Latest results of the 6-R project:

study results from Berlin

Freie Universität

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6R Project – partners

- Regional
- Renaissance
- **Rye**
- **Rapeseed**
- Reduce
- Re-evaluation

Institutes of Animal Nutrition

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KWS

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Why rye and rapeseed?

Both can **replace wheat and soybean** without impairing performance of fattening pigs

Rye

- Strong in periods of **drought, local cultivation**
- New hybrid rye varieties are less susceptible to **ergot**
- low **phytin-P** and high activity of endogenous **phytase**
- Rye arabinoxylans may result in increased microbial production of butyrate, which may **improve gut health**
- Beneficial impact on **animal health** and behaviour?

Rapeseed

- **Local cultivation**
- Positive effects on **soil quality**
- Favourable pattern of **amino acids** (Met, Cys↑)
- **00-varieties** low in ANF content (e.g. glucosinolates)

6R Project – background

→ Hypothesis

The feeding of rye and rapeseed instead of wheat and soybean

- has no negative effects on performance and digestibility
- has beneficial effects on the intestinal development and
- promotes intestinal health in **weaned piglets**.

→ Aim of the study

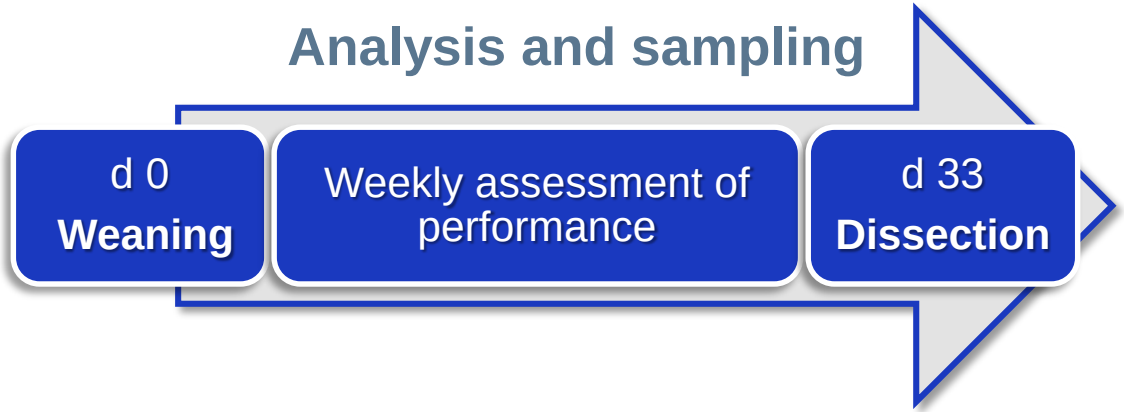
Investigation of the **effects of dietary rye and rapeseed** on **performance, nutrient digestibility, digesta characteristics** and **organ weight** in weaner piglets.

Study design

Animals, housing and diets

- 88 weaner piglets were allocated to 44 pens (German landrace, 2 piglets/ pen)
- 4 isonitrogenous diets were formulated in a 2x2 factorial design (CHO, P; n = 11)
- Pelleted feed was provided *ad libitum* for 33 days

Analysis and sampling



- **Performance data**
- **AID**
- **Organ weight**
- **Digesta**

Diet composition

Group	CHO (Cereal)	P (Protein meal)
T1	**Wheat** 48%	**Soybean** 25%
T2	**Wheat** 48%	**Rapeseed** 30%
T3	**Rye** 48%	**Soybean** 25%
T4	**Rye** 48%	**Rapeseed** 30%

Further components

- Potato protein
- Corn starch
- Vitamin Mix
- Minerals
- Amino acids
- TiO2

Diet composition

	Diet			
Item, g/kg	**T1**	**T2**	**T3**	**T4**
DM	931	937	931	928
Crude ash	52.0	50.1	51.9	49.4
Crude fat	83.4	90.5	74.8	84.1
Crude protein	219	222	220	217
NDF	154	153	162	141
ADF	26.3	74.1	23.0	70.5
ADL	2.2	28.2	4.3	24.9
Ca	8.3	8.0	7.8	7.7
P	5.6	5.7	5.5	5.5

Performance data

Effects of dietary rye and rapeseed on performance of weaner piglets (overall trial period)

	Diet							
	T1	T2	T3	T4		P-value		
					SEM	CHO	P	CHO*P
BW, kg								
d 0	8.34	8.33	8.35	8.32	0.17	0.988	0.951	0.975
d 33	21.94	20.80	21.93	19.77	0.44	0.545	0.062	0.553
ADG, g								
d 0 - 33	424	386	419	354	11.3	0.390	**0.024**	0.545
ADFI, g								
d 0 - 33	592	551	590	516	13.6	0.491	**0.037**	0.546
FCR								
d 0 - 33	1.46	1.48	1.42	1.51	0.03	0.944	0.434	0.644

T1: wheat/soybean, T2: wheat/rapeseed, T3: rye/soybean, T4: rye/rapeseed

Dry matter content and viscosity of digesta

Effects of dietary rye and rapeseed on dry matter content and viscosity of digesta of weaner piglets

	Diet							
	T1	T2	T3	T4		P-value		
					SEM	CHO	P	CHO*P
Dry matter (g/kg)								
Jejunum	135	135	98	115	5.1	**0.006**	0.274	0.445
Colon pars cranialis	181	200	162	181	4.9	**0.048**	0.048	0.965
Colon pars caudalis	256	268	228	243	5.3	**0.010**	0.201	0.871
Viscosity (mPas)								
Jejunum	2.04	1.90	3.08	2.83	0.20	0.013	0.609	0.885
Colon pars cranialis	4.99	5.62	8.69	5.80	0.84	0.255	0.503	0.300
Colon pars caudalis	7.57	7.30	9.71	8.50	0.87	0.198	0.713	0.550

T1: wheat/soybean, T2: wheat/rapeseed, T3: rye/soybean, T4: rye/rapeseed

Faecal scores

Effects of dietary rye and rapeseed on faecal scores of weaner piglets

	Diet					
	T1	T2	T3	T4		
Faecal score					SEM	P-value
d 0 - 7	2.84^{b}	2.98^{a}	2.82^{b}	2.93^{ab}	0.02	**0.019**
d 7 - 14	2.87^{a}	2.95^{a}	2.63^{b}	2.86^{a}	0.03	**0.003**
d 14 - 21	2.70^{c}	2.99^{a}	2.60^{c}	2.93^{b}	0.04	**< 0.001**
d 21 - 28	2.92^{a}	2.93^{a}	2.77^{ab}	2.97^{a}	0.03	0.098
d 28 - 33	2.96^{a}	2.95^{a}	2.76^{b}	2.97^{a}	0.02	**< 0.001**
d 0 - 33	2.86^{b}	2.96^{a}	2.72^{c}	2.93^{ab}	0.02	**< 0.001**

[1] T1: wheat/soybean, T2: wheat/rapeseed, T3: rye/soybean, T4: rye/rapeseed

T1: wheat/soybean, T2: wheat/rapeseed, T3: rye/soybean, T4: rye/rapeseed

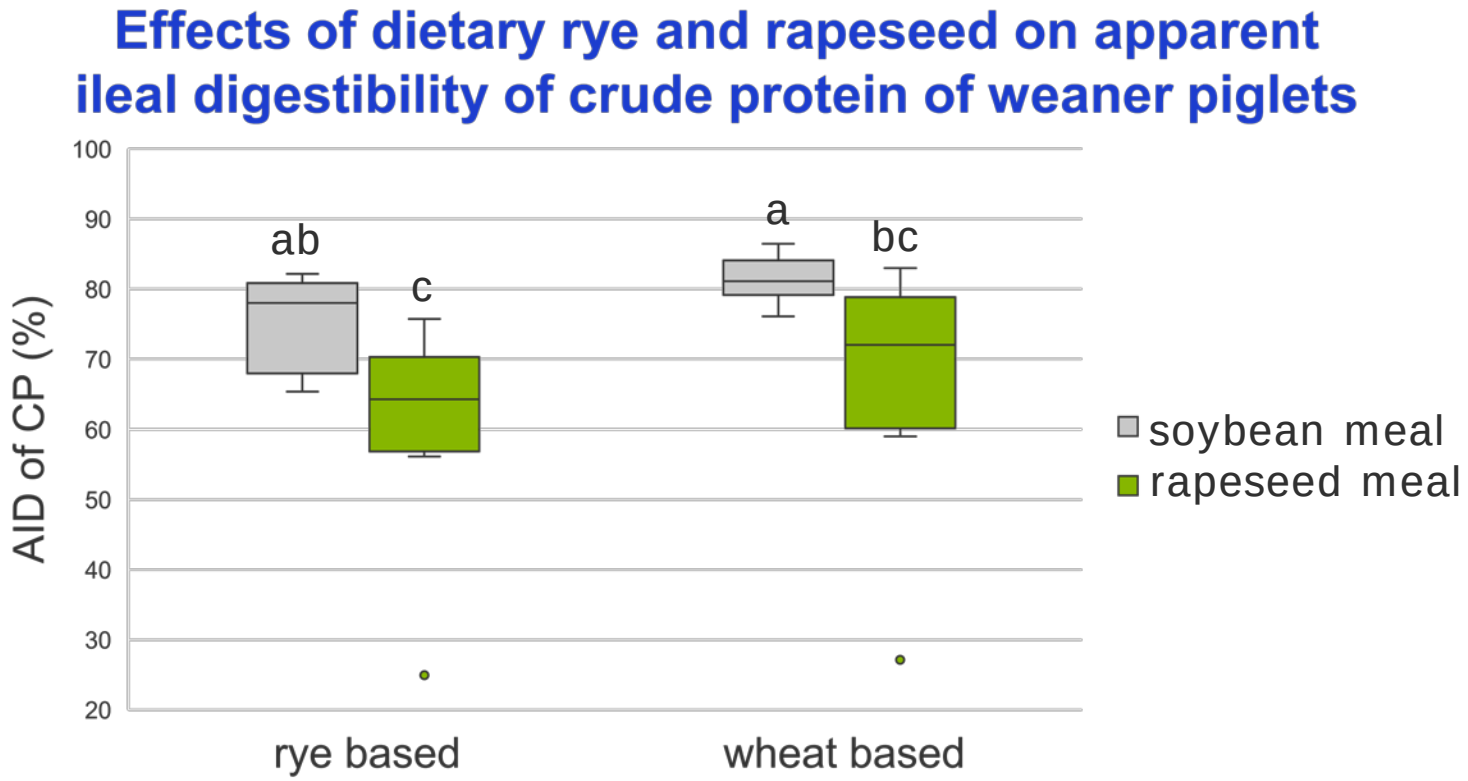
pH of digesta

Effects of dietary rye and rapeseed on pH-values of digesta of weaner piglets

	Diet							
	T1	T2	T3	T4		P-value		
pH					SEM	CHO	P	CHO*P
Jejunum	6.26	6.19	5.86	5.99	0.08	**0.050**	0.842	0.500
Ileum	6.72	7.37	6.33	6.09	0.21	**0.045**	0.617	0.284
Colon ascendens	5.71	5.97	5.75	5.51	0.11	0.346	0.952	0.264
Colon descendens	6.13	6.01	6.31	5.90	0.05	0.737	0.013	0.151

T1: wheat/soybean, T2: wheat/rapeseed, T3: rye/soybean, T4: rye/rapeseed

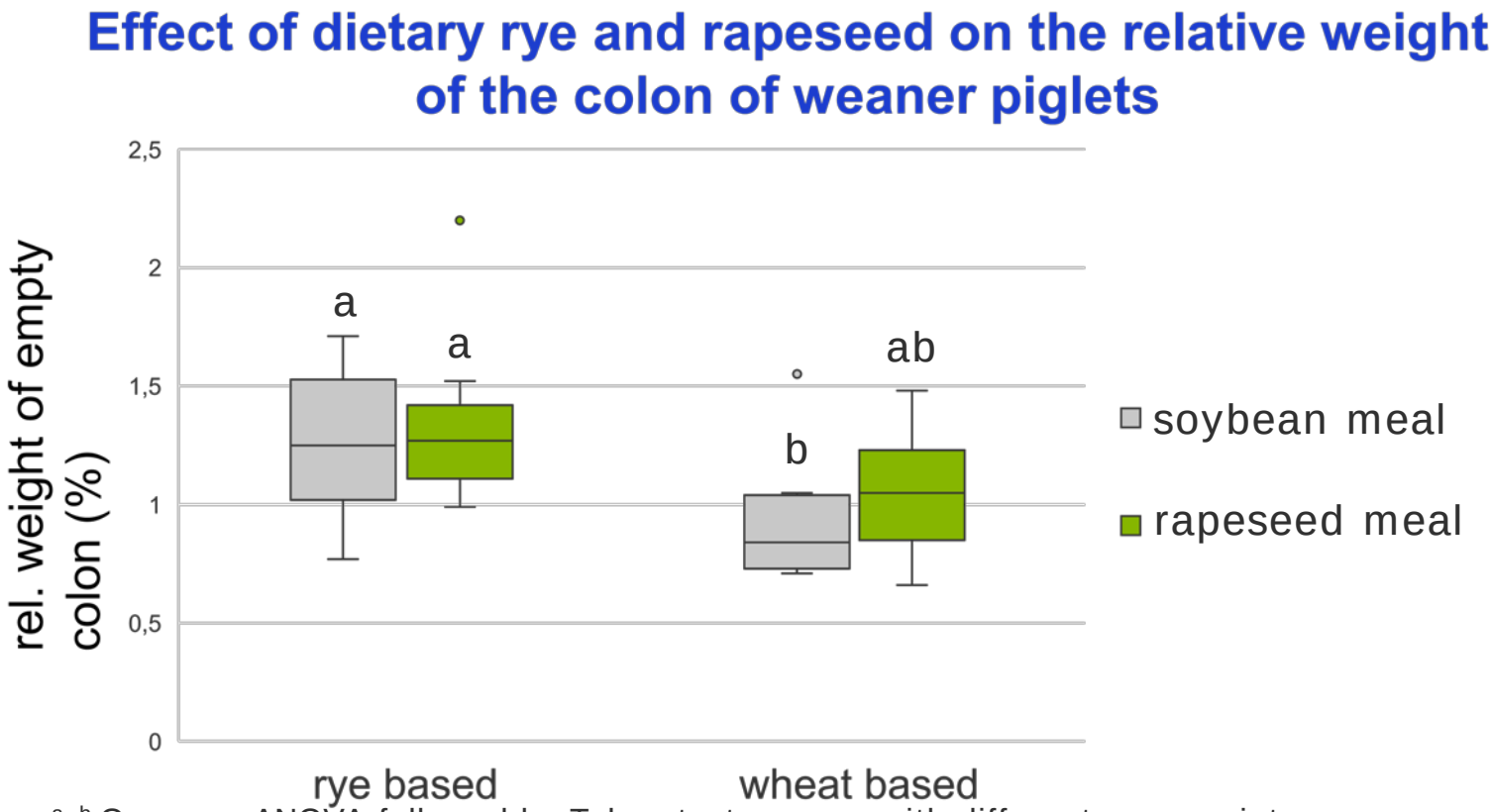
AID of crude protein



[a, b, c] One-way ANOVA followed by Tukey-test: means with different superscripts indicate significant differences ($p < 0.05$).

Impact by rye ($p = 0.005$) and rapeseed ($p < 0.001$)

Colonic weight



[a, b] One-way ANOVA followed by Tukey-test: means with different superscripts indicate significant differences ($p < 0.05$).

Rye → higher relative weight of the colon ($p < 0.001$)

Histology

Diet								
	T1	T2	T3	T4		P-value		
					SEM	CHO	P	CHO*P
Jejunum								
Villus length (µm)	872	744	790	768	19.98	0.458	0.057	0.177
Crypt depth jejunum (µm)	100	100	105	105	1.99	0.259	0.976	0.967
Thickness lamina muscularis (µm)	228	240	289	240	10.27	0.130	0.364	0.132
Colon ascendens								
Crypt depth colon (µm)	441	440	445	432	11.81	0.946	0.772	0.805
Crypt enlargement factor	15.13	15.31	13.93	15.30	0.49	0.549	0.445	0.557
Thickness lamina muscularis (µm)	315	339	303	393	14.99	0.475	0.054	0.263

Summary and discussion

Rye

- Performance: rye = wheat
- Changes in digesta DM
- Increased colonic weight

Rapeseed meal

- No impact on body weight and FCR
- Soybean meal partially superior in ADG and ADFI ↔ impaired digestibility of CP
- Higher dry matter content of colonic digesta

→ Future research focus

- Intestinal microbiome
- Immune system
- Intestinal health