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Effects of Different Types of Diet with or without Supplementation of Vitamins and Trace Minerals on Growth Performance, Carcass and Muscle Quality, and Fecal Mineral Excretion in Late Finishing Pigs

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Abstract: Two experiments were conducted to study the effects of different types of diets with or without supplementation of vitamin-trace mineral premix (hereinafter referred to as VTM) on growth performance, carcass and muscle quality and fecal mineral concentrations in late finishing pigs. In Exp. 1, one hundred and twenty-eight pigs, with an average initial body weight (BW) of (78.5 ± 4.6) kg, were allotted to treatments on the basis of BW and gender with 4 replications of 8 pigs per replicate pen for each treatment. The treatments were designed in a 2 × 2 factorial arrangement, and were as follows: (1) corn-soybean meal (C-SBM) diet with VTM, (2) C-SBM diet without VTM, (3) corn-mixed meals (C-MM) diet with VTM, and (4) C-MM diet without VTM. In Exp. 2, 112 pigs (average initial BW of (90.3 ± 6.3) kg) were allotted to treatments on the basis of BW and gender with 4 replications of 7 pigs per replicate pen for each treatment. The treatments were the same as in Exp. 1. During the finishing period from 79 to 110 kg (Exp. 1), pigs fed C-SBM diets grew faster ($P < 0.01$) and ate more than those fed C-MM diets ($P < 0.05$). During the finishing period from 90 to 105 kg (Exp. 2), pigs also grew faster when they were provided C-SBM diets rather than C-MM diets ($P < 0.05$). However, diets with or without VTM in both types of diets during either finishing period had not significant effect on growth performance ($P > 0.05$). Dietary type and diets without VTM had no effects on carcass traits and muscle quality during either finishing period ($P > 0.05$). Fecal mineral concentrations were not affected by dietary type ($P > 0.05$), but diets without VTM had significantly reduced fecal Cu, Fe and Mn concentrations ($P < 0.01$), and had the tendency to reduce fecal Zn concentrations ($P > 0.05$). The interactions of dietary type × VTM interactions had no significant effect on growth performance, carcass traits, muscle quality and fecal mineral excretion in both experiments ($P > 0.05$). These results indicate that VTM can be removed from either C-SBM or C-MM diets of late finishing pigs, approximately, in the final 25 or 40 days so as to reduce feed cost and nutrients excretion in waste materials.

Key words: Finishing pig; Dietary type; Vitamin; Trace mineral; Performance; Fecal excretion

Feed represents the major (usually greater than 65%) cost in producing pork. Pigs consume more feed daily during the late-finishing period, but the gain/feed ratio is lowest during this phase. Therefore, the dietary nutrient concentrations are relatively lower in late-finishing pigs[1]. However, it is a common practice to over-fortify the finishing diets. This results in an increase in feed cost and also causes excessive nutrient excretion that contributes to environmental pollution. Studies showed that without both vitamin and trace mineral premixes (VTM) during the late finishing period[2-4] or the entire finishing period[5] did not affect growth performance and carcass traits in finishing pigs. However, these studies used

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soybean meal (SBM) as the sole protein supplement in experimental diets. In many countries, rapeseed meal, cottonseed meal and other oilseed meals are frequently-used dietary protein supplements for pigs (especially finishing pigs). It remains unknown whether corn-mixed meals (C-MM) diet without VTM will have no adverse effects on finishing pigs. Thus, the objectives of the study reported herein were to determine the effects of diets without VTM on growth performance, carcass and muscle quality and fecal mineral excretion in late finishing pigs when fed a C-MM diet in comparison with a C-SBM diet.

1 Materials and methods

1.1 Animals and experimental diets

Two experiments were conducted with a total of 240 finishing pigs, and the experiments were conducted in accordance with the Regulation on the Care of Experimental Animals issued by the Science and Technology Commission of Chongqing Municipality. In Exp. 1, 128 pigs (PIC Line 402 sire × C22 dam), with an average initial body weight (BW) of 78.5 (SD of 4.6) kg, were allotted to 4 treatments. The pigs were blocked by initial BW and assigned to treatments based on ancestry and gender. The treatments were designed in 2 × 2 factorial arrangement and included: (1) C-SBM diet with VTM, (2) C-SBM diet without VTM, (3) C-MM diet with VTM, and (4) C-MM diet without VTM. Each treatment included 4 replications of 8 pigs per replicate pen. There were 2 pens of gilts and 2 pens of barrows. Until the initiation of the experiment, pigs were given a pellet diet that met or exceeded the NRC[1] nutrient requirements for all nutrients. For the experiment, diets were also fed in pellet form, and the nutrient content of the control diet (VTM included) was almost identical to or greater than the NRC[1] nutrient requirements (Table 1). Corn was added to the diet to make up for the premixes not added. In Exp. 2, a total of 112 pigs (PIC Line 402 sire × C22 dam), with an average initial BW of 90.3 (SD of 6.3) kg, were allotted to 4 treatments. Each treatment included 4 replications of 7 pigs per replicate pen. There were 2 pens of gilts and 2 pens of barrows. The treatments were the same as in Exp. 1.

Table 1 Composition and nutrient levels of basal diets

(as fed basis, %)

Items[1]	C-SBM diet		C-MM diet	
	Control	No VTM	Control	No VTM
Ingredients				
Corn	77.08	78.08	62.03	63.03
Rice bran	—	—	13.42	13.42
Soybean meal	19.08	19.08	—	—
Rape seed meal	—	—	13.00	13.00
Cotton seed meal	—	—	5.58	5.58
Nacl	0.35	0.35	0.35	0.35
Limestone	0.78	0.78	1.65	1.65
Monocalcium phosphate	1.52	1.52	—	—
VTM[2]	1.00	—	1.00	—
L – Lysine · HCL	0.13	0.13	0.29	0.29
Methioine	0.05	0.05	—	—
Soybean oil	—	—	2.67	2.67
Antibiotic premix[3]	0.01	0.01	0.01	0.01
Calculated composition				
DE(MJ/kg)	13.68	13.68	13.56	13.56
CP	14.5	14.6	14.4	14.5
CF	2.4	2.4	3.9	3.9
Ca	0.90	0.90	0.90	0.90
Total P	0.60	0.60	0.60	0.60
L-Lysine	0.75	0.75	0.75	0.75
Methionine	0.28	0.28	0.24	0.24
Methionine + Cystine	0.51	0.51	0.51	0.51
Measured composition				
CP	14.7	14.8	14.9	14.7
Ca	0.95	0.96	0.97	0.94
Total P	0.58	0.54	0.57	0.55
Cu	88	41	81	31
Fe (mg/kg)	221	143	297	185
Mn(mg/kg)	84	52	104	80
Zn(mg/kg)	111	63	114	56

[1] C-SBM = corn-soybean meal, C-MM = corn-mixed meals, VTM = vitamin and trace mineral premixes; Control diet was a diet with VTM.

[2] Supplied the following per kg of complete diet: 9 000 IU vitamin A, 2 000 IU vitamin D_3, 30 IU vitamin E, 2 mg vitamin K (as menadione), 2 mg thiamin, 5 mg riboflavin, 2.4 mg vitamin B_6, 100 μg biotin, 20 mg niacin, 10 mg panthothenic acid (as D-calcium pantothenate), 1 mg folic acid, 24 μg vitamin B_{12}, 186.5 mg choline, 100 mg Zn, 150 mg Fe, 125 mg Cu, 20 mg Mn, 0.35 mg I, and 0.3 mg Se.

[3] Provided 5 mg of flavomycin per kg of complete diet.

1.2 Animal feeding and management

Pigs were raised in a pen of 70% solid concrete and 30% slated concrete floor. Each pen (2 m × 4.8 m) was equipped with a self-feeder and a nipple waterer. Pigs were allowed to consume feed and water *ad libitum*. Experiments were carried out during spring months, with housing temperature ranging from 15℃ to 26 ℃ and the relative humidity averaging 75% throughout the study.

1.3 Sampling and measurements

The experimental diets were analyzed for crude protein (CP), Ca, total P, Cu, Fe, Mn, and Zn[6]. Pigs were weighed at the beginning and end of each finishing period (79 to 90 kg and 90 to 110 kg in Exp. 1, and 90 to 105 kg in Exp. 2). When a pen of pigs, within a weight block, reached an average BW of 110 kg in Exp. 1 or 105 kg in Exp. 2, the entire block was removed from the growth assay. Feed consumption was recorded daily on pen basis. Average daily gain (ADG), average daily feed intake (ADFI) and feed/gain ratio (F/G) were determined in growth assay. During the growth assay, the top portion of freshly voided feces was obtained in each pen once every five days and the fresh fecal samples were immediately weighed, dried at 65℃, ground in a stainless blender, and frozen at −20℃ until mineral analysis was performed. The fecal samples were pooled on basis of pen, and then subject to Cu, Fe, Mn, and Zn analysis[6]. After the conclusion of the growth assay in the morning, the pigs were shipped in the afternoon to a commercial slaughter facility and were processed before 07:00 h the next day. Twelve pigs from each treatment were randomly selected for evaluation of carcass and muscle quality. The hot carcass weight was recorded to allow calculation of dressing percentage. Off-midline backfat thickness and longissimus muscle (LM) depth were measured at the 10th rib, and the backfat thickness was skin-on thickness. Fat-free lean index was calculated using the equation suggested by the National Pork Producers Council[7]. The LM (approximately 2 cm thick) at the 10th rib was traced and scored for color and marbling according to procedures suggested by the National Pork Producers Council[8]. The LM samples were also measured for pH values within 45 min postmortem by using a pH meter. Water-holding capacity of the fresh LM was evaluated by measuring water loss percentage using the filter paper press method described by Ye[9]. Cooking loss of the fresh LM was determined using the method of Ye[9].

1.4 Data analysis

Data of growth performance, carcass traits, muscle quality, and fecal mineral concentrations were analyzed as a randomized complete block design[10] using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). A linear statistical model which included terms for dietary type (C-SBM or C-MM), VTM (with or without), and the first-order interaction was fitted to the experimental data. Pen was the experimental unit for all response criteria. Hot carcass weight was used as a covariate for analysis of dressing percentage, backfat thickness, LM depth and fat-free lean index.

2 Results

Removing VTM from diets during late finishing periods (approximately the final 40 d in Exp. 1 or 25 d in Exp. 2) had no effects on ADG, ADFI and F/G (Table 2) ($P > 0.05$). However, dietary type had significanteffects on ADG during both finishing periods (Exp. 1 and Exp. 2), ADFI during the finishing period from 79 to 110 kg (Exp. 1), and F/G during the finishing period from 79 to 90 kg (Table 2) ($P < 0.05$ or 0.01). The performance of pigs fed C-SBM diets was higher than that of pigs fed C-MM diets (Table 2). The pigs remained healthy throughout the experiment with no vices (tail biting, ear chewing, etc.), behavioral aberrations and deaths occurred.

Table 2 Effect of diets with or without vitamin and trace mineral premixes on growth performance in late finishing pigs fed different types of diets (Exp. 1 & Exp. 2)[1]

Items	C-SBM diet		C-MM diet		SEM	*P*-values[2]	
	Control	No VTM	Control	No VTM		Diet type	VTM
Exp. 1							
79 ~ 90 kg[3]							
ADG (kg)	1.090	0.985	0.823	0.815	0.06	0.01	0.23
ADFI (kg)	3.060	3.025	2.788	2.810	0.11	0.01	0.30
F/G	2.8	3.1	3.4	3.4	0.23	0.05	0.53
90 ~ 110 kg[3]							
ADG (kg)	0.862	0.852	0.813	0.776	0.07	0.01	0.44
ADFI (kg)	3.041	3.033	2.834	2.664	0.14	0.03	0.38
F/G	3.5	3.6	3.5	3.4	0.37	0.68	0.76
79 ~ 110 kg[3]							
ADG (g)	0.952	0.920	0.829	0.809	0.06	0.01	0.42
ADFI (g)	3.053	3.067	2.813	2.710	0.15	0.04	0.54
F/G	3.2	3.3	3.4	3.3	0.29	0.86	0.73
Exp. 2							
90 ~ 105 kg[3]							
ADG (kg)	0.710	0.728	0.681	0.665	0.07	0.05	0.32
ADFI (kg)	2.671	2.690	2.600	2.361	0.20	0.43	0.55
F/G	3.8	3.7	3.8	3.6	0.28	0.76	0.81

[1] C-SBM = corn-soybean meal, C-MM = corn-mixed meals, VTM = vitamin and trace mineral premixes; Control diet was a diet with VTM.

[2] Diet type × VTM interaction was non-significant ($P > 0.05$).

[3] ADG = average daily gain, ADFI = average daily feed intake, F/G = feed/gain ratio.

The carcass and muscle quality were not affected by both dietary types and VTM inclusion or omission in either finishing period (Table 3 and 4) ($P > 0.05$). The fecal concentrations of Cu, Fe and Mn were significantly reduced during both finishing periods when VTM were omitted from the diets (Table 5) ($P < 0.01$). During the finishing period from 79 to 110 kg, C-SBM diet without VTM resulted in 181%, 39%, and 59% reductions in fecal Cu, Fe, and Mn concentrations, respectively; and C-MM diets without VTM resulted in 242%, 17%, and 32% reductions in fecal Cu, Fe, and Mn concentrations, respectively. During the finishing period from 90 to 105 kg, C-SBM diet without VTM resulted in 108%, 30% and 52% reductions in fecal Cu, Fe and Mn concentrations, respectively; C-MM diet without VTM resulted in 170%, 21% and 31% reductions in fecal Cu, Fe and Mn concentrations, respectively. The fecal concentrations of Zn decreased by 2% ~ 18% during both finishing periods when VMT were removing from either C-SBM or C-MM diets, but the effects were not significant statistically ($P > 0.05$) (Table 5). The fecal mineral concentrations were not affected by dietary type (Table 5) ($P > 0.05$).

Table 3 Effect of diets with or without vitamin and trace mineral premixes on carcass and muscle quality in late finishing pigs fed different types of diets (Exp. 1)[1]

Items	C-SBM diet		C-MM diet		SEM	*P*-values[2]	
	Control	No VTM	Control	No VTM		Diet type	VTM
Dressing percentage(%)	78.4	78.3	77.9	77.7	5.03	0.79	0.76
10th rib backfat thickness (cm)	1.7	1.7	1.6	1.7	0.44	0.84	0.89
Longissimus muscle depth (cm)	6.0	5.9	5.8	5.9	0.37	0.75	0.82
Fat-free lean index (%)[3]	50.5	50.2	50.0	50.2	3.41	0.99	0.89
Longissimus muscle pH	6.3	6.1	6.2	6.5	0.46	0.76	0.84
Longissimus muscle color[4]	3.3	3.6	3.6	3.7	0.52	0.85	0.78
Longissimus muscle marbling[5]	3.5	3.6	3.7	3.4	0.45	0.68	0.72
Water loss (%)[6]	22.3	23.2	24.5	27.4	6.04	0.56	0.46
Cooking loss (%)	44.6	44.7	45.5	46.4	6.15	0.67	0.71

[1] C-SBM = corn-soybean meal, C-MM = corn-mixed meals, VTM = vitamin and trace mineral premixes; Control diet was a diet with VTM.

[2] Diet type × VTM interaction was non-significant ($P > 0.05$).

[3] Calculated using the equation: fat-free lean index (%) = 51.537 + (0.035 × hot carcass wt., lb) - (12.26 × off-midline backfat thickness, in) [7].

[4] Scored on a scale of 1 = pale pinkish gray to white to 6 = dark purplish red [8].

[5] Scored on a scale of 1 = practically devoid to 10 = abundant [8].

[6] A lower value suggests a greater water-holding capacity or vice versa.

Table 4 Effect of diets with or without vitamin and trace mineral premixes on carcass and muscle quality in late finishing pigs fed different types of diets (Exp. 2)[1]

Items	C-SBM diet		C-MM diet		SEM	*P*-values[2]	
	Control	No VTM	Control	No VTM		Diet type	VTM
Dressing percentage	77.9	77.4	76.9	76.5	2.05	0.93	0.85
10th rib backfat thickness (cm)	1.9	1.8	1.6	1.7	0.35	0.67	0.73
Longissimus muscle depth (cm)	6.1	6.0	5.9	5.9	0.39	0.87	0.81
Fat-free lean index (%)[3]	49.3	49.7	50.6	50.1	3.34	0.94	0.90
Longissimus muscle pH	6.7	6.4	6.8	6.6	0.61	0.80	0.93
Longissimus muscle color[4]	3.3	3.6	3.3	3.2	0.46	0.78	0.82
Longissimus muscle Marbling[5]	3.6	3.9	3.5	3.6	0.52	0.65	0.73
Water loss (%)[6]	21.3	23.3	25.0	28.1	6.12	0.45	0.39
Cooking loss (%)	43.5	45.2	45.3	46.6	6.16	0.74	0.69

[1] C-SBM = corn-soybean meal, C-MM = corn-mixed meals, VTM = vitamin and trace mineral premixes; Control diet was a diet with VTM.

[2] Diet type × VTM interaction was non-significant ($P > 0.05$).

[3] Calculated using the equation: fat-free lean index (%) = 51.537 + (0.035 × hot carcass wt., lb) - (12.26 × off-midline backfat thickness, in) [7].

[4] Scored on a scale of 1 = pale pinkish gray to white to 6 = dark purplish red [8].

[5] Scored on a scale of 1 = practically devoid to 10 = abundant [8].

[6] A lower value suggests a greater water - holding capacity or vice versa.

Table 5 Effect of diets with or without vitamin and trace mineral premixes on mineral concentrations (mg/kg fecal DM) in late finishing pigs fed different types of diets (Exp. 1 & Exp. 2)[1]

Items	C-SBM diet		C-MM diet		SEM	*P*-values[2]	
	Control	No VTM	Control	No VTM		Diet type	VTM
Exp. 1							
Cu	542	193	581	170	11.12	0.23	0.01
Fe	950	683	851	730	34.23	0.34	0.01
Mn	569	358	489	371	23.65	0.17	0.01
Zn	170	166	159	147	10.79	0.27	0.23
Exp. 2							
Cu	728	350	648	240	9.75	0.31	0.01
Fe	1041	801	930	771	36.85	0.28	0.01
Mn	641	422	563	430	25.36	0.34	0.01
Zn	169	143	180	171	11.47	0.20	0.23

[1] C-SBM = corn-soybean meal, C-MM = corn-mixed meals, VTM = vitamin and trace mineral premixes; Control diet was a diet with VTM.

[2] Diet type × VTM interaction was non – significant ($P > 0.05$).

3 Discussion

The present study showed that in finishing pigs fed either C-SBM or C-MM diets without VTM did not affect the growth performance, carcass and muscle quality. These results were in agreement with those of several studies[2-5]. In the study of McGlone[4], one trial was performed under commercial conditions. And in the study of Starkey *et al.*[5], pigs were subjected to moderately stressful housing conditions from 68 to 115 kg. Edmonds and Arentson[11] also reported diets without VTM for 12 wk had no effects on growth performance and carcass traits when diets were medicated with bacitracin methylene disalicylate and when pigs were less crowded (0.80 m^2 per pig), whereas they observed pigs fed diets without VTM for 12 wk had lower ADG (but normal carcass traits) when the diets were unmedicated and pigs were crowdedly penned (0.66 m^2 per pig). Choi *et al.*[12] reported that ADG and feed efficiency were lowered by reducing or removing dietary VTM for the last 4 wk of period when finishing pigs were expected to suffer environmental stresses because their trail was performed under commercial farm condition rather than university farm condition. In their study, the carcass traits, however, were not affected by reducing or removing dietary VTM.

In this study, the mineral (Cu, Fe, Mn and Zn) concentrations of either C-SBM or C-MM diets with VTM removed were still greater than those defined by NRC[1]. However, the intakes of vitamins in the diets, from which VTM were depleted were below the concentrations recommended by NRC[1] (data not shown). The failure to observe clinical signs of nutrient deficiency, retarded growth rate and declined carcass muscle quality in pigs in this study suggests that tissue stores of nutrients were not seriously depleted during the late finishing phase deprived of dietary vitamin and trace mineral supplementation. The depletion of minerals and vitamins from the tissue stores to the extent needed to produce clinical signs of deficiency requires weeks or months in swine approaching market weight[4]. Kridder *et al.*[13] found no depression in growth of weanling pigs without B-vitamin supplementation for 7 wk, although retarded growth rate and deficiency signs appeared later. Weanling pigs are more sensitive to nutritionally inadequate diets than finishing pigs, and would be expected to become depleted

in B-vitamins more quickly than finishing pigs. Therefore, the dites without of VTM for pigs destined for pork production within a limited period after the inception of unsupplemented diets, appears to be an attractive feeding strategy for minimizing pork production cost and reducing environmental pollution.

This study showed that dietary type had significant effects on the growth performance in late finishing pigs. The growth performance of pigs fed C-SBM diets was higher than that of pigs fed C-MM dies. Although these two types of diet were identical in digestible energy (DE), CP, Ca, total P, lysine and sulfur-containing amino acids concentrations, the nutrient availability of these two types of diet might be different. Rapeseed meal and cottonseed meal used in the C-MM diets generally contain less available amino acids than SBM[14]. Because of the higher fiber content in both rapeseed meal (>11%) and cottonseed meal (>10%), they contain less DE than SBM. For example, canola (a cultivar of rapeseed) meal contains about 15 to 25 less DE than SBM[15]. Rapeseed meal and cottonseed meal contain more antinutritional factors. The presence of glucosinolates is the major factor limiting the use of rapeseed meal[15-17]. Although these substances themselves are biologically inactive, they can produce goitrogenic compounds on enzymatic hydrolysis with myrosinase[15,18-19]. Cottonseed meal contains gossypol which is toxic to animals[18,20-22]. In addition, gossypol can form insoluble complexes with proteins and Fe, and this affects the utilization of protein and Fe in pigs[14]. Rapeseed meal and cottonseed meal may cause palatable problems, and rapeseed meal, for instance, is less palatable than SBM[18]. In the present study, the feed intake of late finishing pigs was lower when they were provided C – MM diets. Furthermore, there may exist a difference in dietary amino acid patterns and vitamin and trace mineral concentrations between these types of diets.

In swine production, most diets are formulated to meet or exceed the estimated requirements for specific nutrients at all stages of life cycle. The nutrients ingested and exceeded the needs will contribute to soil and water pollution. The present study showed that removing VTM from pig diets during the late finishing period resulted in a remarkable reduction in fecal Cu, Fe, Mn, and Zn concentrations. Since high Cu diets were still widely-used in finishing swine production in many countries[23], the control diets used in our study were designed to contain high doses of Cu, and thus the reductions of fecal Cu concentrations with diets of without VTM were much greater (a decrease by 108 to 242%). In the study of Shaw et al. [24], diets without VTM as well as a two – thirds reduction in dietary inorganic phosphorus for 28 d preslaughter decreased fecal Ca, P, Cu, Fe, Mn, and Zn concentrations. In the present study, differences in fecal mineral concentrations between diets with or without VTM in either type of diet were reflective of differences in daily mineral intakes, which can be calculated using analyzed dietary mineral concentrations (Table 1) and ADFI (Table 2) (data not presented). Therefore, removing VTM in the finishing pig diet is particularly significant in reducing environmental pollution.

Tissue vitamin and mineral concentrations were not evaluated in our study. Results from Patience and Gillis[25] suggested that removing VTM from pig diets for 35 d prior to market resulted in reduced thiamin, but not riboflavin or niacin concentrations in fresh meat. Edmonds and Arentson[11] reported finishing pigs devoid of supplemental vitamins and trace minerals for either 6 or 12 wk had markedly reduced muscle vitamin E concentrations in both LM and ham muscle opposed to those fed diets with adequate vitamin and trace mineral fortification. Conversely, Choi *et al*[25] reported no difference in the LM vitamin E concentrations with 4-wk VTM remo-

ving in finishing pigs. According to Shaw *et al.* [24], removing of dietary VTM and a two-thirds reduction in dietary inorganic phosphorus in finishing pigs for 28 d preslaughter decreased concentrations of riboflavin and niacin in LM, but did not affect LM thiamin and vitamin E concentrations as well as either Cu/Zn superoxide dismutase or glutathione peroxidase activity. Therefore, the effects of diets without VTM on tissue vitamin concentrations of finishing pigs were inconsistent. Furthermore, it is worth mentioning that most vitamins are subjected to destruction as a result of fresh meat cooking.

Removing dietary VTM and reducing two – thirds dietary inorganic phosphorus for 28 d preslaughter did not affect Fe, Cu, Zn, and Ca concentrations in LM[24]. Edmonds and Arentson[11] also reported that removing VTM from finishing diets either 6 or 12 wk prior to slaughter did not affect Zn, Cu and Fe concentrations in LM and Zn and Fe concentrations in ham muscle. Only Cu concentrations in the ham muscle decreased in their study when medication was devoid in the diet without VTM pigs were crowdedly penned. Therefore, unlike vitamins, tissue trace mineral concentrations were relatively consistent regardless of dietary concentrations[26]. For instance, muscle Zn concentrations were maintained during times of low Zn intake[27], and muscle Cu concentrations were not affected by dietary deficiencies[28] or excesses[29-30].

4 Conclusion

Removing supplemental vitamins and trace minerals from either C-SBM or C-MM diets during late finishing periods (approximately the final 25 or 40 days) would not affect growth performance, carcass and muscle quality. Furthermore, removing supplemental vitamins and trace minerals from late finishing diet had reduced the excesses of minerals in waste material. The growth performance of finishing pigs fed C-SBM diets was higher than that of pigs fed C-MM diets. To justify whether removing supplemental vitamins and trace minerals from the late finishing diet in practical pig production, it is essential to conduct further studies to investigate the impact of the removing vitamin and trace mineral premixes on pork storage, processing, and nutritive value for human consumption.

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饲粮类型和肥育后期不添加维生素和微量矿物元素对猪生长性能、胴体和肌肉品质、粪中矿物元素排泄的影响

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摘 要:本研究共开展两个试验,探讨饲粮类型和不添加维生素和微量矿物元素对猪肥育后期生长性能、胴体和肌肉品质、粪中微量矿物元素排泄的影响。在试验 1 中,选用 128 头平均体重(78.5 ±4.6) kg 的肥育猪,根据体重和性别分成 4 组,每组 4 圈(重复),每个重复 8 头猪。四组试验猪的试验处理为 2 ×2 因子设计,即两种类型(玉米 – 豆粕型和玉米 – 杂粕型)饲粮和添加或不添加维生素/微量矿物元素预混料。在试验 2 中,选用 112 头平均体重(90.3 ±6.3) kg 的肥育猪,根据体重和性别分成 4 组,每组 4 圈(重复),每个重复 7 头猪。试验处理同试验 1。结果显示,在 79 ~ 110 kg 肥育期中(试验 1),采食玉米 – 豆粕型饲粮的猪的增重速度和采食量显著高于采食玉米 – 杂粕型饲粮的猪($P < 0.01$ 或 0.05)。在 90 ~ 105 kg 肥育期中(试验 2),采食玉米 – 豆粕型饲粮的猪的增重速度仍然高于采食玉米 – 杂粕型饲粮的猪($P < 0.05$)。但是,维生素和微量矿物元素添加与否对生长性能无显著影响($P > 0.05$)。饲粮类型和不添加维生素和微量矿物元素对胴体和肌肉品质均无显著影响($P > 0.05$)。粪中微量矿物元素含量不受饲粮类型的影响($P > 0.05$),但不添加维生素和微量矿物元素时,粪中铜、铁、锰的含量显著降低($P < 0.01$),粪中锌含量也有降低的趋势($P > 0.05$)。对于生长性能、胴体和肌肉品质以及微量矿物元素排泄量,饲粮类型 × 维生素/微量矿物元素预混料的交互作用不显著($P > 0.05$)。结果表明,在猪的肥育后期(最后约 25 ~ 40 d),在玉米 – 豆粕型和玉米 – 杂粕型饲粮中可不添加维生素和微量矿物元素,从而可降低饲料成本和减少微量矿物元素的排泄。[动物营养学报,2007,19(1):1 –10]

关键词:肥育猪;饲粮类型;维生素;微量矿物元素;生产性能;排泄

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