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An investigation into the effect of dietary particle size and pelleting of diets for finishing pigs

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ABSTRACT

The aim of the study was to investigate the effects of feed form (meal or pellets) and dietary particle size profile (fine or coarse) in a 2 × 2 factorial design on finishing pig performance and nutrient digestibility. A simple cereal soya-based finishing pig diet was formulated to provide 13.6 MJ/kg digestible energy (DE) and 167 g/kg crude protein (CP). The coarsely ground diets were made using 2 × 14 mm + 4 × 10 mm screens and 6 × 4 mm screens were used to produce the finely ground diets. Diets were then pelleted or not. The effect of feed form and particle size was tested on pig performance (20 pigs per pen, 8 replicates per treatment) and nutrient digestibility (8 pigs/replicates per treatment) in two separate trials. Data were analysed by Analysis of Variance (ANOVA) using Genstat Version 14.0 according to the 2 × 2 factorial design. There was no significant interaction ($P > 0.05$) between particle size and feed form. However, the ADG and feed conversion ratio (FCR) of pigs between 18 weeks of age and finish was significantly improved ($P < 0.05$ and < 0.001, respectively) when diets were in pellet form (990 g/day and 2.79, respectively) compared with when diets were in meal form (940 g/day and 3.01, respectively). Pigs offered the finely ground diets also had a higher ADG (989 g/day, $P < 0.05$) (between 18 weeks and finish) and a better FCR (2.82, $P < 0.01$) than pigs offered coarsely ground diets (941 g/day and 2.98, respectively). Overall FCR between 12 weeks of age and finish was improved by 5.5% when diets were pelleted ($P < 0.001$) and by 3% when diets were finely ground ($P < 0.05$). Pelleting of the diet significantly improved dry matter (DM) digestibility and DE content (both $P < 0.05$) and tended ($P < 0.1$) to improve energy digestibility and ash digestibility. Reducing the particle size of the diet significantly improved CP digestibility ($P < 0.05$) and tended ($P < 0.1$) to improve DM, energy digestibility and digestible energy content. Nitrogen excretion was reduced ($P < 0.05$) by 10% when pigs were offered diets in pellet form compared to meal form. There was no effect of feed form or particle size ($P > 0.05$) on stomach ulceration. Overall, the results suggest a cumulative effect of feed form and particle size on FCR, nutrient digestibility and DE content of the diet since these parameters were optimized when pigs were offered a pelleted diet with a fine particle size profile but were poorest when meal diets with a coarse particle size profile were offered.

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1. Introduction

Pelleting of pig diets has been reported to improve pig performance through a number of mechanisms which include, increasing the dry matter (DM) content of feed, improving nutrient digestibility, reducing feed wastage, improving the hygienic quality of feed, destroying anti-nutritive factors and changing the speed of flow in the gastrointestinal tract (I'Anson et al., 2013, 2012; Lundblad et al., 2011; Morrow, 1992). In the review of literature by Morrow (1992) it was concluded that pelleting could improve pig performance in terms of growth rate and feed conversion ratio (FCR) by 7.9% and 7.7% respectively. Whilst it is mainly concluded that much of the observed improvements in feed use efficiency are due to a reduction in feed wastage (Morrow, 1992), compared with diets in meal form, there is also evidence to suggest that pelleting may improve nutrient digestibility through disruption of endosperm cell walls (Graham et al., 1989). However, some workers have not found beneficial effects of pelleting on pig performance, for example Walker (1990), Patterson (1989). Patterson (1989) also found no effect of pelleting on nutrient digestibility or energy metabolizability. However it should be noted that a 'cold' pelleting process was used in the work by Walker (1990) and Patterson (1989) which may have contributed to the lack of effect observed.

With regard to particle size, results have been inconsistent although it is generally believed that reductions in dietary particle size improve nutrient digestibility and performance but increases the incidence of stomach ulceration. For example, Wondra et al. (1995) found that a reduction in maize particle size from 600 to 400 μm improved feed efficiency by 8% and energy digestibility by 7%. In addition, Lahaye et al. (2008) found improvements in nutrient digestibility when wheat was finely ground in pig diets. However, Wondra et al. (1995) also reported that stomach lesions and keratinization increased with reduced particle size. Cappai et al. (2013) recently classed feed containing 42.6% or more particles with a size < 0.4 mm as 'high risk' of causing stomach ulceration since gastric lesions were found in 62% of finishing pigs offered such diets. On the other hand, Morel and Cottam (2007) found no significant difference in ADG or FCR when they compared barley particle sizes between 1000 and 434 μm and neither did I'Anson et al. (2012) when comparing contrasting wheat particles. As noted above there is evidence that both pelleting and particle size improve pig performance but any interactive effects between them on pig performance are largely unknown. Kilburn and Edwards (2001) reported that pelleting improved the metabolizable energy value of coarsely ground maize diets but not finely ground maize diets offered to broilers which may suggest that interactive effects exist. Given that feed is still the largest cost in pig production, there is an urgent need to establish the effect of feed form, dietary particle size and any interactive or cumulative effects between them on pig performance, stomach integrity and nutrient digestibility.

Therefore, the aim of this study was to investigate the effect of offering finishing pigs a finely or coarsely ground diet in meal or pellet form on pig performance, nutrient digestibility, stomach keratinization and ulceration.

2. Materials and methods

2.1. Dietary treatments and manufacture

The trial was designed as a 2×2 factorial design with feed form (meal or pellets) and particle size (fine or coarse) as the main treatments. A simple cereal soya-based finishing pig diet was formulated to provide 13.6 MJ/kg digestible energy and 167 g/kg CP (Table 1). After the ingredients were mixed, the diet was processed as necessary to generate the four dietary treatments which were; (1) finely ground diet in meal form, (2) coarsely ground diet in meal form, (3) finely ground diet in pellet form and (4) coarsely ground diet in pellet form. The diets were manufactured at John Thompson and Sons Ltd (Knockmore site), Northern Ireland. The screen sizes used to produce the coarsely ground diets were two 14 mm and four 10 mm screens. The screen sizes used to produce the finely ground diets were six 4 mm screens. The particle size profile, and hence screen size, used to produce the coarse ground diets reflected the particle size profile of diets made by 'home millers' in Northern Ireland (Table 2). The particle size profile of the finely ground diet represented the normal particle size profile of compound feed offered to pigs (Table 2). A particle size test is carried out by stacking sieves of differing mesh sizes with a solid base at the bottom.

Table 1
Composition of the experimental treatments and formulated analysis.

Ingredient	g/kg (as fed)
Barley	412.04
Wheat	360.15
Soyabean meal	188.05
Limestone	13.3
Dicalcium phosphorus	7.6
Vegetable oil blend[a]	10.0
Salt (NaCl)	2.76
Knockmore pig finisher[b]	2.5
Lysine	2.30
NSP liquid[c]	0.5
Methionine	0.4
Phytase[c]	0.4
Formulated analysis	
DE (MJ/kg)	13.6
Crude protein (g/kg)	167
Fibre (g/kg)	33.4
Ash (g/kg)	47.6
Lysine (g/kg)	9.6
Oil B (g/kg)*	31.7
Calicum:phosphorus	1.68

[a] Supplied by John Thompson and Sons Ltd. Vegetable oil blens contains a minimum of 30% C18:2 and is a fixed mixture of soya bean oil, crude palm oil and mixed soft acid oil.

[b] The Knockmore pig finisher delivered the following minerals and vitamins per tonne of finished feed: 60 mg zinc, 30 mg manganese, 80 mg iron, 0.2 mg cobalt, 0.2 mg iodine, 0.2 mg selenium, 6 mg copper, 4000 iu Vit A, 600 iu Vit D_3, 75 iu Vit E, 1 mg Vit K, 2 mg Thiamin B_1, 2 mg Riboflavin B_2, 20 mg Nicotinic acid, 10 mg pantothenic acid, 2 mg pyridoxine B_6, 0.02 mg cyanocobalamin B_{12}, 0.05 mg biotin, 0.5 mg folic acid and 50 mg chorine.

[c] The NSP liquid enzyme component included 610 μ/kg 4a15 endo-1,4-beta-xylanase and 76 μ/kg endo-1,3(4)-beta-glucanase 76 μ/kg. The phytase used was 4a1640 6-phytase with an activity of 500 FTU.

* Oil B is a method to determine fat content and is similar to ether extract. There is a hydrolysis period prior to extraction (Official Journal of the European Communities, 1998).