

# Fine particle size and enzyme supplementation as factors improving utilization of protein from diets with lowered protein contents by pigs

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## ABSTRACT

Thirty-two crossbred barrows were fed from about 28 to 100 kg body weight on a coarsely ground (800  $\mu\text{m}$ ) diet with a standard protein content (diet C), and on two finely ground (500  $\mu\text{m}$ ) diets with protein contents lowered by 8%, with or without supplementation with glucanase and xylanase (diets F and FE, respectively). Fine grinding (diet F vs C) and enzyme supplementation (diet FE vs F) increased protein digestibility, while grinding also increased energy digestibility. Pigs fed the F and FE diets excreted less nitrogen and retained the same amount of nitrogen as animals on diet C. Daily gains, feed utilization, carcass leanness, and fat and protein contents in *Musculus longissimus dorsi* were not significantly affected by treatment. Protein conversion was better in groups F and FE than in C.

KEY WORDS: particle size, enzymes, growth, digestibility, nitrogen balance, pigs

## INTRODUCTION

The feed industry applies several methods to increase the nutritional value of feed mixtures, including milling and enzyme supplementation. The reduction of feed particle size increases the surface area exposed to digestive enzymes, thus improving absorption of nutrients (Wondra et al., 1995; Oryschak et al., 2002). The addition of enzymes that hydrolyse non-starch polysaccharides in cereal grains also increases the digestibility of nutrients (Baidoo et al., 1998). However, particle size reduction or enzyme supplementation may fail to increase the performance of pigs when the dietary contents of crude protein, amino acids and energy are not reduced (Mavromichalis et al., 2000).

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The objective of the experiment was to evaluate the effects of fine grinding and addition of  $\beta$ -glucanase and xylanase as factors improving protein utilization from diets with a lowered protein level that contributes to decreasing nitrogen excretion by growing-finishing pigs.

## MATERIAL AND METHODS

A growth experiment was carried out on 32 crossbred castrated males fed individually on grower (28.5-65.2 kg body weight (BW) and finisher (65.2-99.7 kg BW) diets. Three diets were prepared: a coarsely ground (800  $\mu\text{m}$ ) control diet formulated according to Polish standards (diet C), a finely ground (500  $\mu\text{m}$ ) diet with an 8% lower protein content (diet F), and diet F supplemented with  $\beta$ -glucanase and xylanase (Porzyme 9100) (diet FE) (Table 1). Diets were fed in wet form in daily rations increased from 1.6 to 3.0 kg, water was given *ad libitum* after the meals. A 6-day balance experiment was carried out on 17 pigs of mean BW 55.3 kg to determine protein and energy digestibility and nitrogen (N) retention. Meat content in the carcass and fat and protein content in *Musculus longissimus dorsi* were determined after slaughter at 100 kg BW.

Table 1. Formulation and nutritional value of the diets,  $\text{g} \cdot \text{kg}^{-1}$

Item	Grower diet			Finisher diet		
	C	F	FE	C	F	FE
Barley	553.4	577.2	576.2	676.7	696.4	695.4
Wheat	250.0	260.0	260.0	200.0	210.0	210.0
Soyabean meal	164.0	129.0	129.0	96.0	65.0	65.0
Minerals	25.0	26.0	26.0	20.0	21.0	21.0
Trace mineral-vitamin premix <sup>1</sup>	5.0	5.0	5.0	5.0	5.0	5.0
L-lysine HCl	2.0	2.2	2.2	1.9	2.2	2.2
DL-methionine	0.6	0.6	0.6	0.4	0.4	0.4
Porzyme 9100 <sup>2</sup>	-	-	1.0	-	-	1.0
<i>Nutritional value</i>						
crude protein (analysed)	169	157	155	149	138	138
lysine	9.3	8.5	8.5	7.7	7.1	7.1
methionine	3.0	2.8	2.8	2.5	2.3	2.3
ME, MJ/kg	12.5	12.5	12.5	12.5	12.5	12.5
Mean particle size, $\mu\text{m}$	812	516	512	818	528	521

<sup>1</sup> premix on ground limestone carrier, containing 1g/kg flavomycin

<sup>2</sup> enzyme preparation containing 400 U/g  $\beta$ -glucanase and 400 U/g ksylnase

## RESULTS AND DISCUSSION

Both fine grinding and enzyme supplementation of the finely ground diet increased the digestibility of crude protein to the same extent (by 2.8%;  $P < 0.01$ ; Table 2). The digestibility of gross energy was slightly more affected by the fine grinding than by the enzyme supplementation (group F vs C;  $P < 0.01$ , and FE vs

F;  $P < 0.05$ ). Pigs fed the finely ground diets with a lower protein content excreted less ( $P < 0.01$ ) N and retained daily the same amount of N as those fed the coarsely ground diet with a higher protein content. Enzyme supplementation of diet FE did not increase N retention or the N retained/N intake ratio.

Table 2. Balance and growth experiment (28.5 - 99.7 kg) results and carcass characteristics

Item	Diet			SEM	P value
	C	F	FE		
<i>Balance experiment</i>					
crude protein digestibility, %	77.4 <sup>C</sup>	79.6 <sup>B</sup>	81.8 <sup>A</sup>	0.486	<0.01
energy digestibility, %	81.5 <sup>cB</sup>	83.2 <sup>bA</sup>	84.4 <sup>aA</sup>	0.349	<0.01
N intake, g/day	62.23	57.74	57.15	-	-
N excreted, g/day	35.04 <sup>A</sup>	30.83 <sup>B</sup>	30.41 <sup>B</sup>	0.617	<0.01
N retained, g/day	27.19	26.91	26.74	0.358	0.890
N retained, % of intake	43.7	46.6	46.8	0.685	0.137
<i>Growth experiment</i>					
initial body weight, kg	28.09	29.60	27.82	0.525	0.352
final body weight, kg	98.86	100.25	100.04	0.629	0.637
average daily gain, g	827	832	854	8.35	0.363
feed conversion ratio, kg/kg	2.96	2.94	2.85	0.033	0.360
crude protein conversion, g/kg	467 <sup>A</sup>	432 <sup>B</sup>	415 <sup>B</sup>	6.23	<0.01
carcass meat, %	53.26	52.67	52.60	0.634	0.899
protein in <i>l. dorsi</i> muscle, %	23.55	23.28	23.29	0.114	0.543
fat in <i>l. dorsi</i> muscle, %	1.64	1.79	1.84	0.077	0.552

a,b,c-  $P < 0.05$ ; A,B,C-  $P < 0.01$

Pigs fed the finely ground diet containing less protein (F) had similar daily gains and feed utilization as those fed the control diet with a higher protein content, but coarsely ground. The supplementation of diet FE with  $\beta$ -glucanase and xylanase tended to increase daily gains and feed utilization (by 2.6 and 3.1%, respectively). Pigs fed diets F and FE used less crude protein per kg body gain than those fed diet C (432 and 415 vs 467 g/kg;  $P < 0.01$ ). Decreasing the crude protein content by 8% in the finely ground diet, used with or without enzyme supplementation, did not lower carcass meatiness or the protein and fat content in the *l. dorsi* muscle.

The increased digestibility of protein and energy as a result of the reduction in dietary particle size is consistent with the results of Oryschak et al. (2002). A increase of ileal digestibility at a greater difference between particle size, 1000 vs 500  $\mu\text{m}$ , was observed by Lahaye et al. (2004). In the presented study, the F diet was a low-excretion diet since it reduced not only nutrient excretion in faeces, but also urea N excretion. Supplementing the finely ground diet with  $\beta$ -glucanase and xylanase increased protein digestibility, but not N retention, and affected the performance of pigs from the FE group to a small extent.

## CONCLUSIONS

Reduction of particle size from 800 to 500  $\mu\text{m}$  in pig diets allows for a decrease in dietary protein content and reduction of nitrogen excretion without deterioration of growth performance or carcass quality. Further supplementation with carbohydrases has little effect.

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## STRESZCZENIE

**Rozdrabnianie paszy i dodatek enzymów jako czynniki poprawiające wykorzystanie białka z mieszanek o obniżonej zawartości białka dla świń**

32 wieprzki żywiono od ok. 28 do 100 kg m.c. dietą grubo zmieloną (800  $\mu\text{m}$ ) o normalnej zawartości białka (dieta C) oraz dwiema dietami drobno zmielonymi (500  $\mu\text{m}$ ) o zawartości białka obniżonej o ok. 8%, z których jedna była nie uzupełniona, a druga uzupełniona glukanazą i ksylanazą (odpowiednio dieta F i FE). Mielenie (dieta F vs C) i uzupełnienie enzymami (dieta FE vs F) spowodowało zwiększenie strawności białka, a mielenie także strawności energii. Świnie żywione dietami F i FE wydalaly mniej azotu i miały taką samą retencję N jak zwierzęta żywione dietą C o wyższej zawartości białka. Rodzaj diety nie wpłynął na przyrosty, wykorzystanie paszy, zawartość mięsa w tuszy oraz zawartość białka i tłuszczu w *Musculus longissimus dorsi*. Wykorzystanie białka na przyrost było lepsze w grupach F i FE niż w C.