Influence of feed quantity offered on growth performance, carcass yield, organs weight and back-fat composition of finishing pigs

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Abstract

A study was conducted to determine the effect of feed quantity offered (1.5, 2.0 or 2.5 kg) on growth performance, carcass yield, organs weight and backfat composition. A total of 48 Large White grower male pigs with initial average weight of 36.48±2.25 kg were allotted to 3 treatments of 16 pigs per treatment and were further replicated into 4 with 4 pigs per replicate. Data were collected on weekly basis and carcass characteristics were performed when the pigs on each experimental group attained an average weight 70 kg. Final body weight, daily weight gain and daily feed intake were significantly (P<0.05) increased by feeding level with highest mean values obtained by the pigs fed 2.5 kg feed daily. Pigs on 1.5 kg daily feeding level took 108.31 days to attain the target weight of 70 kg which was significantly (P<0.05) longer than 92.23 and 79.94 days obtained by those on 2.0 and 2.5 kg daily feeding levels respectively. Most of the parameters considered for carcass yield were not significantly (P>0.05) enhanced by feed quantity offered. The weight of ham (11.54, 12.18 and 13.41 %) increased significantly (P<0.05) with increase in feeding level while kidney weight decreased significantly (P<0.05) with increase in feed quantity offered. Heart values of the pigs fed 2.0 and 2.5 kg feed daily were similar but differed significantly from those fed 1.5 kg feed daily. The depth of fat at first and last ribs, and subcutaneous fat depth increased significantly (P<0.05) with increase in feeding level. These results showed that quantity of feed offered greatly influenced growth performance (final body weight, daily weight gain, daily feed intake and days to target weight), ham, kidney, heart and backfat composition of finishing pigs, hence, it could be used as a management tool to improve growth performance and carcass traits of pigs.

Key words: Feed quantity offered, performance, carcass yield, organs, finishing pigs

Introduction

Feeding level, diet composition and pattern of feeding are some nutritional tools used to manipulate growth rate, composition of weight gain and intramuscular fat deposition. Nutrition is vital in livestock production and management, as inadequate and poor quality ration may impair the growth potential and carcass quality. Adequate nutrition is pivotal to the success of livestock industry as feed cost alone accounts for 60-75 % total cost of production (Okai *et al*., 2001; Adesehinwa *et al*., 2003). The choice of feeding periods for pigs is based on the nutritional requirements of the pig and economy of production (INRA, 1984; English *et al*., 1988). Pigs meant for pork production are designed for cost efficiency and rapid growth (Fanimo *et al*., 2003). Knowing what, when and how to feed and manage pigs will enable pig producers to be competitive and successfully meet the challenges encountered during production process.

The meat industry requires animals to be as lean as possible since pork with low fat content reduces human caloric intake and intramuscular fat is related to lower sensory quality traits (Fernandez *et al*., 1999). High

level of carcass fat is therefore unacceptable because of the associated health problems. Feeding affects growth rate, carcass quality, amount of nutrient excreted and farmer's profitability, there is need to carry out this research in order to determine the influence of feed quantity offered on growth performance, carcass yield, organs weight and backfat composition of finishing pigs.

Materials and Methods

Experimental Site

The experiment was carried out at the Piggery Unit of the Teaching and Research Farms Directorate (TREFAD), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The farm lies within latitude 7° 10′ N, longitude 3° 2′ E and altitude 76 mm. It is located in the derived savannah zone of South-Western Nigeria. It has a humid climate with mean annual rainfall of about 1037 mm and temperature of about 34.7° C. The relative humidity ranges from 63 to 96 % in the rainy season (late March to October) and from 55 to 82 % in the dry season (November to early March) with an annual average of 82 %. The seasonal distribution of annual rainfall is approximately 44.96 mm in the late dry season (January-March); 212.4 mm in the early wet season (April-June); 259.3 mm in the late wet season (July-September) and 48.1 mm in the early dry season (October-December) as recorded in Google Earth (2012).

Experimental Animals and their Management

Forty eight (48) grower Large White male pigs of 16 weeks old with mean body weight of 36.48 ± 2.25 kg were randomly assigned to three experimental groups in a completely randomized design. The pigs were grouped based on weight equalization to three groups (group 1 consisting of pigs fed 2.5 kg feed daily, while pigs in groups 2 and 3 were offered 2.0 and 1.5 kg feed daily, respectively) of sixteen (16) pigs each. Each group was replicated four times with 4 pigs per replicate. Each replicate consisting of four pigs were fed and housed together in naturally ventilated pen with floor size dimension of 3m x 2 m. Fresh and clean water was supplied *ad libitum* throughout the duration of the experiment.

Experimental Design

The pigs were randomly assigned to 3 experimental groups in a Completely Randomized Design of 16 pigs per group. The experimental groups consisted of the daily amount of dietary portion fed to each of the pigs. Pigs were offered 2.5, 2.0 or 1.5 kg feed daily until the pigs on replicate attained mean liveweight of 70 kg. Each pig received ½ of their daily ration at 08:00hr and the remaining portion at 14:00 hr. Diets were formulated to meet the body requirements of growing pigs. The ration contained 16.48% crude protein and metabolisable energy of 2986.70 kcal DE/kg as shown in Table 1.

Data Collection

Feed intake was determined daily by subtracting the feed left-over from the feed supplied. Initial body weight of growing pigs were taken using weighing scale with a 0.05 g precision and documented when the pigs arrived at the experimental site and weekly records of change in body weight were subsequently taken and documented. The feed conversion ratio was calculated as ratio of feed/gain. Records of the number of days required for the pigs on each experimental group to attain average liveweight of 70 kg were kept.

Carcass Characteristics

Twenty four (24) pigs consisting of 8 pigs per treatment were randomly selected,

Table 1: Composition of Experimental Diet (%)

Ingredients	Fattener ration
Maize	47.00
Groundnut cake	14.00
Wheat offal	24.00
Palm kernel cake	12.50
Bone meal	2.00
Premix*	0.20
Common salt	0.20
Lysine	0.05
Methionine	0.05
TOTAL	**100.00**
Calculated Analysis	
Crude protein (%)	16.48
Crude fibre (%)	6.48
Calcium (%)	0.54
Phosphorus (%)	0.25
ME (Kcal DE kg)	2986.70

*Premix supply the following per kg diet: Vitamin A, 12600 IU; Vitamin D_3, 2800 IU; Vit. E, 49 IU; Vit.K_3, 2.8 mg; Vit. B_1, 1.4 mg; Vit. B_2 5.6 mg; Vit. B_6 1.4 mg; Vit. B_{12} 0.014 mcg; Niacin 21 mg; Pantothenic Acid 14 mg; Folic Acid 1.4 mg; Biotin 0.028 mcg; Choline Chloride 70 mg; Manganese 70 mg; Zinc 140 mg; Iron 140 mg; Copper 140 mg; Iodine 1.4 mg; Selenium 0.28 mg; Cobalt 0.7 mg; Antioxidant 168 mg.

slaughtered and analysed for carcass yield, cut-up parts and fat composition at the end of the experiment. The pigs were weighed and fasted for 16 hours, and the fasted weight of each pig meant for slaughtering was taken before they were stunned by percussion method and bled by incision using a sharp knife cutting through the jugular vein between the skull and the atlas. Complete bleeding and dehairing were done. The stomach of the pigs was opened along the greater curvature and emptied. After the removal of the visceral organs, the remaining part was measured as carcass weight and later expressed as percentage of the live weight to get the dressing percentage. The head was removed by section at the occipito-atlas joint and the feet by sawing through the hock joint at a right angle to the long axis of the leg. The carcass was divided longitudinally. The left half of the carcass was dissected as described by FAO (1991). Ham was separated by locating the division between the 2nd and 3rd sacral vertebrae and saw perpendicularly along axis of the ham. Shoulder of the pig was separated from the loin and belly by a straight cut between the second and third ribs and a straight cut 2.5 cm ventral to the ventral edge of the scapula. The parts were weighed and recorded. Back-fat depth was taken at the first and last rib using vernier calliper. The fat-free index was estimated using the formulae postulated by National Pork Producers Council (1994).

Fat-free index = 50.767 + (0.035 x hot carcass weight, kg) – (8.979 x last rib midline back-fat on hot carcass, cm).

Statistical Analysis

Data were processed by one-way analysis of variance using Statistical Analyst Software (SAS, 2000) package. Significantly ($P<0.05$) different means among variables were separated using New Duncan's Multiple Range Test as contained in SAS (2000) package.

Results

Effect of feed quantity offered on performance of finishing pigs

The effect of feed quantity offered (Table 2) was significant (P<0.05) for most of performance considered with exception of feed conversion ratio. The final body weight, daily weight gain and daily feed intake increased (P<0.05) significantly with increase in feed quantity offered. Whereas, days to target weight decreased significantly as feed quantity offered increased. The highest mean values for final body weight (78.19 kg), daily weight gain (0.497 kg) and daily feed intake (2.33 kg) were recorded for the pigs offered 2.5 kg feed daily, while their corresponding least values of 69.63 kg, 0.318 kg and 1.48 kg, respectively were documented for the pigs offered 1.5 kg feed daily. The pigs offered 1.5 kg feed daily attained an average live weight of 70 kg in 108.31 days which was significantly higher (P<0.05) than 92.23 days (pigs offered 2.0 kg feed daily) and 79.94 days (pigs offered 2.5 kg feed daily).

Effect of quantity of feed offered on carcass characteristics of finishing pigs

The effect of quantity of feed offered on carcass characteristics of finishing pigs is documented in Table 3. The result revealed that ham, kidney and heart weights were significantly (P<0.05) influenced by feed quantity offered. Ham weight increased with increase in feed quantity offered while heart and kidney weights decreased with increase in feed quantity offered. The highest recorded mean value for ham was 13.41% (pigs fed 2.5 kg feed/day) while the least value (11.54%) was obtained among pigs fed 1.5kg feed/day. The mean values for kidney ranged from 0.11% (pigs fed 2.5 kg feed/day) to 0.20% (pigs fed 1.5 kg feed/day). Pigs fed 1.5 kg feed daily had highest (P<0.05) heart weight (0.20%) while those fed 2.0 kg feed daily had the least (0.15%). Although, no significant (P>0.05) differences were noted in live weight, fasted weight, bled weight, eviscerated weight, left carcass weight and shoulder weight. These parameters increased numerically with increase in feed quantity offered with the highest recorded values obtained for pigs fed 2.5 kg/day while those on 1.5 kg feed/day had the least values. The fore-legs and hind-legs weights decreased with increase in feed quantity offered. Those on 1.5 kg feed per day had the highest mean values while those on 2.5 kg feed had the least mean values.

Effect of quantity of feed offered on back fat composition of finishing pigs

The effect of quantity of feed offered on back fat composition of finishing pigs is shown in Table 4. There were no significant (P>0.05) differences noted for longissimus dorsi muscle "A", longissimus dorsi muscle "B", subcutaneous fat depth "C" and fat free index. However, significant (P<0.05) differences were noted for fat at first rib, fat

Table 2: Effect of feed quantity offered on the performance of finishing pigs

	Quantity of feed offered			
Parameters	1.5	2.0	2.5	SEM
Initial weight (kg)	36.25	37.00	36.19	2.25
Final weight (kg)	69.63^{b}	74.93^{ab}	78.19^{a}	2.31
Daily weight gain (kg)	0.318^{c}	0.415^{b}	0.497^{a}	0.02
Daily feed intake (kg)	1.48^{c}	1.87^{b}	2.33^{a}	0.11
Feed conversion ration	4.91	4.67	4.61	0.15
Days to target weight	108.31^{a}	92.23^{b}	79.94^{c}	3.79

^{abc}-means within rows having different superscripts are significantly different

Table 3: Effect of feed quantity offered on carcass characteristics of finishing male pigs

	QUANTITY OF FEED OFFERED			
Measurements	1.5 kg	2.0 kg	2.5 kg	SEM
live weight (kg)	71.25	72.00	75.00	2.54
Fasted weight (kg)	69.00	69.25	72.75	2.33
Bled weight (kg)	65.63	64.73	68.60	2.96
Hot carcass weight (kg)	56.88	55.75	58.58	2.65
Dressing percentage (%)	79.81	77.42	79.81	1.12
Eviscerated weight (kg)	45.75	47.00	49.25	1.84
Left carcass weight (kg)	22.75	23.50	24.50	1.03
Hot carcass length (cm)	66.00	65.00	68.00	1.19
Cut parts (% live weight)				
Head weight	9.49	8.85	9.74	0.42
Ham weight	11.54^{c}	12.18^{ab}	13.41^{a}	0.55
Shoulder weight	9.73	10.76	11.05	0.56
Fore-leg weight	0.86	0.74	0.74	0.06
Hind-leg weight	1.15	1.08	1.07	0.05
Offals weight (% live weight)				
Liver weight	1.97	1.67	1.69	0.05
Lung weight	0.75	0.79	0.83	0.03
Kidney weight	0.20^{a}	0.18^{ab}	0.11^{b}	0.01
Heart weight	0.20^{a}	0.15^{b}	0.16^{b}	0.01
Spleen weight	0.13	0.14	0.13	0.04

^{abc}- means within rows having different superscripts are significantly (P<0.05) different

at last rib and subcutaneous fat at "K". The values increased (P<0.05) significantly with increase in feed quantity offered. The pigs on 2.5 kg feed daily had the highest recorded values while those on 1.5 kg feed per day had the least values. Fat at first rib had the mean values ranged from 3.49 cm (pigs offered 1.5 kg feed/day) to 4.12 cm (pigs offered 2.5 kg feed/day). Pigs fed 2.5 kg feed daily had the highest fat at last rib (2.53 cm) while the least value 1.68cm was obtained from the pigs fed 1.5 kg feed per day. The values for subcutaneous fat depth "K" ranged from 1.60 cm (pigs fed 1.5 kg feed daily) to 2.47 cm (pigs fed 2.50 kg feed daily). The highest numerical values for subcutaneous fat depth "C" (1.35 cm) were obtained in 2.5 kg feed /day fed pigs while their least mean values 1.03 cm were obtained for the pigs on 1.5 kg feed/day

Discussion

The experimental pigs were equalized before the commencement of the experiment. The initial weight ranged from 36.19 to 37.00 kg. Increase in the weight gain with increasing feeding level was a function of plane of nutrition (Snetsinger, 1994), thereby resulting in adequate intake of nutrients required to sustain rapid growth and development (Esonu *et al*., 2002). Sufficient offering of feed to pigs is vital in optimizing overall growth performance. Garcia-Valverde *et al*. (2008) reported that pigs on high level of nutrition deposited both lean and fat at a faster rate than those fed moderate level of nutrition on both age- and weight- constant bases. This is in line with the observations noted in this present study where feed intake was significantly influenced by feed quantity offered. The pigs offered highest quantity of feed had the best feed intake both in total- as well as in daily feed intake. Final body weight and daily weight followed the same trend as that of feed intake with the highest observed mean values recorded by the pigs fed 2.5 kg feed per day. Garcia-Valverde *et al*. (2008)

Table 4: Effect of quantity of feed offered on backfat composition of finishing male pigs

	QUANTITY FEED OFFERED			
Measurements	1.5 kg	2.0 kg	2.5 kg	SEM
Live weight (kg)	71.25	72.00	75.00	2.54
Hot carcass weight (kg)	56.88	55.75	58.58	2.65
Longissimus dorsi muscle 'A' (cm)	7.92	7.64	6.63	0.27
Longissimus dorsi muscle 'B' (cm)	4.21	3.96	3.89	0.24
Fat at first rib (cm)	3.49^{b}	3.94^{ab}	4.12^{a}	0.17
Fat at last rib (cm)	1.68^{b}	2.35^{ab}	2.53^{a}	0.17
Subcutaneous fat depth 'C' (cm)	1.03	1.12	1.35	0.09
Subcutaneous fat depth 'K' (cm)	1.60^{b}	1.93^{ab}	2.47^{a}	0.12
Fat free index	49.90	48.52	47.78	0.60

[ab]- means within rows having different superscripts are significantly (P<0.05) different

"A" (cm) Maximum width of the Longissimus dorsi muscle at the widest point
"B" (cm) Maximum width of the Longissimus dorsi muscle at the greatest depth and perpendicular to the point A measurement
"C" (cm) Subcutaneous fat depth immediately above the B measurement
"K" (cm) Subcutaneous fat depth at the dorso-lateral edge of the Longissimus dorsi muscle

reported that pigs responded to increase in feed offered with increased rate of weight gain and fat deposition. There was no significant difference in feed conversion ratio with increase in feed quantity offered. The pigs on daily ration of 2.5 kg feed had the least numerical value in feed conversion ratio, although, these pigs consumed more feed than others. The reduced feed conversion ratio with increased feed quantity offered might be linked to better feed efficiency. The increase in growth rate with increasing feed offered indicates that protein deposition had larger effect on growth rate than fat deposition. The extra feed consumed by the pigs on 2.5 kg feeding regime could have resulted to increase in protein deposition which mainly determines the growth rate of growing pigs. The extra gain in growth rate could be hypothesised to be proportionately higher than the increase in feed intake resulting in a reduced and therefore improved feed conversion ratio. Affentranger *et al*. (1996) reported better feed intake and feed efficiency in pigs fed under different feeding regimes. Feeding level, feed composition and feeding patterns have been used as tools to manipulate growth rate, weight gain, fat deposition and pork quality (Devol *et al*., 1988; Wood *et al*., 2004). So, feeding level have been applied to increase/decrease growth rate and thereby decrease/increase age at slaughter at a given body weight (Garcia-Valverde *et al*., 2008; Lebret, 2008a). This observation conforms to the result obtained in this present study where pigs on feed quantity of 2.5 kg per day attained the target weight of 70 kg first, followed by those on 2.0 kg and later by those on 1.5 kg daily feeding regime.

According to the growth model of de Vries and Kanis (1992) growing pigs on any nutritional plane first meet their energy requirement for maintenance. If feed intake exceeds this requirement, the surplus energy is used for protein and fat deposition. The increasing levels of feed offered reduced the age at slaughter by 14 days (2.00 kg/day) and 30 days (2.50 kg/day). Affentranger *et al*. (1996) and Lebret *et al*. (2001) confirmed that besides the genetic make-up of pigs, the feed composition as well as the feeding intensity can directly influence the age of slaughtering at a given body weight. From

this study, the pigs were slaughtered at market weight of at least 70 kg. The non significant mean values obtained in live weight, fasted, bled, hot carcass, left carcass weights, as well as dressing percentage and hot carcass length might be connected to the uniform weight at slaughter. This implies that feed quantity offered did not add extra variability in these parameters. Although these mean values increased with increasing feed quantity offered while age at slaughter decreased with increasing feed quantity offered. This finding is in consonance with the submission of Lebret (2008b) and Yakubu *et al*. (2007) that feed restriction affected fat more than lean tissue deposition when applied during finishing period. Since, body fat deposition rate increases with age, in contrast to protein deposition rate which remains almost constant during the growing-finishing periods (Reeds *et al*., 1993). The significant difference noted in the ham weight as percentage of live weight as well as the numerical increase in the mean value of shoulder weight with increasing levels of feeding might be linked to the slight difference noted in the growth and digestibility of the pigs given the highest quantity of feed. The pigs must have obtained sufficient amount of nutrients from the dry matter intake to compensate the energy requirement for body maintenance and as well for tissue growth. As adequate quantity of energy intake is critical to optimize lean growth and efficiency (Augenstein *et al*., 1997). Hence, the feeding level, pattern and protein : energy ratio of the diet, together with genetic growth potential of the pigs determine the growth rate and composition of weight gain at both whole-body and muscle level (Lebret, 2008b; Merck, 2008).

Kidney and heart weight as percentages of live weight differed significantly across treatments. The observed differences suggested that compensatory growth due to improved feed conversion ratio, without increase in feed intake must have occurred (Oksbjerg *et al*., 2002; Therkildsen *et al*., 2004). Bikker *et al*. (1996) and Lebret (2008a) assert that at the whole body level, compensation in the rate and often efficiency of weight gain mainly results from an increase in adipose tissue and internal organ growth, but not from a higher carcass lean deposition, generally giving rise to similar carcass composition at slaughter. The observation contradicted the work of Susbilla *et al*. (1994); Tumova *et al*. (2003) and Iheukwumere *et al*. (2004) who did not find significant difference in heart weight.

Many research findings have shown that the level of feed offered greatly influenced the fat deposition in pigs. Feed restriction affects fat tissue more than lean tissue deposition when applied during the finishing phase. Therefore, restricted feeding leads to leaner carcasses compared with *ad libitum* feeding (Ellis *et al*., 1996; Wood *et al*., 1996; Lebret *et al*., 2001). Decrease in subcutaneous fat, adipocyte volume and lipogenic capacity in pigs is some of the effects of restricted feeding (Mersmann *et al*., 1981; Leymaster and Mersmann, 1991; Gondret and Lebret, 2002). The least values obtained in subcutaneous fat at first and last ribs were recorded for the pigs restricted to feeding regime of 1.5 kg feed per day. Hence, the importance of feed restriction on production indices over the growth period and meat quality cannot be over-emphasised and this depends very much on feeding pattern, degree and duration (Campbell *et al*., 1983; Prince *et al*., 1983; Donker *et al*., 1986; Critser *et al*., 1995). The amount of feed offered per day played vital role in the growth which therefore had

direct bearing on the quality of carcass produced. Limited-feeding led to depletion of apparent rate of glycogen as measured by muscle acidity (Mcphee and Trout, 1995) resulting to reduction in subcutaneous fat and increased in rate of lean growth (Mcphee *et al*., 1988). Pigs raised on restricted feeding were reported by Nguyen and Cam (2001) to have high growth rate, low back fat and high lean percentage in the carcass of their descendants, hence, the advantage of limited feeding transcends a generation.

Conclusion

The results of this study show that the growth performance (final body weight, weight gain, feed intake, days to target weight) and ham weight of finishing pigs were influenced by feed quantity offered but not the feed conversion ratio. The organs (heart and kidney) and backfat composition of the finishing pigs were also affected by feed quantity offered. Therefore, a degree of feed restriction may result in a discernible improvement in organs weight and carcass quality of finishing pigs.

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Received: 1st August, 2012
Accepted: 31st December, 2012