

Interactive Compensatory Response of Growing Pigs to Feed Withdrawal Periods and Ascorbic Acid Supplementation

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Target audience: Pork Producers, Animal Scientist and Pork Consumers

Abstract

A total of fifty four Large White growing pigs with weight range of 21.70-23.89 kg were used in a 60-day trial to determine the compensatory response of growing pigs to feed withdrawal periods and ascorbic acid supplementation. The pigs were grouped on weight equalization into 9 treatments with 3 replicate groups of 2 pigs each. The experimental layout was a 3x3 factorial arrangement with 2 factors; factor A consisting of three levels of feed withdrawal periods (0, 2 and 4 hours) and factor B consisting of 3 levels of ascorbic acid supplementation (0, 1500 and 2500 mg/kg feed). Pigs were subjected to 90 days feed withdrawal periods with or without ascorbic acid supplementation and 60 days realimentation period. Growth performance, morphological and physiological parameters data were collected fortnightly. Results obtained revealed that final weight, weight gain, average daily weight gain, total feed intake, and average weekly feed intake were significantly ($P<0.05$) influenced by interactive effect of feed withdrawal periods and ascorbic acid supplementation during the realimentation period, pigs formerly subjected to 2 hours feed withdrawal period with 2500 mg/kg feed ascorbic acid supplementation recorded the best results for all indices of growth performance. Tail length and loin girth were significantly ($P<0.05$) compensated by the interaction between feed withdrawal periods and ascorbic acid supplementation. Physiological indices monitored were significantly ($P<0.05$) affected by the interaction between feed withdrawal periods and ascorbic acid supplementation. The results of this study indicated that pigs earlier subjected to 2 hours feed withdrawal period and ascorbic acid supplementation at 2500 mg/kg feed exhibited a better compensatory growth in terms of weight gain, tail length and loin girth as well as the vital signs of the pigs hence, it could be used as a management tool to improve growth performance and welfare of growing pigs.

Key words: Compensatory, physiological, supplementation and withdrawal periods

Description of Problem

Duration and degree of feed restriction in fast growing animal has now become

an important issue of animal welfare because feed restriction can act as a stressor on the animal (1). Mild feed

restriction techniques can be adopted to attenuate the negative effect of severe restriction while promoting the beneficial effects. Metabolic heat production associated with feeding and digestion can contribute significantly to heat stress in domestic animal raised in a hot humid environment especially during the hot hours of the day. Feed denial during these hot periods of the day can assist in the reduction of metabolic heat production thereby leading to a decline in heat stress.

Also, antioxidant nutrient supplementation; especially vitamins C has been reported to attenuate the negative effects of environmental temperatures (2, 3). This management strategy can promote the welfare of domestic animals raised in hot humid environment of the world, thereby increasing the production level and profitability of the livestock farmers. A handful of information exists in literature on effect of feed withdrawal periods as welfare promoting mechanism in pig production. To this effect, this study is aimed at evaluating the compensatory response of growing pigs to feed withdrawal periods and ascorbic acid supplementation.

Materials and Methods

Experimental Animals and Management

The experiment was carried out at the Piggery Unit of the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. Fifty four mixed breed weaner pigs with body weight of 5.00 - 5.20 kg were bought from a commercial farm within Abeokuta metropolis. The pigs were grouped based on their body weight into 9

treatment groups with 3 replicates of 2 pigs per replicate. Two pigs serving as a replicate were housed together in a naturally ventilated pen with floor dimension of 4 m by 3 m, equipped with concrete feeding and drinking troughs. Routine management practices were done on daily basis, with fresh water supplied *ad libitum* throughout the experimental period. Pigs on treatment one were fed *ad libitum* throughout the period, while those on treatment two and three were offered daily ration at 07:00 hrs. Feeders were withdrawn at 12:00 hrs and later returned at 14:00 and 16:00 hrs of same day respectively for the two treatments. The rations of pigs on treatment 1 to 3 did not contain ascorbic acid. Pigs on treatment 4 were fed *ad libitum* with ration that contained ascorbic acid at the rate of 1500 mg/kg feed. The feeders of pigs on treatment 5 that contained ascorbic acid at 1500 mg/kg feed were withdrawn from 12:00 noon to 14:00 hours daily. Treatment 6 consists of pigs whose kilogram of feed contained 2500 mg ascorbic acid was withdrawn from 12.00 noon to 16.00 hours daily. Pigs on treatment 7 were fed *ad-libitum* while those in treatments 8 and 9 were subjected to two hours (12:00 - 14:00 hours) and four hours (12:00 - 16:00 hours) daily feed withdrawal periods respectively. The diets offered to pigs on treatments 7, 8 and 9 contained ascorbic acid at the rate of 2500 mg/kg feed. The concentrate diet given contained 18% crude protein, 4.30% ether extract, and 8.59% crude fibre and 2474.39 KJ/kg metabolizable energy as indicated in Table 1. The experimental pigs were subjected to 90 days feed withdrawal periods while 60 days were allotted for realimentation period.

Table 1: Percentage composition of the experimental diet

Ingredients	Percentage
Maize	50
GNC	11.5
PKC	20.6
Wheat Offal	15
Bone Meal	2.6
Salt	0.05
Lysine	0.05
Methionine	0.05
*Pig premix	0.05
Total	100
Determined Analysis (%)	
Crude protein	18
Fat	4.3
Fibre	8.59
Calcium	0.79
ME (kcal/kg)	2474.39

*Contained the following per kg diet vit A 10000000 IU; Vit D3 2500000 IU; Vit E 40000 IU ; Vit K3 4000 mg, Vit B1 750 mg, Vit B2 2000 mg, Vit B6 2000 mg, Vit B12 10 mcg, Niacin 13000 mg, Pantothenic Acid 5000 mg, Folic Acid 1000 mg, Biotin 10 mcg, Choline Chloride 50000 mg, Manganese 50000 mg, Zinc 100000 mg, Iron 80000 mg, Copper 50000 mg, Iodine 1000 mg, Selenium 200 mg, Cobalt 500 mg, Antioxidant 120000 mg

Data Collection

Physiological parameters (rectal temperature and pulse rate), changes in weight and body morphological parameters of the pigs were measured on fortnight basis for 60 days to determine the compensatory responses of pigs to feed withdrawal periods. The daily feed intake was determined by subtracting the feed leftover from the feed offered. The body morphological parameters measured include; chest and loin girths, height at wither body, face and tail lengths. These were determined using measuring tape. The physiological parameters were monitored with the aid of digital thermometer for rectal temperature while stethoscope was used to monitor the pulse rate. The weight gain was determined by subtracting initial weight from the final weight. The feed conversion ratio was determined by dividing the feed intake by weight gain.

Statistical Analysis

Data generated were subjected to a one-way analysis of variance in a 3x3 factorial layout using SAS (4). Significantly ($P \leq 0.05$) different means among the variables were separated using New Duncans Multiple Range Test as contained in the same statistical package.

Results

Interaction between feed withdrawal periods and ascorbic acid supplementation on growth performance of growing pigs during realimentation period

The interactive effect of feed withdrawal periods and ascorbic acid supplementation on growth performance of growing pigs is depicted in Table 2. Significant impact ($P < 0.05$) were observed in all growth performance indices except for initial weight and feed conversion ratio ($P > 0.05$). The highest values for total weight gain and average daily weight gain (21.17 kg and 377.98 g/day respectively) were recorded in pigs earlier subjected to 2 hours feed withdrawal period and 2500 mg/kg ascorbic acid supplementation. The highest total feed intake and average weekly feed intake values ($P < 0.05$) were also recorded in pigs fed diet supplemented with 2500 mg/kg ascorbic acid with 2 hours feed withdrawal period (69.45 kg and 8.69 kg/week respectively). Though not significant ($P > 0.05$), the best feed utilization was recorded in pigs fed diet supplemented with 2500 mg/kg ascorbic acid with feed withdrawal

Table 2: Interaction between feed withdrawal periods and ascorbic acid supplementation on growth performance of growing pigs during re-alimentation period

Parameters	0 mg/kg				1500 mg/kg				2500 mg/kg				SEM
	0 hr	2 hrs	4 hrs	0 hr	2 hrs	4 hrs	0 hr	2 hrs	4 hrs	0 hr	2 hrs	4 hrs	
Initial weight at the end FWP (kg/pig)	22.67	19.50	20.00	25.00	21.00	25.67	24.00	22.50	19.67	0.85			
Final weight at the end of 60 day realimentation period (kg/pig)	38.00 ^{ab}	31.00 ^b	30.67 ^b	38.33 ^{ab}	31.67 ^b	37.67 ^{ab}	38.67 ^{ab}	46.47 ^a	30.67 ^b	1.51			
Weight gain (kg/pig)	15.33 ^{ab}	11.50 ^b	10.67 ^b	13.33 ^{ab}	10.67 ^b	12.00 ^b	14.67 ^{ab}	21.17 ^a	11.00 ^b	0.99			
Daily weight gain (g/pig/day)	273.10 ^{ab}	205.36 ^b	190.48 ^b	238.10 ^{ab}	190.48 ^b	214.29 ^b	261.90 ^{ab}	377.98 ^a	196.43 ^b	17.73			
Total feed intake (kg/pig)	44.47 ^b	41.42 ^{bc}	32.10 ^{bc}	44.01 ^{bc}	30.98 ^{bc}	44.70 ^b	42.80 ^{bc}	69.48 ^a	27.47 ^c	2.66			
Feed intake (kg/pig/wk)	5.56 ^b	5.18 ^{bc}	4.01 ^{bc}	5.50 ^{bc}	3.87 ^{bc}	5.59 ^b	5.35 ^{bc}	8.69 ^a	3.43 ^c	0.33			
FCR	2.89	4.03	3.02	3.45	2.99	3.68	3.39	3.44	2.80	0.16			

^{a,b,c} Means on the same row having different superscripts are significantly ($P < 0.05$) different. **SEM**=standard error of mean FCR; feed conversion ratio; FWP: feed withdrawal period

period of 4 hours, while pigs on diet without ascorbic acid and 2 hours withdrawal period had the poorest feed utilization.

Interaction between feed withdrawal periods and ascorbic acid supplementation on morphological indices of growing pigs during realimentation period

Table 3 shows the interactive effect between feed withdrawal periods and ascorbic acid supplementation on morphological indices of growing pigs during re-alimentation period. Interaction between feed withdrawal periods and ascorbic acid supplementation had significant effect ($P < 0.05$) on tail length and loin girth, while the interaction had no significant effect ($P > 0.05$) on height at wither; face length, body length and chest length. The highest tail length and loin girth values of 0.60 cm/pig/week and 2.60 cm/pig/week were recorded in pigs on 2 hours feed withdrawal period and diet

supplemented with 2500 mg/kg of ascorbic acid. The highest value for body length (2.46 cm/pig/week) was recorded for pigs fed diet supplemented with 1500 mg/kg ascorbic acid and 4 hours feed withdrawal period, while the least value of 1.40 cm/pig/week was recorded in pigs fed diet supplemented with 2500 mg/kg ascorbic acid and 4 hours feed withdrawal period. Pigs fed diet supplemented with 1500 mg/kg of ascorbic acid with zero hour feed withdrawal period had the highest value ($P > 0.05$) for height at wither (1.67 cm/pig/week), while pigs fed ration supplemented with 1500 mg/kg ascorbic acid and subjected to 2 hours feed withdrawal period had the least value for height at wither (0.88 cm/pig/week). Supplementation with 2500 mg/kg of ascorbic acid with 2 hours of feed withdrawal resulted in the longest chest length (1.88 cm/pig/week) though not significant ($P > 0.05$)

Table 3: Effect of interaction between feed withdrawal periods and ascorbic acid supplementation on morphological indices of growing pigs during realimentation period

Parameters (cm/pig/week)	0 mg/kg			1500 mg/kg			2500 mg/kg			SEM
	0 hr	2 hrs	4 hrs	0 hr	2 hrs	4 hrs	0 hr	2 hrs	4 hrs	
Height at wither	1.21	1.08	1.04	1.67	0.88	1.21	1.38	1.38	1.04	0.10
Face length	0.31	0.29	0.35	0.29	0.25	0.33	0.44	0.41	0.35	0.03
Tail length	0.27 ^b	0.42 ^{ab}	0.33 ^{ab}	0.42 ^{ab}	0.29 ^b	0.33 ^{ab}	0.50 ^{ab}	0.60 ^a	0.35 ^{ab}	0.03
Body length	2.02	1.67	1.75	1.96	1.46	2.46	1.94	2.01	1.40	0.12
Chest length	1.75	1.63	1.50	0.92	0.92	1.38	1.75	1.88	1.46	0.12
Loin girth	2.28 ^{ab}	1.96 ^{abc}	1.13 ^c	1.29 ^{bc}	1.08 ^c	1.83 ^{abc}	1.75 ^{abc}	2.60 ^a	1.83 ^{abc}	0.13

^{a,b,c}Means on the same row having different superscripts are significantly ($P < 0.05$) different.

S.E.M: standard error of mean

Interaction between feed withdrawal periods and ascorbic acid supplementation on physiological indices of growing pigs during realimentation period

Table 4 shows the interactive effect of feed withdrawal periods and ascorbic acid supplementation on physiological indices of growing pigs during realimentation period. Pulse rate and rectal temperature were significantly ($P < 0.05$) influenced by the interaction between feed withdrawal periods and ascorbic acid supplementation. Pigs on 2 hours feed withdrawal period fed ration supplemented with ascorbic acid at 2500

mg/kg feed had the highest pulse rate of 149.30 beats/minute, while the lowest pulse rate of 120.00 beats/minute was recorded for pigs on zero feed withdrawal period with ration supplemented with ascorbic acid at 2500 mg/kg feed. Feed withdrawal for 4 hours and 2 hours with ascorbic acid supplementation of 1500 mg/kg and 2500 mg/kg feed resulted in the highest rectal temperature (39.43C and 39.51C respectively), while pigs fed with ration supplemented with ascorbic acid at 1500 mg/kg feed with 2 hours feed withdrawal period had the lowest value of 38.10C rectal temperature.

Table 4: Effect of interaction between feed withdrawal periods and ascorbic acid supplementation on physiological indices of growing pigs during realimentation period

Parameters	0 mg/kg			1500 mg/kg			2500 mg/kg			SEM
	0 hr	2 hrs	4 hrs	0 hr	2 hrs	4 hrs	0 hr	2 hrs	4 hrs	
Pulse rate (beats/minute)	136.89 ^{abcd}	127.11 ^{cde}	141.33 ^{abc}	134.22 ^{abcde}	121.33 ^{de}	130.67 ^{bcde}	120.00 ^e	149.30 ^a	146.67 ^{ab}	2.36
Rectal temperature (°C)	39.11 ^{ab}	38.88 ^{abc}	38.45 ^{bc}	39.08 ^{ab}	38.10 ^c	39.43 ^a	38.94 ^{abc}	39.51 ^a	38.80 ^{abc}	0.11

^{ab,c,d,e}- Means on the same row with different superscripts are significantly ($P < 0.05$) different. SEM=standard error of mean

Discussion

Satisfying the consumer preference by providing high quality pork is an integral part of successful and sustainable pig production. Unfortunately, the effort to satisfy consumer demands by producing leaner pigs through manipulation of their nutrients in recent years has resulted to a reduction in overall productivity of pigs, which has adverse effects on economy of production of the farmers. Compensatory growth has been used to increase the overall efficiency of nutrient utilization and minimizes adverse impacts of pig production on the environment. The results of this present study showed that pigs earlier subjected

to 2 hours feed withdrawal period and ascorbic acid supplementation at the rate of 2500 mg/kg feed had the overall growth performance record compared to pigs in other treatment groups. The variation in values is an indication of occurrence of compensatory growth that could be associated to reduction in maintenance requirements. The reduction in maintenance requirements of the pigs allocate comparatively more energy for growth during realimentation period, thus contributing to the compensatory growth. Whang (5) concluded that pigs subjected to a period of dietary restrictions utilized feed more efficiently during the realimentation than their unrestricted counterparts. (6)

also, asserted that pigs provided an *ad libitum* feeding for about 42 days prior to slaughter after a period of restriction had similar carcass and muscle mass compared to pigs given *ad libitum* feed throughout the experimental period. Ascorbic acid acts synergistically with feed withdrawal period, resulting to better performance recorded by the pigs on 2 hours feed withdrawal period and 2500 mg/kg feed. Ascorbic acid plays a major role in gluconeogenesis to enhance energy supply during environmental, pathological and nutritional stress periods (7). (8) reported that requirement for ascorbic acid may be increased under stressful condition because of its active transport into tissues and possible reduction in efficiency of production of ascorbic acid by animals during period of stress. Sahin (9) reported that dietary ascorbic acid and folic acid supplementation attenuated the decline in performance and anti-oxidant status caused by heat stress. The enhanced performance recorded in this present study is in line with the observation of (10) who indicated that ascorbic acid supplementation enhanced productivity, immune responses and survivability under nutritional stress. Likewise, (11) reported that ascorbic acid supplementation improved weight gain and resulted in better feed utilization in piglets.

Linear body measurements (chest girth, heart girth, height at wither, and body length) are used in evaluating the body size or weight of pig (12). They provide good information on performance, productivity and carcass characteristics of animals (13). (14) stated that linear

body measurements could be used in evaluating growth rate, body weight, feed utilization and carcass characteristics in livestock production industry. Also, (15) stated that changes in linear body dimensions are resultant effect of tissue growth which is evident in the muscle growth and fat tissue deposition. Morphological parameters tend to increase as the animal grows overtime as noticed in this present study where the interaction between 2 hours feed withdrawal period and 2500 mg/kg feed influenced the tail weight and loin girth of pigs that had the best growth performance record during the realimentation period.

The interaction between feed withdrawal periods and ascorbic acid supplementation resulted in a progressive increase in pulse rate and rectal temperature of growing pigs. Since body temperature in homeotherms is largely dependent upon oxidative phosphorylation, increment in rectal temperature in terms of dietary crude protein level is likely to be a reflective increase in the rate of oxygen required for the combustion of extra unit of excess feed consumed during the realimentation period by the pigs subjected to withdrawal periods. (16) stated that the elevation of peripheral temperature can be attributed to an increase of blood flow in the skin's vessels for dissipation of body heat. (17) measured heat production as an indicator of basal metabolic rates in steers and noted gradual increase in heat production during realimentation. Increase in pulse rate could be as a result of flow of blood into the heart to digest and transport nutrients to the various

parts of the body. (18) reported that the resting heart rate of 105 (Range 83-140) beats min⁻¹ of pigs remain unchanged until haemorrhage resulted in increased to a maximum of 162 (Range 126-245) beats min⁻¹. Rectal temperature values in this study fell within the normal limits (38.6-39.8C) for physiologically healthy pigs (19).

Conclusion and Application

The results of this study indicated that

1. Pigs subjected to 2 hours feed withdrawal and 2500 mg/kg feed ascorbic acid supplementation exhibited better compensatory response in terms of weight gain, feed intake and improvement in physiological state of the pigs.
2. Hence, it can be used as management tool to enhance the productivity and profitability of pig enterprise.

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