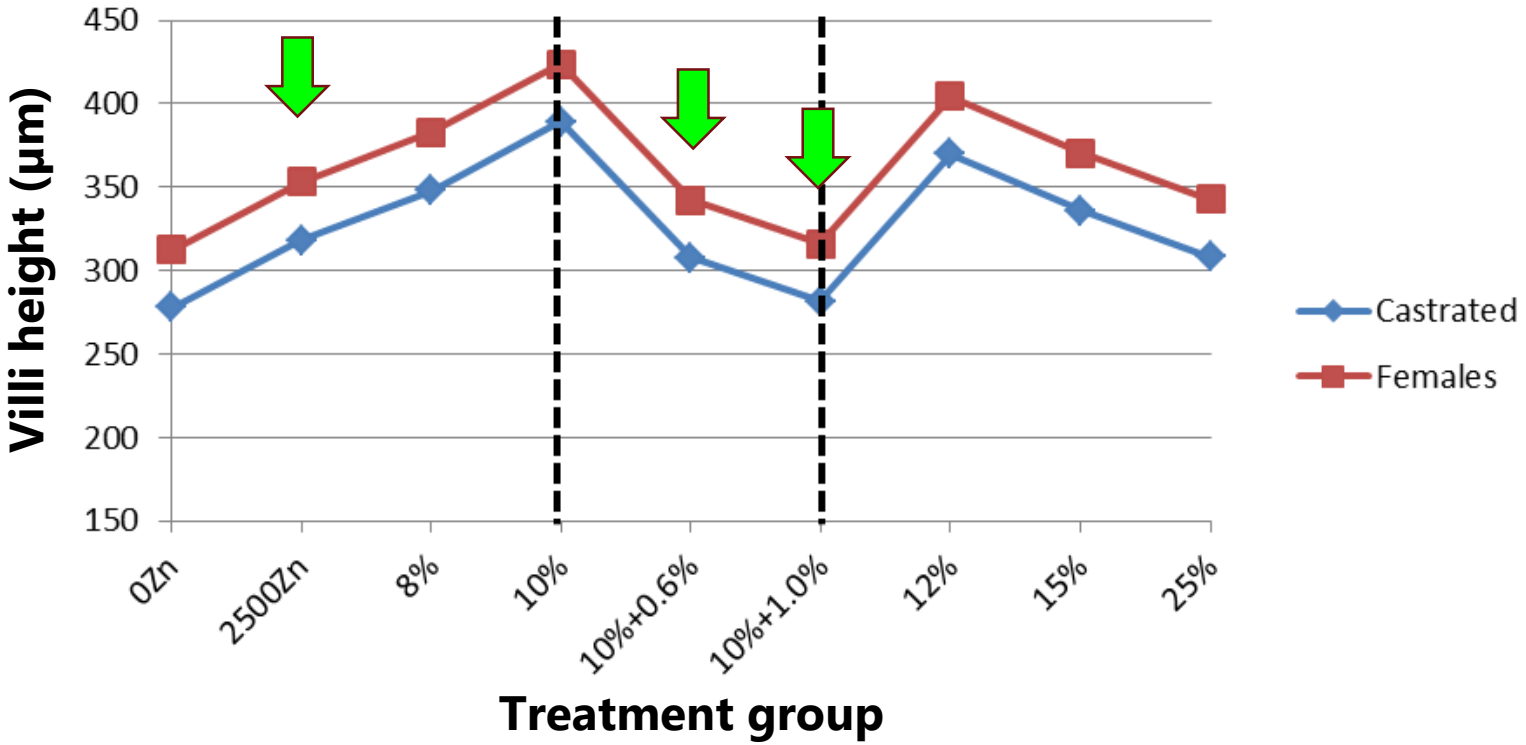
Results: Small intestinal villi height (6 slaughtered piglets D11 after weaning per TG)

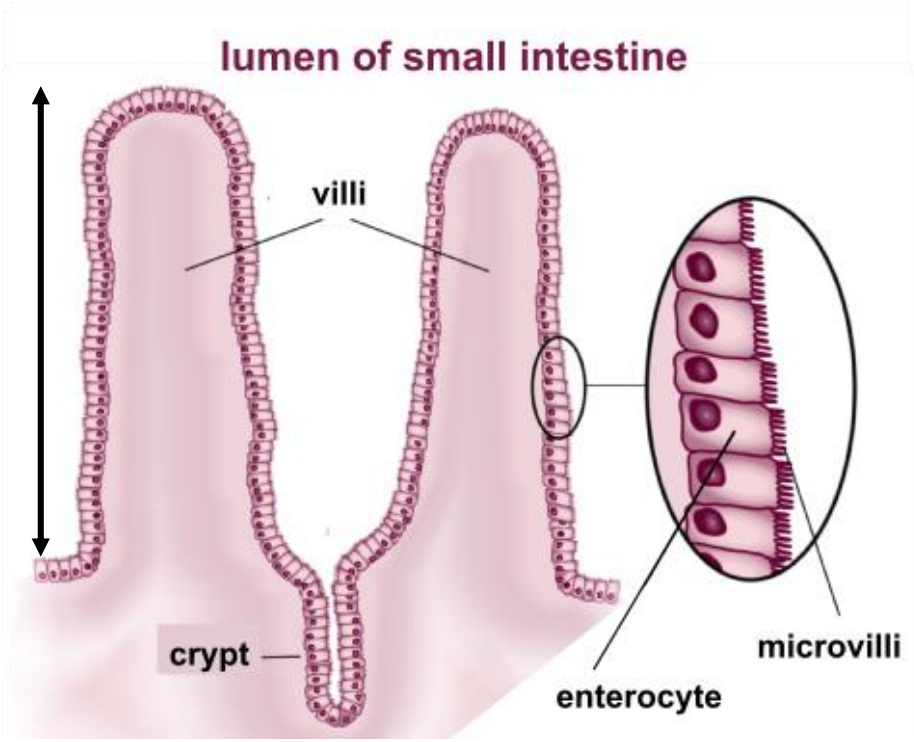




EP100:
- Increased small intestinal villi height <35% (maximal effect: 10% EP100i in diet)
- Stimulated extensive folding of villi => ↑↑↑ increase in surface area
- Immune cell infiltration and enterocyte morphological changes absent
  - Also in colon

Results: Small intestinal villi height (6 slaughtered piglets D11 after weaning per TG)

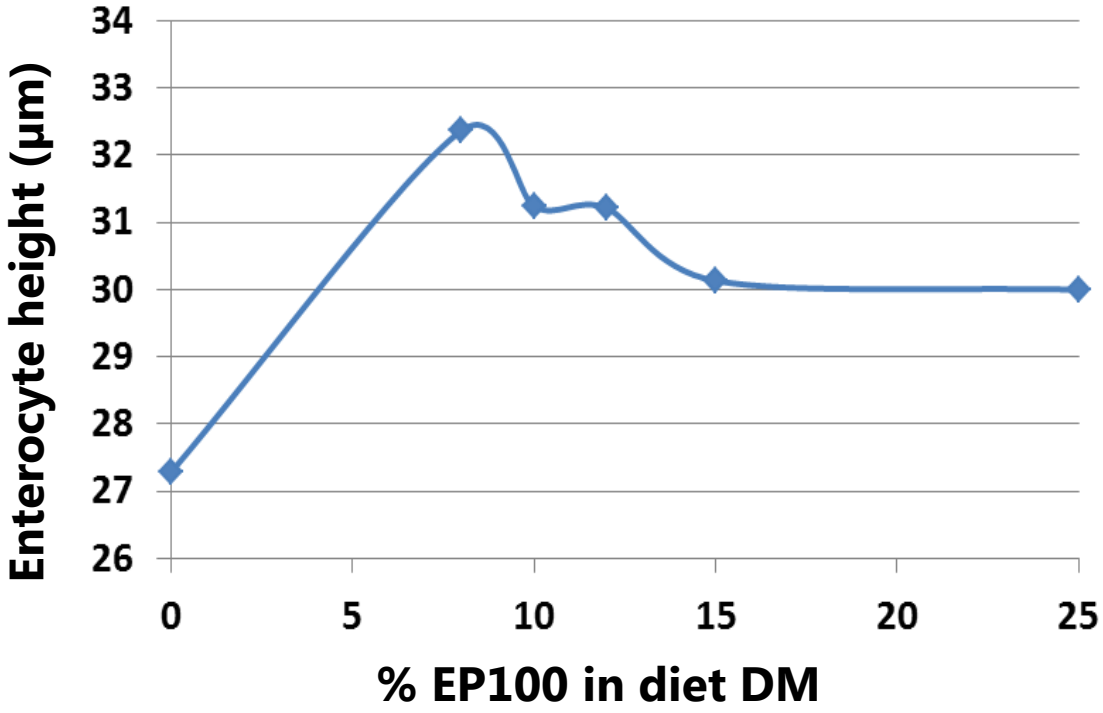


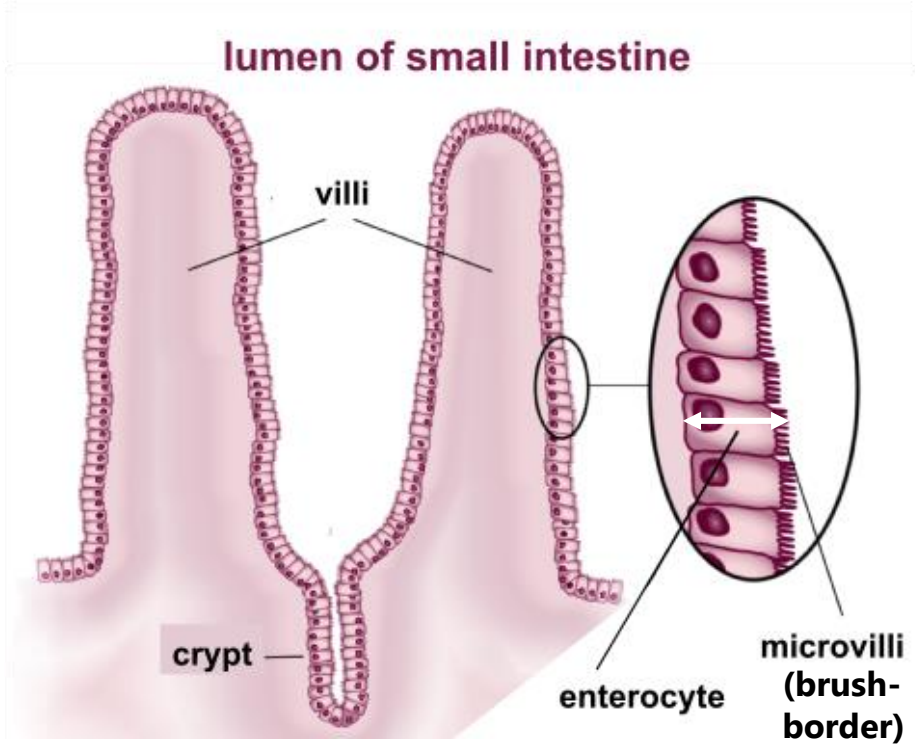


2500Zn: No significant impact on villi height
Did not prevent immune cell infiltration or enterocyte morphology changes

BA: Counteracted the effect of EP100i on villi height
But not on barrier function traits

Results: Small intestinal enterocyte height (6 slaughtered piglets D11 after weaning per TG)

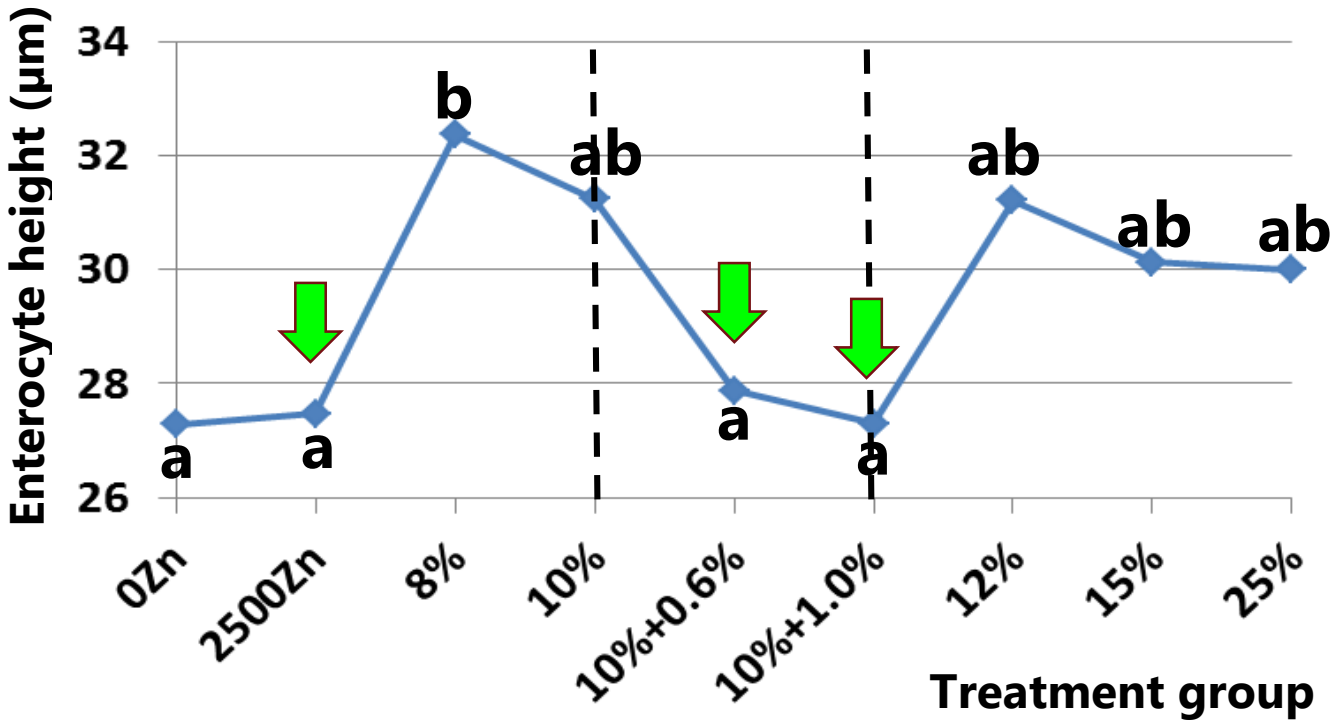


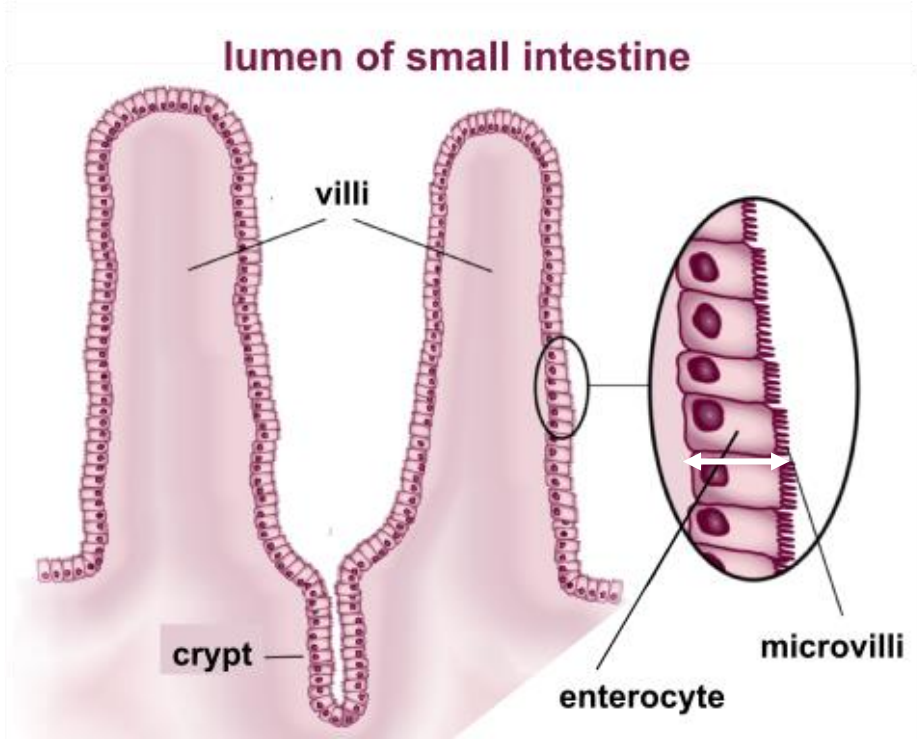


EP100i addition:

- Increased enterocyte height <20% (diminishing effect >8% in DM)
- Clear and intact brush border

Results: Small intestinal enterocyte height (6 slaughtered piglets D11 after weaning per TG)





2500Zn: No impact on enterocyte height
Did not block immune cell infiltration in small and large intestinal tissues
Some improvement in brush border integrity (compared to 0Zn)

BA: Abolished effect of EP100i on enterocyte height (but not on brush border integrity)

Conclusion 1 – Effect of EP100i (prefermented rape seed)

- EP100i compared to 0Zn:
  - Increased ADG (dose-response) from 10 days before weaning until exit from weaner unit
    => increased weaning and exit weights
  - Stimulated villi and enterocyte development (maximum effects at 10 and 8% DM in diet)
  - Improved small and large intestinal barrier function and small intestinal surface area
    - Increased absorptive capacity and improved resistance to bacterial infections
  - Reduced no. of lost and eliminated piglets without reducing diarrhea incidence
    - Feed induced osmotic rather than pathogen induced diarrhea
- EP100i compared to 2500Zn:
  - Higher ADG and FCR (D10 pre- to D30 post-weaning)
    => heavier piglets at weaning and exit
  - Prevented mortality and need for antibiotics treatment to the same extent

Conclusion 2 – Effect of brown algae (BA) product: EP900 (when added to 10% EP100i diet)

- Increased piglet weight at weaning
- Decreased ADG from D31-64 after weaning and hence exit weight
- Blocked stimulating effect of EP100i on villi length and enterocyte height
  - But not the effect of EP100i on intestinal barrier function
- Beneficial in susceptible period pre-weaning?
  - Antimicrobial effect?
  - Complementing barrier function effect of EP100i?

Acknowledgements

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