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Comparative effect of crumbled or mashed feed form on growth performance, nutrient digestibility, backfat thickness, and carcass quality of growing-finishing pigs

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Abstract

Feed processing methods can substantially enhance the nutrient value of feed. The aim of our study was to compare the effects of mash or crumble feed on growth performance, nutrient digestibility, back-fat thickness, and carcass quality of growing-finishing pigs. In total, 50 ([Landrace × Yorkshire] × Duroc) growing pigs with initial body weight of 46.24 ± 3.57 kg were randomly assigned to two dietary treatment groups. The two dietary treatments were: 1) mash and 2) crumble feed forms for 14 weeks of trials. Five replication pens per treatment, comprised five pigs (2 males and 3 females) each. Growth performance, nutrient digestibility, back-fat thickness, and carcass quality were observed at different weeks. There were no significant differences in growth performance, nutrient digestibility, back-fat thickness, and carcass quality throughout the experimental trial. Further study is required to understand the effects of mash and crumble feed on growing-finishing pigs.

Keywords: carcass quality, feed form, growing-finishing pig, growth performance, nutrient digestibility

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Introduction

Pig farming is the largest sub-sector in the livestock industry; from this sector, large of global animal protein demand is fulfilled. The growing-finishing stage of pig production is the crucial period for fulfillment of global protein demand and has significant effects on profitability. About 55 - 75% of the total production cost of pigs is feed. After the realization of this, several industries and nutritionists were encouraged to search for strategies to improve animal growth performance by minimizing feed costs. The physical form (mash, pellet, extrusion, and crumble) of mixed feed is directly influencing pig production. Besides feed cost, the form and particle size of the feed in the swine diet have become critical factors in determining efficient feed utilization (Ball et al., 2015). Feed processing methods may change feedstuff's physical, chemical, and nutritional values through several mechanisms (Kim et al., 2015). Processed feed has been broadly used in the commercial pig industry. Generally, mash and pellets were fed to young and growing pigs, respectively. Yang et al. (2001) reported that the use of crumble feed reduced feed costs by 15% per kg of body weight gain compared to a mash diet. Even Nguyen et al. (2017) reported that with the crumble feed feeding, growth performance significantly increased and reduced market day age, along with increased meat quality in growing-finishing pigs. On the contrary, Al-Rabadi et al. (2009) and Rojas and Stein (2015) reported that decreasing the particle size of feed improved the pig's performance. Besides, Goodband and Hines (1988) described that the fine particle size of feed has negative effects on the gastrointestinal health of pigs. Sampath and Kim (2023) reported that supplementations of 50% mash and 50% crumble feed increased feed efficiency and reduced feed costs without affecting production performance compared to mash-form feed.

Very recently, scientists have placed more emphasis on the pellet form of swine feed because it is widely accepted that the pellet form of pig diet improves average daily gain and gain to feed ratio (Kim et al., 2015). Crumble feed has recently become popular in the poultry industry (Nguyen et al., 2017; Khan et al., 2023). Jahan et al. (2006) reported that higher body weight gain was seen with crumble feed supplementation compared to mash and pellet feed. However, comparative studies of mash and crumble feed in growing-finishing pigs are still limited. We hypothesized that comparative effects of mash and crumble feed form could influence the growth performance, nutrient digestibility, and carcass grade in growing-finishing pigs. Thus, in this present study, we evaluate the comparative effects of mash and crumble feed used in growing-finishing pigs.

Materials and Methods

The research protocol was confirmed by the Animal Care Committee of Dankook University in South Korea (Protocol No. DK-2-2207).

Animals, diets, and experimental design

In total, 50 ([Landrace × Yorkshire] × Duroc) growing pigs with an initial body weight of (46.24 ± 3.57) kg were randomly allocated between two dietary treatment groups. Five replicate pens per treatment, including five pigs (2 males and three females) in each pen. Pigs were fed mash and crumble feed for 14 weeks of the trial period. All the experimental diets were formulated according to the following NRC (2012) guidelines (Table 1). All pigs were raised in an environmentally controlled shed where the floor was plastic slatted. The shed temperature was maintained automatically at around 24℃. Each pen was well arranged with an automatic feeder and a nipple drinker. Pigs were always allowed to feed and drink throughout the experiment.

Sampling and analysis

Individual pig body weight and feed consumption (for each pen) were recorded on the last day of weeks 4, 8, 12, and 14 to calculate the average body weight gain and gain to feed ratio (G/F). As an indigestible marker, 0.5% chromium oxide (Cr_2O_3) was added to the pigs' diet seven days before fecal collection to determine the digestibility of dry matter (DM), nitrogen (N), and energy (GE). Fresh fecal samples were collected from two pigs (1 male and 1 female) per pen through the rectal palpation method on the last day of weeks 1, 4, 8, 12, and 14. Immediately, the collected samples were shifted to the laboratory for analysis, and the samples were allowed to dry for 72 hours in a hot air-drying oven at 60℃, then ground well

Table 1. Diet composition of experimental growing-finishing pigs.

Item	Growing	Finishing
Corn	37.98	36.15
Wheat	24.00	29.00
Rice bran	2.00	2.00
Wheat bran		
Parm kernel meal	3.00	3.00
Soybean meal	3.00	3.00
Dehulled soybean meal	11.34	8.12
Rape seed meal	4.00	4.00
Sesame meal	2.00	2.00
Brown rice	5.00	5.00
Animal fat	3.26	2.89
Molasses	2.00	2.00
Limestone	1.08	1.10
MDCP	0.10	0.09
Salt	0.30	0.30
Methionine 98%	NA	0.01
Threonine 98%	0.01	0.05
Lysine 25%	0.49	0.79
Choline chloride 50%	0.09	0.10
Vitamin/mineral mixture[z]	0.35	0.40
Total	100.00	100.00
Chemical composition		
Digestible energy (kcal/kg)	3,540	3,510
Metabolic energy (kcal/kg)	3,260	3,250
Crude protein (%)	16.00	15.00
Crude fat (%)	5.90	5.50
Crude ash (%)	4.20	4.10
Crude fiber (%)	3.90	3.90
Total lysine (%)	0.88	0.86
Calcium (%)	0.65	0.65
Phosphorus (%)	0.39	0.39

MDCP, monodicalcium phosphate; NA, not available.
[z] Provided per kg diet: 20,000 IU of vitamin A; 4,000 IU of vitamin D3; 80 IU of vitamin E; 16 mg of vitamin K3; 4 mg of thiamine; 20 mg of biotin, riboflavin; 6 mg of pyridoxine; 0.08 mg of vitamin B12; 120 mg of niacin; 50 mg of Ca-pantothenate; and 2 mg of folic acid and 0.08 mg of biotin.

and filtrated using a 1 mm screen bolter. DM and N were analyzed by following the guidelines of AOAC (2005). The existing amount of chromium in feed and fecal samples was measured using UV-1201 spectrophotometry (Shimadzu Corporation, Japan). Using the TecatorTM Kjeltec8400 analyzer (FOSS, Denmark), the protein content (N) in feed and fecal samples was analyzed. The GE was calculated by measuring the combustion heat production in the samples using a bomb calorimeter (6400 Automatic Isoperibol Calorimeter, Parr Instrument Company, USA). The nutrient digestibility was calculated using ND = [1 - {(Nf × Cd)/(Nd × Cf)}], where Nf = nutrient concentration in feces, Nd = nutrient concentration in diets, (Cf = chromium concentration in feces, and Cd = chromium concentration in diets. The back-fat thickness (BFT) of pigs was checked using an actual-time ultrasound instrument (Piglog 105, Frontmatec Group, Denmark) at the beginning and end of weeks 4, 8, 12, and 14. For statistical analysis, the mean value of BFT was used. Backfat thickness (mm), carcass weight, and carcass grade were measured. The quality of pork carcasses was graded into “Grade 1+”, “Quality Grade 1”, or “Grade 2”, based on characteristics such as marbling, lean color, and conditions of belly streaks (KAPE, 2010). Carcass BFT was adjusted to a live weight of 115 kg, as described previously (Ha et al., 2010).

Statistical analysis

All of the experimental data were analyzed using SAS (SAS version 9.4, SAS Institute Inc., USA) (general linear model technique) in a completely randomized block design. The pen was considered an experimental unit. Less than 0.05 was considered as a statistical significance.

Results and Discussion

The form of feed (mash/crumble) is a crucial factor for production performance. For the past few decades, nutritionists have focused on improving the nutritional value of feed. Feed forms and their processing methods can improve the nutritional value of ready-made feed. Mash is one of the complete feed types where feed ingredients are finely ground and well-mixed to ensure a balanced diet for animals. It enhances the growth performances of animals and is more economical. Crumble is another type of ready feed that is prepared at the feed mill by pelleting the well-mixed feed ingredients and then crushing the pellet to a consistency coarser than mash (Sureshkumar and Kim, 2021). Crumble feed production costs are comparatively higher than mash due to its higher processing costs. Even then, crumble feed is getting more attention in broiler productions because of its convenience. Generally, mash feed is produced specially for young animals for their better body development and muscle building. It contains high-quality protein and a higher level of amino acids, which are also helpful for the rapid growth and development of pigs. Recently, extruder and expander processing getting more attention because some previous researches reported that nutritional value may altered by extruder and expander conditions for an example degree of temperature. Crumble feed significantly increased the growth performance of growing-finishing pigs compared to mash feed (Nguyen et al., 2017). Additionally, Sampath and Kim (2023) stated that supplementation of 50% mash and 50% crumble feed enhanced the feed efficacy and reduced the feed cost compared to only mash feed. In this study, mash and crumble form of feed had no significant effects on average daily gain (ADG), feed intake (FI) and G/F in growing-finishing pig throughout the experiment (Table 2). Similarly, Kim et al. (2015) reported that crumble and mash feed had no significant effects on growth performances in sows. Additionally, Sampath and Kim (2023) reported that mash and crumble feed had no significant differences on body weight, daily gain, daily feed intake in growing-finishing pig. The possible reason for no significant effects would be the different nutritional source, manufacturing technology or feed structure, farm environment and management practices etc. But the actual mechanism is still uncleared. The effects of mash and crumble feed form on nutrient digestibility of growing-finishing pig is summarized in Table 3. There were no significant effects in the nutrient digestibility of DM, N, and GE of pigs throughout the experiments. Similarly, Sampath and Kim (2023) reported that no significant effects on nutrient digestibility on DM, N and GE in growing-finishing pigs by the using of mash Vs 50% mash and 50% crumble. However, Owsley et al. (1981) reported that reduction particle size of sorghum from 1262 μm to 802 μm to 471 μm has enhanced the apparent nutrient digestibility of DM, starch, N and energy measured at the marginal ileum of the total digestive tract of growing pigs. In our best knowledge very, limited study has been carried out on animals fed mash or crumble feed form that enhance the nutrient digestibility parameter. We speculate that no significant on growth performance is probably due to lack of nutrient digestibility, while the main cause is still unclear, thus it needs further study. In our study, no significant was observed in back-fat thickness (Table 4), which was constant with the findings of Sampath and Kim (2023) and Nguyen et al. (2017). Moreover, Sampath and Kim (2023) and Pettersson and Bjórklund (1976) stated no significant differences in carcass quality (Table 5) in pigs fed mash and crumble feed.

Table 2. The effect of mash and crumble feed on growth performance in growing-finishing pigs.

Item	TRT1	TRT2	SEM	p-value
Body weight (kg)				
Initial	46.24	46.24	0.000	0.9932
Week 4	65.31	65.39	0.028	0.9189
Week 8	85.89	86.20	0.109	0.7624
Week 12	108.58	108.97	0.137	0.7817
Week 14	120.64	121.10	0.162	0.7732
Initial - Week 4				
ADG (g)	681	684	1.060	0.8165
ADFI (g)	1,256	1,255	0.353	0.9784
G/F	0.542	0.546	0.001	0.6454
Week 4 - 8				
ADG (g)	735	743	2.828	0.5738
ADFI (g)	1,412	1,434	7.778	0.6413
G/F	0.521	0.519	0.007	0.6938
Week 8 - 12				
ADG (g)	811	813	0.707	0.8613
ADFI (g)	1,943	1,948	1.767	0.9217
G/F	0.417	0.418	0.001	1.0000
Week 12 - 14				
ADG (g)	861	866	1.767	0.7506
ADFI (g)	2,566	2,507	20.859	0.4761
G/F	0.336	0.346	0.003	0.3319
Overall				
ADG (g)	759	764	1.767	0.7463
ADFI (g)	1,684	1,683	0.353	0.9792
G/F	0.451	0.454	0.001	0.3972

TRT1, mash feed; TRT2, crumble feed; ADG, average daily gain; ADFI, average daily feed intake; G/F, gain to feed ratio; SEM, standard error of means.

Table 3. The effect of mash and crumble on nutrient digestibility in growing-finishing pigs.

Item (%)	TRT1	TRT2	SEM	p-value
Initial				
Dry matter	76.85	77.49	0.226	0.8307
Nitrogen	73.40	73.93	0.187	0.8670
Energy	76.36	76.98	0.219	0.8868
Week 4				
Dry matter	75.99	75.99	0.000	0.9992
Nitrogen	76.99	73.07	1.385	0.2874
Energy	74.98	73.71	0.449	0.7700
Week 8				
Dry matter	74.55	73.20	0.477	0.8129
Nitrogen	73.51	72.48	0.364	0.8337
Energy	74.23	72.60	0.576	0.7545
Week 12				
Dry matter	72.96	70.18	0.982	0.5900
Nitrogen	71.43	69.94	0.526	0.8055
Energy	69.66	68.87	0.279	0.7971
Week 14				
Dry matter	70.40	71.22	0.289	0.5559
Crude protein	69.88	68.90	0.346	0.7331
Gross energy	64.09	64.29	0.070	0.8899

TRT1, mash feed; TRT2, crumble feed; SEM, standard error of means.

Table 4. The effect mash and crumble feed on backfat thickness in growing-finishing pigs.

Item	TRT1	TRT2	SEM	p-value
Initial				
Backfat thickness (mm)	8.4	8.6	0.070	0.4831
Lean meat (%)	63.46	63.48	0.007	0.9422
Week 8				
Backfat thickness (mm)	14.5	14.9	0.141	0.3912
Lean meat (%)	57.65	57.49	0.056	0.3428
Week 14				
Backfat thickness (mm)	18.7	18.7	0.000	0.9210
Lean meat (%)	52.59	52.59	0.000	1.0000

TRT1, mash feed; TRT2, crumble feed; SEM, standard error of means.

Table 5. The effect of mash and crumble feed on carcass grade in growing-finishing pigs.

Item	TRT1	TRT2	SEM	p-value
Carcass weight (kg)	92.24	89.04	1.131	0.0594
Backfat thickness (mm)	18.96	19.00	0.014	0.9698
1+ (%)	28.00	32.00	NA	NS
1 (%)	44.00	40.00	NA	NS
2 (%)	28.00	28.00	NA	NS

TRT1, mash feed; TRT2, crumble feed; SEM, standard error of means; NA, not available; NS, not significant.

Conclusion

In conclusion, mash or crumble feed did not show any significant differences on the growth performance, nutrient digestibility, back-fat thickness and carcass quality in growing-finishing pigs.

Conflict of Interests

No potential conflict of interest relevant to this article was reported.

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