Effect of feed enzymes on growth and feed efficiency in finisher pigs

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1. Evaluation of phytase, carbohydrases and protease enzymes in diets containing rapeseed meal and wheat DDGS for finisher pigs

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No. 311794.

Introduction

- **Objective:**

  ✓Establish the **combination of feed additives** which optimises **feed efficiency** in finisher pigs

- **Hypothesis**

  ✓ Supplementation of **enzymes** into by-product (RSM and DDGS) based diets can **improve feed efficiency** in finisher pigs.

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Material and Methods

DIETARY TREATMENTS:

1) **Positive control (PC):** exceeds NRC (2012) requirements
2) **Negative control (NC):** basal diet with 5% reduction in energy and amino acid levels.
3) **NC + Heat stable phytase**
4) **NC + Xylanase and β-glucanase complex (Xβ)**
5) **NC + protease**
6) **NC + phytase + protease**
7) **NC + phytase + Xβ**
8) **NC + Xβ + protease**
9) **NC + phytase + Xβ + protease**

162 pigs (~39kg LW) - Duration: 76 days

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Material and Methods

	T1	T2	T3	T4	T5	T6	T7	T8	T9
Phytase, g/tone	-	-	100	-	-	100	100	-	100
Carbohydrase, g/tone	-	-	-	100	-	-	100	100	100
Protease, g/tone	-	-	-	-	200	200	-	200	200
Net Energy, MJ/kg	**9.9**	**9.4**	**9.4**	**9.4**	**9.4**	**9.4**	**9.4**	**9.4**	**9.4**
Av. Lysine, g/kg	**0.83**	**0.79**	**0.79**	**0.79**	**0.79**	**0.79**	**0.79**	**0.79**	**0.79**
P:Ca, g/g	0.85	0.85	0.83	0.85	0.85	0.83	0.83	0.85	0.83
Av. Phosporus, g/kg *Phytase sparing effect*	0.30	0.30	0.22 *+0.15*	0.30	0.30	0.22 *+0.15*	0.22 *+0.15*	0.30	0.22 *+0.15*

*Calculated composition

- ✓ **Diets based on Rapeseed meal (9.6-10%), wheat (30-39%), barley (35-38%) and wheat DDGS (20%)**

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Results – Global period (39-106 kg)

	ADG, g/day	ADFI, g/day	FCR, g/g
T1, Positive control	1041	2667^{b}	2.60^{B}
T2, Negative control	1037	2847^{a}	2.79^{A,B}
T3, NC+Phytase	1067	2880^{a}	2.77^{A,B}
T4, NC+Carbohyrdase (Xβ)	1086	2926^{a}	2.73^{A,B}
T5, NC+Protease	1051	2814^{a,b}	2.71^{A,B}
T6, NC+Phytase +Protease	1042	2867^{a}	2.81^{A,B}
T7, NC+Phytase+Xβ	1029	2779^{a,b}	2.76^{A,B}
T8, NC+Xβ+Protease	1036	2879^{a}	2.83^{A}
T9, NC+Phytase+Xβ+Protease	1069	2860^{a}	2.68^{A,B}
Pooled SEM	*23.1*	*41*	*0.055*
P-Value			
Treatment	0.70	<0.001	0.089
Sex	<0.001	0.18	<.0001
Time	<0.001	<0.001	<.0001
Trt*sex	0.67	<0.01	0.11

Proc Mixed of SAS, repeated measures, pen experimental unit
Model includes trt, sex and treat*sex. Covariate by initial body weight

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Results – Global period (39-106 kg)

- **Contrast estimates for dietary formulation**

	ADG, g/day	ADFI, g/day	FCR, g/g
Positive Control vs. Negative Control			
Estimate	-11.0 ± 24.24	-189.2 ± 43.4	-0.16 ± 0.058
P-value	0.65	<0.01	<0.01
High P vs. reduced P			
Estimate	-1.8 ± 15.40	-19.5 ± 27.3	-0.02 ± 0.036
P-value	0.90	0.48	0.51

Proc Mixed of SAS, repeated measures, pen experimental unit
Model includes trt, sex and treat*sex. Covariate by initial body weight

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Results – Global period (39-106 kg)

- **Interaction protease x sex**

	ADG (g/day)	ADFI (g/day)	FCR (g/day)
Female			
Protease -	1001 ± 18.3	2711 ± 33.5^{a,b}	2.75 ± 0.044^{a,b}
Protease +	994 ± 22.2	2770 ± 40.5^{a,b}	2.82 ± 0.053^{a,b}
Male			
Protease -	1096 ± 16.8	2802 ± 30.9^{a}	2.59 ± 0.040^{a}
Protease +	1092 ± 20.9	2732 ± 38.2^{b}	2.49 ± 0.050^{b}
P-value	0.93	0.03	0.03

Proc Mixed of SAS, repeated measures, pen experimental unit
Model includes trt, sex and treat*sex. Covariate by initial body weight

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Conclusions

- A reduction of 5% in energy and AA on a commercial Irish diet might not be sufficient to see the potential of feed enzymes
- Phytase: The sparing effect for P and Ca was effective
- Xylanase and β-glucanase complex: did not improve FCR
- Protease: may have greater potential to increase feed efficiency in males than in females
- Excellent performance without soya

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Evaluation of feed enzymes in liquid diets for growing pigs

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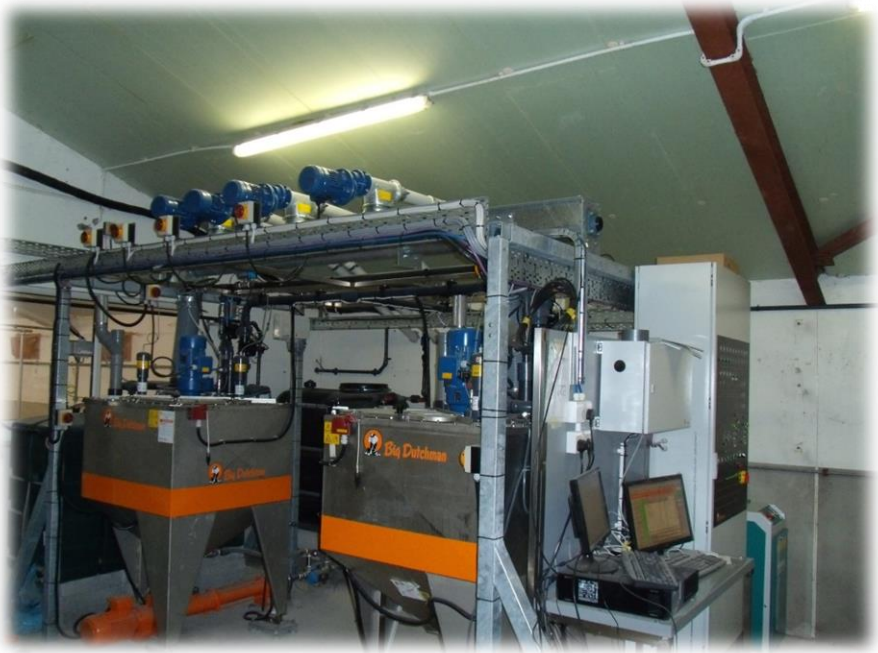
Introduction

Processing effect of liquid feeding?

- Activation of endogenous / exogenous enzymes
- Pre-degradation of NSP present in the diet



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Exp. 1 – Soaking + Enzymes

Objective:

To assess the efficacy of pre-soaking the cereal fraction and enzyme supplementation of liquid diets on pig growth performance, nutrient digestibility and diet viscosity.

Hypothesis:

- Soaking the cereal fraction of the diet ↑ enzyme activity even prior to feeding
- Pig growth and FE is improved by soaking ingredients with added enzymes
- Enzymes supplementation ↓ viscosity of soaked diets

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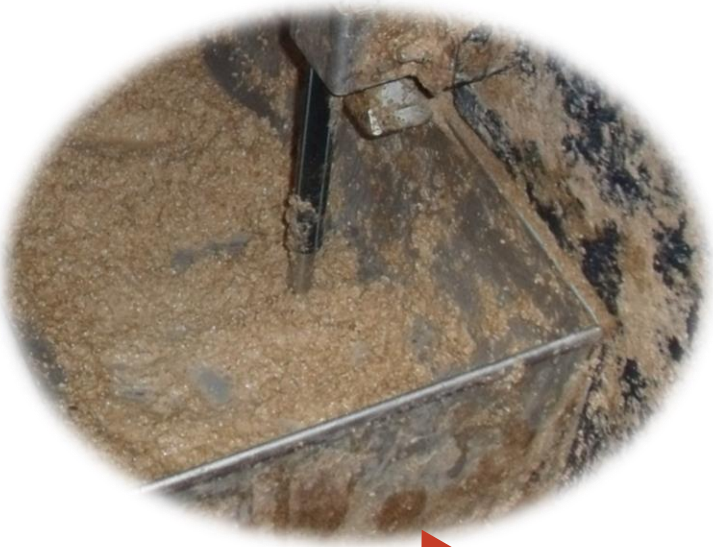
Introduction

- Probe/sensor feeding



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Experiment

- Soaking **cereal fraction only** with enzyme supplementation

Treatments:

1) **Fresh liquid diet (FLD)**
2) **FLD supplemented with enzyme (FLD+,** *Rovabio, Adisseo***)**
3) **Soaked liquid diet (SLD)**
4) **SLD supplemented with enzyme (SLD+,** *Rovabio, Adisseo***)**

- 36 pens with 7 pigs/pen
- Duration: 72 days
- 3 hours soak

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Diet Ingredients and nutritional composition

- Barley, wheat, soya, pollard based diet
- Only barley, wheat & pollard component soaked
- Balancer containing soya, AA, minerals and vitamins mixed just prior to feeding

Nutrient	Content
DM, g/kg	868
Protein, g/kg	160
Ash, g/kg	47
Fat, g/kg	20
Fibre, g/kg	42
NDF, g/kg	167
ADF, g/kg	54
DE, MJ/kg	**13.00**
NE, MJ/kg	**9.39**
Lysine, g/kg	**10.61**
SID LYSpig, g/kg	**9.15**
Ca, g/kg	6.48
Digestible P, g/kg	2.40

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Results

Growth performance

	Soaking			Enzyme		
	0h.	3h.	P-value	-	+	P-value
Initial weight, kg	31.1	31.0	0.97	31.0	31.0	1.00
Final weight, kg	97.8	99.0	0.14	98.6	98.2	0.67
ADG, g/day	921	947	0.14	937	931	0.74
ADFI, g/day	2484	2508	0.66	2499	2494	0.92
FCR, g/day	2.72	2.67	0.52	2.68	2.70	0.78

Proc Mixed of SAS, repeated measures, pen experimental unit
Model includes soaking|enzyme|sex time. Covariate by initial body weight

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Results

Carcass quality

	Soaking			Enzyme		
	0h.	3h.	P-value	-	+	P-value
Cold weight, kg	71.1	72.0	0.28	71.7	71.5	0.82
Lean meat, %	56.9	57.0	0.71	57.3	56.6	0.01
Muscle, mm	49.9	50.0	0.78	50.4	49.5	0.09
Fat, mm	12.7	12.6	0.69	12.3	13.0	0.04

Proc Mixed of SAS, repeated measures, pen experimental unit
Model includes soaking|enzyme|sex time. Covariate by initial body weight

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Conclusions

- ADG, ADFI and FCR were not affected by enzyme supplementation.
- Lean meat yield was reduced by enzyme supplementation
  - Additional energy released
  - Insufficient AA for lean growth?
- Numerical increases in ADG due to soaking of cereals which were significant in first weeks

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EVALUATION OF PROTEASE AND ALPHA-GALACTOSIDASE IN DIETS BASED ON FIELD BEANS

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Introduction

Objective:

To assess the efficacy of supplementation of

1. protease (Ronozyme Proact, DSM), and
2. a complex of α-galactosidase and xylanase (ITPSA)

in a barley/faba bean diet on pig growth and nutrient digestibility.

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Dietary treatments

1) Cereal / soya optimum energy and AA
2) Cereal / soya low energy and AA
3) Cereal / field beans optimum energy and AA
4) Cereal / field beans low energy and AA
5) Cereal / extruded field beans low energy and AA
6) Cereal / field beans low energy and AA + protease
7) Cereal / field beans low energy and AA + α-galactosidase
8) Cereal / field beans low energy and AA + protease and α-galactosidase

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Questions Answered

A. 2 x 2 (Density – high, low & Diet – Soya, Bean)

- 1. Cereal / soya optimum energy and AA
- 2. Cereal / soya low energy and AA
- 3. Cereal / field beans optimum energy and AA
- 4. Cereal / field beans low energy and AA

B. 2 x 2 (Enzyme – yes, no & Enzyme Type – protease, galactosidase)

- 4. Cereal / field beans low energy and AA
- 5. Cereal / field beans low energy and AA + protease
- 6. Cereal / field beans low energy and AA + galactosidase
- 7. Cereal / field beans low energy and AA + protease and galactosidase

Other comparisons

- 4. Cereal / field beans low energy and AA
- 8. Cereal / extruded field beans low energy and AA

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Ingredient composition

Ingredient (kg/ton)	Diet 1 Opt. E&AA	Diet 2 Low E&AA	Diet 3 Opt. E&AA	Diet 4 Low E&AA	Diet 5 Low E&AA +Protease	Diet 6 Low E&AA Galactosidase	Diet 7 Low E&AA +Prot&Galacto	Diet 8 Low E&AA +extrusion
Barley	762.9	830.2	477.3	544.0	543.8	543.8	543.6	596.0
Soya Hi-Pro	176.4	143.6	45.3	12.5	12.5	12.5	12.5	8.0
Field beans	**0.0**	**0.0**	**400.0**	**400.0**	**400.0**	**400.0**	**400.0**	**0.0**
Field beans extruded	0.0	0.0	0.0	0.0	0.0	0.0	0.0	368.0
Fat, soya oil	33.5	0	48.61	15.2	15.24	15.24	15.24	0.30
Lysine HCl	3.84	3.47	2.99	2.60	2.62	2.62	2.62	2.80
DL-Methionine	1.26	0.83	2.47	2.10	2.07	2.07	2.07	2.00
L-Threonine	1.67	1.38	2.00	1.70	1.72	1.72	1.72	1.70
L-Tryptophan	0.09	0.04	0.59	0.5	0.53	0.53	0.53	0.5
Vitamins and Minerals	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Salt feed grade	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Mono DiCal Phos	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Limestone flour	11.0	11.2	11.5	12.0	12.0	12.0	12.0	11.5
Celite	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Protease[1]	0	0	0	0	0.2	0	0.2	0.0
α-galactosidase[2]	0	0	0	0	0	0.19	0.19	0.0

[1]Ronozyme Proact, DSM, Germany.
[2]ITPSA, Spain.

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Chemical composition

	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6	Diet 7	Diet 8
	Opt. E&AA	Low E&AA	Opt. E&AA	Low E&AA	Low E&AA	Low E&AA	Low E&AA	Low E&AA
Nutrient (g/kg)					+Protease	+Galactosidase	+Prot&Galacto	+extrusion
Dry matter	884.3	879.7	857.4	852.9	852.9	852.9	852.9	879.3
Protein	**165.0**	**155.0**	**165.0**	**155.0**	**155.0**	**155.0**	**155.0**	**155.0**
Digestible energy, MJ/kg	13.9	13.1	13.7	12.9	12.9	12.9	12.9	13.0
Net Energy, MJ/kg	**10.0**	**9.3**	**10.0**	**9.3**	**9.3**	**9.3**	**9.3**	**9.3**
Lysine	11.0	10.0	11.3	10.3	10.3	10.3	10.3	10.3
SID LYSpig	**9.9**	**8.9**	**9.9**	**8.9**	**8.9**	**8.9**	**8.9**	**8.9**

[1]Ronozyme Proact, DSM, Germany.
[2]ITPSA, Spain.

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Preliminary results

Growth performance

	ADG (g/day)	ADFI (g/day)	FCR (g/day)	Initial LW (kg)	Final LW (kg)
Density					
High	1039	2271	2.19[a]	38.8	111.5
Low	1027	2364	2.31[b]	38.8	110.8
P-value	*0.59*	*0.07*	*0.001*	*0.95*	*0.63*
Protein source					
Soyabeans	1002[b]	2242[b]	2.24	39	109.2[b]
Field beans	1064[a]	2394[a]	2.26	39	113.1[a]
P-value	*0.01*	*0.001*	*0.71*	*0.97*	*0.01*

Proc mixed of SAS with repeated measures. Model includes density|protein_source|sex
Covariated by initial body weight. ADFI and FCR expressed as DM basis.

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Preliminary results

Growth performance

		ADG (g/day)	ADFI (g/day)	FCR (g/day)	Initial LW (kg)	Final LW (kg)
Protease						
-		1068	2459	2.31	38.9	114.1
+		1070	2392	2.24	39.1	114.2
	P-value	*0.93*	*0.11*	*0.04*	*0.54*	*0.90*
α-Galactosidase						
-		1067	2430	2.27	38.9	114.0
+		1071	2422	2.27	39.0	114.3
	P-value	*0.81*	*0.84*	*0.69*	*0.80*	*0.78*

Proc mixed of SAS with repeated measures. Model includes protease|galactosidase|sex
Covariated by initial body weight. ADFI and FCR expressed as DM basis.

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Conclusions

- Density: Intake ↑, ADG ↔ and FCE poorer on low density diet
- Protein Source: Intake ↑, ADG ↑ and FCE ↔ on bean diets
- Protease: FCE improved due to ↓ intake while ADG ↔
- α-Galactosidase: No Effect
- Extrusion: No Benefit to pig growth
- Field beans effective as a protein source in pig diets with or without enzymes

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Questions?