Effects of feed withdrawal periods and ascorbic acid supplementation on growth performance and morphological measurements of growing pigs

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ABSTRACT

Eighty-one Large White pigs with weight ranged from 4.83 to 5.22 kg/pig were used to assess the influence of feed withdrawal periods and ascorbic acid supplementation on the growth performance and morphological measurements of growing pigs in a humid tropical environment. Pigs were acclimatized for one week and distributed based on weight equalization into nine treatment groups in a 3 × 3 factorial layout. Factor A consisted of 3 levels of feed withdrawal periods (0, 2, and 4 hours) and factor B consisted of 3 inclusion levels of ascorbic acid (0, 1,500, and 2,500 mg/kg feed). The individual treatment had three replicates with three pigs in each replicate group. Data collected on growth performance and morphological measurements on weekly basis were analyzed using a one-way analysis of variance. Results indicated that growth performance indices and linear body measurements of pigs were not significantly influenced by the daily feed withdrawal periods. A numerically better feed conversion ratio of 2.36 ± 0.13 was observed in pigs subjected to 4 hours feed withdrawal period. The daily feed intake of pigs was significantly influenced by ascorbic acid supplementation ($P < 0.05$) with the highest value of 671.48 ± 37.20 g/pig recorded for pigs on 1,500 mg/kg dietary ascorbic acid supplementation. Interaction between feed withdrawal period and ascorbic acid supplementation showed a positive impact on feed intake of pigs ($P < 0.05$). It was thereby concluded that pigs can be raised on 2 or 4 hours daily feed deprivation periods without dietary ascorbic acid supplementation.

Keywords: Feed denial, growth indices, linear body measurements, pigs, vitamin C

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INTRODUCTION

An increment in oxidative stress and an imbalance in antioxidant conditions are some negative impacts of stressful environments in livestock production in the tropics. Ahmadu *et al*. (2016) reported that the frequency of oxidative damages increases in stressed domestic animals with decreasing levels of plasma antioxidants vitamins like vitamin C, E, and folic acid; and minerals (zinc). During stress conditions, free radicals' production in the tissue is habitually eminent to a level that overpowers tissue antioxidant defense mechanisms, leading to oxidative damage and impairment of antioxidant activity (Sahin *et al.,* 2001; Tuleun *et al.,* 2011). Modification of animal environment by producers to combat the adverse effects of harsh environmental conditions in the tropic is not economically practicable; hence, the need for the search for nutritional strategies that could be used to ameliorate the adverse effects of this condition is vital for livestock sustainability.

A restrictive feeding strategy has been used to improve the growth performance and optimum lean body mass of domestic animals. Allowing fast-growing domestic animals full access to feed

leads to excess feed intake over the requirement for maintenance and production, the surplus energy intake is transformed into body fat (Cuddington, 2004). High-fat deposition reduces carcass quality, resulting in consumers and processors rejecting the meat. Feed restriction improves feed efficiency (Tůmová *et al.*, 2003) as a result of its ability to induce compensatory growth after reverting to *ad libitum* feeding (Chodova *et al.*, 2012; Gidenne *et al.*, 2012), decrease in the occurrence of metabolic diseases and mortality (Gidenne *et al.*, 2003).

Ascorbic acid supports the production of anti-stress hormones that assist domestic animals to combat the negative effects of stress. It combines with toxins, thereby, eliminating toxic substances from the body of farm animals. Under stress conditions, tissue requirements of ascorbic acid exceed the amount synthesized by the animal (Ayo *et al.*, 2011). Hence, exogenous ascorbic acid supplementation has been reported to be advantageous in assuaging the adverse effect of stress and stress-induced tissue damage in domestic animals (Ayo and Sinkalu, 2007; Tuleun *et al.*, 2011). In view of the numerous benefits associated with feed manipulation strategies in livestock production, this study investigated the effects of daily feed withdrawal periods during hot periods of the day and ascorbic acid supplementation on growth response and morphological measurements of growing pigs.

MATERIALS AND METHODS

Animals and Experimental Design

This study was carried out at the Piggery Unit of the Directorate of University Farms, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. Eighty-one Large White breed of weaner pigs with body weight ranging from 4.83 to 5.22 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 3 pigs per replicate. The pigs were housed in an open ventilated individual pen with a floor dimension of 2 m by 2 m, equipped with concrete feeding and drinking troughs. Routine management practices were done on daily basis, with freshwater supplied *ad libitum* throughout the experimental period. Pigs on treatment 1 were fed *ad libitum* throughout, while those on treatments 2 and 3 were offered daily ration at 07:00 hours. Feeders were withdrawn at noon and later returned at 14:00 and 16:00 hours of the same day respectively. The rations of pigs on treatment 1 to 3 did not contain ascorbic acid. Pigs on treatment 4 were fed *ad libitum* with a ration that contained ascorbic acid at the rate of 1,500 mg/kg feed. The feeders of pigs on treatment 5 that contained ascorbic acid at 1,500 mg/kg feed were withdrawn from 12:00 (noon) to 14:00 hours daily. Treatment 6 consisted of pigs whose diet contained 2,500 mg of ascorbic acid with the feeder 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 2,500 mg/kg feed. The concentrate diet given contained 18% crude protein, 4.30% ether extract, 8.59% crude fibre, and 2,474.39 KJ/kg metabolizable energy as indicated in Table 1. The diet composition (%) used in this present study was developed in line with the recommendation of Aduku (2004) and the nutrients were offered to the growing pigs on an as-fed basis. The experimental pigs were subjected to 90 days feed withdrawal periods. The study protocol was conducted under the Animal Ethics Committee guidelines of the Federal University of Agriculture, Abeokuta, Nigeria (FUNAAB, 2013).

Table 1 Composition of the experimental diets

Diet composition	Percentage (%)
Ingredients	
Maize	50.00
Groundnut cake	11.60
Wheat offal	22.00
Palm kernel cake	13.00
Bone meal	2.60
Salt	0.35
Lysine	0.10
Methionine	0.05
Pig premix*	0.30
Total	100.00
Determined analysis	
Crude protein (%)	18.00
Metabolizable energy (KJ/kg)	2,474.39
Fat (%)	4.30
Fibre (%)	8.59
Calcium (%)	0.79
Lysine (%)	0.80
Methionine (%)	0.30

Note: * Vitamin (Vit) A 100,000 IU, Vit D3 2,500,000 IU, Vit E 40,000 IU, Vit K3 4,000 mg, Vit B1 750 mg, Vit B2 2,000 mg, Vit B6 2,000 mg, Vit B12 10 mcg, niacin 13,000 mg, pantothenic acid 5,000 mg, folic acid 1,000 mg, biotin 10 mcg, choline chloride 50,000 mg, manganese 50,000 mg, zinc 100,000 mg, iron 80,000 mg, copper 50,000 mg, iodine 1,000 mg, selenium 200 mg, cobalt 500 mg, and antioxidant 120,000 mg

Data Collection

Growth performance indices

Initial body weights of the pigs were measured before the commencement of the study and subsequently on weekly basis. Weight gain was determined as the difference in the body weight of two consecutive weightings for each replicate group. Feed intake was obtained weekly by deducting the total left-over feed for the week from the total initial feed offered for the week. Feed conversion ratio was calculated as feed intake per body weight gain.

Morphological parameters

The morphological parameters of the growing pigs measured and recorded on a weekly basis included body length (BL), chest girth (CG), loin girth (LG), height at wither (HTW), face length (FL), and tail length (TL). These indices were assessed following the procedures of Njoku *et al.* (2013) with the aid of a tape rule. BL was determined as the distance between the last cervical vertebrae to the last lumbar vertebrae. CG was determined by measuring the circumference perpendicular to the

median vertebrae immediately after the shoulder. LG was measured as the body circumference at about the point of the fourth lumbar vertebrae. HTW was determined as the length between the most dorsal point of wither and the floor level. FL involves the distance from the anterior point of attachment of the head to the body, down to the tip of the snout. TL was assessed as the length from the tip of the posterior vertebrae to the point of attachment of the body.

Data Analysis

All data obtained were set in a 3×3 factorials in a completely randomized design and then analyzed using SAS (2000) package. Duncan's new multiple range test was used to separate significant means among treatments at $P < 0.05$. Statistical model of the experiment was:

$$y_{ijkl} = \mu + A_i + B_j + (AB)_{ij} + \varepsilon_{ijk}$$

where y_{ijkl} is the observed value of the dependent variable, A_i is the effect of feed withdrawal periods (0, 2, and 4 hours), B_j is the effects of ascorbic acid supplementation (0, 1,500, and 2,500 mg/kg), $(AB)_{ij}$ is an interaction effect between feed withdrawal periods and ascorbic acid supplementation, and ε_{ijk} is the random residual error.

RESULTS AND DISCUSSION

Effects of Feed Withdrawal Periods on Growth Performance of Growing Pigs

Feed withdrawal periods had no significant ($P > 0.05$) influence on all the growth performance indices considered in this study (Table 2). Pigs fed *ad libitum* had the highest numerical mean values for final weight (31.28 ± 2.75 kg), total weight gain (26.44 ± 2.70 kg), daily weight gain (281.32 ± 28.75 g), total feed intake (62.64 ± 3.65 kg), and daily feed intake (666.39 ± 38.82 g) compared to the final weight (28.00 ± 2.59 and 27.89 ± 0.29 kg), total weight gain (22.78 ± 2.67 and 23.06 ± 1.82 kg), daily weight gain (242.32 ± 28.38 and 245.27 ± 19.39 g), total feed intake (56.93 ± 3.13 and 54.50 ± 4.19 kg), and daily feed intake (605.61 ± 33.28 and 579.75 ± 44.42 g) noted in pigs subjected to daily 2 and 4 hours feed withdrawal periods respectively.

Table 2 Effect of feed withdrawal periods on growth performance of growing pigs

Parameters	Feed withdrawal periods		
	0 hour	2 hours	4 hours
Initial weight (kg)	4.83 ± 0.46	5.22 ± 0.52	4.83 ± 0.29
Final weight (kg)	31.28 ± 2.75	28.00 ± 2.59	27.89 ± 0.29
Total weight gain (kg)	26.44 ± 2.70	22.78 ± 2.67	23.06 ± 1.82
Daily weight gain (g)	281.32 ± 28.75	242.32 ± 28.38	245.27 ± 19.39
Total feed intake (kg)	62.64 ± 3.65	56.93 ± 3.13	54.50 ± 4.19
Daily feed intake (g)	666.39 ± 38.82	605.61 ± 33.28	579.75 ± 44.42
Feed conversion ratio	2.39 ± 0.19	2.49 ± 0.21	2.36 ± 0.13

The non-significant difference in the initial body weights of the growing pigs subjected to the different daily feed withdrawal periods implies that the experimental pigs were balanced for weight prior to the commencement of the experiment. The statistically similar final weight, total weight gain and daily weight gain in pigs fully fed compared to those on 2 and 4 hours feed withdrawal periods could be attributed to sufficient nutrient intake due to compensatory response. The 10.48% and 10.83%

reduction in the final weight of pigs on 2 hours and 4 hours feed withdrawal periods respectively is an indication of lower feed access time noted for pigs on feed withdrawal periods compared to their *ad libitum* fed counterparts. Feed withdrawal periods of 2 and 4 hours led to 9.12% and 13.00% reduction in feed intake of pigs respectively. This observation is in tandem with the investigation of Njoku *et al.* (2017) that noted a similarity in growth performance indices of growing rabbits on 4 hours feed withdrawal period. Conversely, Tůmová *et al.* (2003) and Obasa *et al.* (2016) reported that feed intake of restricted fed farm animals was significantly lower in comparison to the *ad libitum* fed group. The similar values recorded in feed conversion ratio of pigs fed the *ad libitum* and those on feed withdrawal periods could be attributed to a better nutrient digestibility of the pigs in the restricted groups. This observation is in consonance with the reports of Acheampong-Boateng *et al.* (2012) and Njoku *et al.* (2017) that observed no significant differences in feed conversion ratio of restrictively and *ad libitum* fed animals. However, the numerically better feed conversion ratio observed in growing pigs subjected to 4 hours daily feed withdrawal period indicates that 4 hours daily feed withdrawal period enhanced feed utilization of the growing pigs as affirmed by Tůmová *et al.* (2003) and Di Meo *et al.* (2007) who reported that feed restriction improved nutrient digestibility and feed efficiency.

Effect of Ascorbic Acid Supplementation on Growth Performance of Growing Pigs

The effect of ascorbic acid on growth performance of growing pigs is shown in Table 3. Comparable means were obtained in the feed intake of pigs across all treatment groups with the highest numerical value of 63.12 ± 3.49 kg documented for pigs on a ration containing ascorbic acid at the rate of 1,500 mg/kg feed when compared to the values noted for pigs on control ration (51.40 ± 3.05 kg/pig) and their counterparts on a ration containing ascorbic acid supplementation at the rate of 2,500 mg/kg feed (59.54 ± 3.81 kg/pig). A significant difference was observed in daily feed intake with the pigs on a ration containing ascorbic acid at the rate of 1,500 mg/kg feed having the highest mean value of 671.48 ± 37.20 g while the least value of 546.83 ± 32.43 g was noted for pigs on the control diet. Statistically similar values ($P > 0.05$) were observed in feed conversion ratio of pigs subjected to different inclusion levels of ascorbic acid supplementation (2.34 ± 0.17, 2.75 ± 0.20, and 2.48 ± 0.15 for 0, 1,500, and 2,500 mg/kg ascorbic acid supplementation, respectively).

Table 3 Effect of ascorbic acid supplementation on growth performance of growing pigs

Parameters	Ascorbic acid supplementation		
	0 mg/kg	1,500 mg/kg	2,500 mg/kg
Initial body weight (kg)	5.17 ± 0.42	4.89 ± 0.53	4.83 ± 0.34
Final body weight (kg)	28.00 ± 1.92	29.17 ± 2.71	30.00 ± 2.73
Total body weight gain (kg)	22.83 ± 2.01	24.28 ± 2.68	25.17 ± 2.69
Daily weight gain (g)	242.91 ± 21.39	258.27 ± 28.50	267.73 ± 28.58
Total feed intake (kg)	51.40 ± 3.05^{b}	63.12 ± 3.49^{a}	59.54 ± 3.81^{ab}
Daily feed intake (g)	546.83 ± 32.43^{b}	671.48 ± 37.20^{a}	633.45 ± 40.58^{ab}
Feed conversion ratio	2.34 ± 0.17	2.75 ± 0.20	2.48 ± 0.15

$^{a, b}$ Means on the same row with different superscripts are significantly different at $P < 0.05$

The absence of weight difference in pigs to ascorbic acid supplementation is consistent with the reports of Zhao *et al.* (2002) and Fernández-Dueñas *et al.* (2008) that reported no improvement in weight gain of nursery pigs on dietary supplementation of ascorbic acid but contradicted the reports of Ching *et al.* (2002) and Sun *et al.* (2008) that noticed transient improvements in weight gain with different levels of ascorbic acid supplementation. The implication of similarity in weight gain of pigs in this study indicated that under normal feeding and management conditions, dietary supplementation of ascorbic acid has little or no effect on growth rate.

Interaction between Feed Withdrawal Periods and Ascorbic Acid Supplementation on Growth Performance of Growing Pigs

Table 4 shows the interaction between feed withdrawal periods and ascorbic acid supplementation. Final weight, daily weight gain, and feed conversion ratio were statistically not different across the treatment groups. Pigs on 2 hours feed withdrawal period had reduced feed intake when provided 1,500 mg/kg ascorbic acid compared to the values noted for their counterparts fed diet that had no ascorbic acid supplementation or those fed diets with 2,500 mg/kg ascorbic acid, but pigs on *ad libitum* feed intake or 4 hours feed withdrawal period showed no positive impact on feed intake even with ascorbic acid supplementation (interaction, $P < 0.05$). The comparable feed conversion ratio was noted for pigs across all treatment groups with range values of 2.02 ± 0.26 noted for pigs on *ad libitum* fed ration containing 2,500 mg/kg feed to 2.98 ± 0.40 observed in pigs on 2 hours feed withdrawal period fed diet that contained 1,500 mg ascorbic acid per kilogram feed offered. The significant difference noted in the pigs subjected to feed withdrawal period and fed dietary ascorbic acid supplementation could be attributed to suppressed stress responses initiated by the existence of ascorbic acid at tissue and plasma levels. This must have led to a higher basal metabolic rate in the pig on dietary supplementation of ascorbic acid. This observation is in line with the report of Ali and Al-Qarawi (2010) who concluded that dietary supplementation of ascorbic acid led to the scavenging of free radicals generated by stress factors, resulting in improved feed intake. The lower feed intake value observed in pigs on dietary ascorbic acid supplementation at the rate of 2,500 mg/kg feed compared to the value documented for their counterparts on 1,500 mg/kg feed supplementation of ascorbic acid is in harmony with the assertion of Kutlu and Forbes (2000) that in absence of stress, excessive supplementation of dietary ascorbic acid led to a reduction in growth indices of pigs. Likewise, Adeyemi *et al.* (2015) reported that ascorbic acid produces anti-stress hormones which help to combat the effect of stress imposed on the animal body by the environment. There was an indication of interaction between feed withdrawal periods and ascorbic acid supplementation on feed intake of pigs. This indicates that feed withdrawal periods had increased the pig's need for ascorbic acid beyond its capacity to synthesize the vitamin.

Table 4 Interaction between feed withdrawal periods and ascorbic acid supplementation on growth performance of growing pigs

Feed withdrawal period	**0 hour**			**2 hours**			**4 hours**		
Ascorbic acid supplementation	**0 mg/kg**	**1,500 mg/kg**	**2,500 mg/kg**	**0 mg/kg**	**1,500 mg/kg**	**2,500 mg/kg**	**0 mg/kg**	**1,500 mg/kg**	**2,500 mg/kg**
Initial body weight (kg)	5.00 ± 1.00	5.50 ± 1.04	5.00 ± 0.00	4.67 ± 1.17	4.67 ± 1.17	5.33 ± 0.67	4.83 ± 0.44	5.50 ± 0.76	4.17 ± 0.44
Final body weight (kg)	31.67 ± 2.33	24.67 ± 2.91	27.67 ± 4.26	31.17 ± 7.42	25.33 ± 4.18	31.00 ± 2.08	31.00 ± 5.51	34.00 ± 5.29	25.00 ± 3.21
Total weight gain (kg)	26.67 ± 1.45	19.17 ± 3.77	22.67 ± 4.26	26.50 ± 7.37	20.67 ± 3.81	25.67 ± 2.73	26.17 ± 5.59	28.50 ± 5.62	20.83 ± 2.89
Daily weight gain (g)	283.69 ± 15.46	203.90 ± 40.08	241.13 ± 45.27	281.91 ± 78.36	219.86 ± 40.55	273.45 ± 29.03	278.37 ± 59.42	303.19 ± 59.79	221.63 ± 30.76
Total feed intake (kg)	60.90 ± 4.37^{ab}	49.73 ± 3.33^{b}	43.57 ± 2.06^{b}	64.97 ± 8.26^{a}	58.68 ± 4.63^{ab}	65.70 ± 6.48^{a}	62.05 ± 8.25^{ab}	62.37 ± 6.54^{ab}	54.22 ± 6.52^{ab}
Daily feed intake (g)	647.87 ± 46.45^{ab}	529.08 ± 35.38^{ab}	463.55 ± 21.96^{b}	691.21 ± 87.70^{a}	624.29 ± 49.24^{ab}	698.94 ± 68.89^{a}	660.11 ± 87.75^{ab}	663.48 ± 69.57^{ab}	576.77 ± 69.38^{ab}
Feed conversion ratio	2.28 ± 0.08	2.73 ± 0.38	2.02 ± 0.26	2.72 ± 0.52	2.98 ± 0.40	2.56 ± 0.07	2.52 ± 0.37	2.30 ± 0.31	2.62 ± 0.11

^{ab} Means on the same row with different superscript are significantly different at $P < 0.05$

Effects of Feed Withdrawal Periods on Morphological Parameters of Growing Pigs

The effect of feed withdrawal periods on morphological measurements of growing pigs is presented in Table 5. The feed withdrawal periods resulted in statistically similar (P > 0.05) body length, chest girth, loin girth, height at wither, face length, and tail length. The highest mean values for the body length (2.85 ± 0.25 cm/week), chest girth (2.18 ± 0.26 cm/week), and loin girth (2.23 ± 0.21 cm/week) were recorded in growing pigs fed *ad libitum* daily when compared to the values noted for those on 2 and 4 hours daily feed withdrawal periods. Height at wither was numerically highest (1.82 ± 0.11 cm/week) in growing pigs exposed to 4 hours daily feed withdrawal period while their counterparts on 2 hours feed withdrawal period per day recorded the least value of 1.43 ± 0.17 cm/week. Sulabo *et al.* (2006) stated that morphological parameters provide information on growth rate and feed utilization of boar and that it increases as animal grows over time. The daily feed withdrawal periods considered in this study did not significantly influence the morphological parameters. The similarity observed in the morphological measurements indicates a positive compensatory growth effect after the daily feed withdrawal period. The pigs must have obtained sufficient nutrients to compensate for the limited intake during the withdrawal periods and this is similar to the findings of Yakubu *et al.* (2007) who observed that feed restriction did not affect linear body measurements in rabbits. Daza *et al.* (2003), Bee *et al.* (2007), and Serrano *et al.* (2008) also observed that feed restriction did not affect growth indices of animals. On the contrary, Njoku *et al.* (2013) reported variations in the linear body measurements of finishing pigs subjected to quantitative feed restriction. The disparity in these results may be attributed to the different restriction techniques adopted.

Table 5 Effect of feed withdrawal periods on morphological parameters of growing pigs

Parameters	Feed withdrawal periods		
	0 hour	2 hours	4 hours
Body length (cm/week)	2.85 ± 0.25	2.41 ± 0.32	2.48 ± 0.16
Chest girth (cm/week)	2.18 ± 0.26	1.90 ± 0.30	1.83 ± 0.20
Loin girth (cm/week)	2.23 ± 0.21	2.05 ± 0.31	2.08 ± 0.25
Height at wither (cm/week)	1.53 ± 0.19	1.43 ± 0.17	1.82 ± 0.11
Face length (cm/week)	0.57 ± 0.03	0.58 ± 0.03	0.54 ± 0.04
Tail length (cm/week)	0.62 ± 0.08	0.64 ± 0.07	0.60 ± 0.05

Effect of Ascorbic Acid Supplementation on Morphological Parameters of Growing Pigs

Table 6 shows that there were no significant differences in all morphological parameters considered. Chest girth and height at wither increased (P > 0.05) numerically with increasing levels of ascorbic acid supplementation. Pigs on 1,500 mg/kg ascorbic acid supplementation recorded the highest numerical values in body length (2.76 ± 0.30 cm/week) and loin girth (2.31 ± 0.27 cm/week). The least weekly face length increment was documented for pigs on dietary ascorbic acid supplementation at the rate of 1,500 mg/kg feed. The non-significant differences in morphological indices of growing pigs with ascorbic acid supplementation could be linked to the absence of weight variability in the pigs. It has been concluded by earlier workers that a high correlation exists in morphological parameters and body weight in pigs (Singh *et al*., 1985; Njoku *et al.,* 2013). Likewise, Onyimonyi *et al*. (2010) concluded that changes in morphological measurements are an indication of tissue growth and tend to increase with the rate of growth. The present observation is in line with the study of Yen and Pond (1988) who reported that dietary inclusion of ascorbic acid had no beneficial impact on growth rate of pigs.

Table 6 Effect of ascorbic acid supplementation on morphological parameters of growing pigs

Parameters	Ascorbic acid supplementation		
	0 mg/kg	1,500 mg/kg	2,500 mg/kg
Body length (cm/week)	2.51 ± 0.15	2.76 ± 0.30	2.47 ± 0.29
Chest girth (cm/week)	1.92 ± 0.27	1.96 ± 0.24	2.04 ± 0.28
Loin girth (cm/week)	1.92 ± 0.25	2.31 ± 0.27	2.13 ± 0.24
Height at wither (cm/week)	1.48 ± 0.11	1.63 ± 0.16	1.68 ± 0.21
Face length (cm/week)	0.57 ± 0.04	0.53 ± 0.03	0.60 ± 0.04
Tail length (cm/week)	0.64 ± 0.03	0.64 ± 0.08	0.59 ± 0.08

Interaction between Feed Withdrawal Periods and Ascorbic Acid Supplementation on Morphological Parameters of Growing Pigs

The interaction between feed withdrawal periods and ascorbic acid supplementation is shown in Table 7. The interactive effect had no significant effect on morphological parameters considered in this present study. The body length ranged from 2.14 ± 0.46 cm/week (pigs on 4 hours feed withdrawal period fed ration containing ascorbic acid at 2,500 mg/kg feed) to 3.03 ± 0.78 cm/week (pigs on zero feed withdrawal period fed ration containing ascorbic acid at 1,500 mg/kg feed). Pigs on 0 hour feed withdrawal period without ascorbic acid supplymentation recorded the highest chest girth of 2.44 ± 0.45 cm/week while those on 4 hours feed withdrawal periods fed zero dietary inclusion of ascorbic acid had the lowest chest girth of 1.50 ± 0.36 cm/week. Loin girth ranged from 1.39 ± 0.41 cm/week in pigs on 4 hours feed withdrawal period fed ration containing no ascorbic acid supplementation to 2.78 ± 0.55 cm/week documented for their counterparts on 4 hours feed withdrawal period fed ration containing ascorbic acid at 1,500 mg/kg feed. Pigs on 2 hours feed withdrawal period fed without ascorbic acid supplementation had the least height at wither of 1.28 ± 0.33 cm/week while their counterparts on 4 hours feed withdrawal period fed ration containing ascorbic acid at 2,500 mg/kg feed had the highest height at wither of 2.11 ± 0.35 cm/week. Face length ranged from 0.50 ± 0.05 cm/week (pigs on 2 hours feed withdrawal period fed diet containing ascorbic acid at 1,500 mg/kg feed) to 0.69 ± 0.03 cm/week (pigs on 2 hours feed withdrawal period fed ration that contained ascorbic acid at 2,500 mg/kg feed. The least tail length of 0.53 ± 0.25 cm/week was noted for pigs on 4 hours feed withdrawal period fed ration containing ascorbic acid at 2,500 mg/kg feed while the highest tail length of 0.71 ± 0.21 cm/week was documented for pigs fed *ad libitum* on ration containing ascorbic acid at 1,500 mg/kg feed.

Table 7 Interaction between feed withdrawal periods and ascorbic acid supplementation on morphological parameters of growing pigs

Feed withdrawal period	0 hour			2 hours			4 hours		
Ascorbic acid supplementation	**0 mg/kg**	**1,500 mg/kg**	**2,500 mg/kg**	**0 mg/kg**	**1,500 mg/kg**	**2,500 mg/kg**	**0 mg/kg**	**1,500 mg/kg**	**2,500 mg/kg**
Body length (cm/week)	2.81 ± 0.10	3.03 ± 0.78	2.71 ± 0.32	2.26 ± 0.41	2.43 ± 0.53	2.55 ± 0.88	2.47 ± 0.34	2.83 ± 0.44	2.14 ± 0.46
Chest girth (cm/week)	2.44 ± 0.45	2.11 ± 0.60	2.00 ± 0.47	1.81 ± 0.62	1.60 ± 0.43	2.31 ± 0.59	1.50 ± 0.36	2.17 ± 0.30	1.82 ± 0.94
Loin girth (cm/week)	2.42 ± 0.13	2.26 ± 0.49	2.00 ± 0.47	1.96 ± 0.64	1.89 ± 0.58	2.31 ± 0.57	1.39 ± 0.41	2.78 ± 0.55	2.07 ± 0.52
Height at wither (cm/week)	1.53 ± 0.10	1.67 ± 0.42	1.40 ± 0.48	1.28 ± 0.33	1.48 ± 0.31	1.52 ± 0.34	1.64 ± 0.19	1.72 ± 0.32	2.11 ± 0.35
Face length (cm/week)	0.63 ± 0.07	0.54 ± 0.09	0.56 ± 0.06	0.56 ± 0.06	0.50 ± 0.05	0.69 ± 0.03	0.53 ± 0.21	0.56 ± 0.05	0.54 ± 0.13
Tail length (cm/week)	0.60 ± 0.06	0.71 ± 0.21	0.56 ± 0.13	0.67 ± 0.06	0.60 ± 0.14	0.68 ± 0.18	0.65 ± 0.02	0.63 ± 0.15	0.53 ± 0.25

CONCLUSION

The daily feed withdrawal period had no implications on the growth performance parameters and morphological measurements of growing pigs whilst ascorbic acid supplementation impacted feed intake of growing pigs positively. Therefore, 2 or 4 hours daily feed derivation is not too severe feeding strategy that can be adopted in pig production. Also, ascorbic acid supplementation at the rate of 1,500 mg/kg feed can be utilized in the pig production system as a feed intake booster especially during stressful conditions posed by harsh hot environments of the tropics.

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