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Haematological and behavioural responses of growing pigs to quantitative feed restriction

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Abstract

A study was carried out to assess the effects of feed quantity offered on haematological parameters and behavioural characteristics of pigs. A total of 48 Large White grower male pigs with initial average body weight of 7.15±0.55 kg were assigned to 3 treatment groups of 16 pigs per group and were further replicated in 2 pigs per replicate on the 8th, 14th and 20th weeks of the experiment. Two digital cameras were mounted above the pen to monitor the behaviour of the pigs. The results obtained for the study indicated that quantitative feed restriction had no positive impact ($p>0.05$) on the haematological parameters considered whilst it influenced ($p<0.05$) standing, sitting, lying inclined, lying lateral and walking behaviours of the pigs. Walking behaviour (11.93, 8.52, 4.55%) decreased significantly ($p<0.05$) with increasing levels of feed offered, conversely lying inclined (5.77, 5.77, 13.46%) and lateral (5.26, 6.58, 13.16%) increased ($p<0.05$) with increasing levels of feed offered. Conclusively, quantitative restriction had no significant impact on the haematological indices of growing pigs but enhanced some behavioural traits (standing, sitting, lying and walking).

Key words: Behavioural traits, growing pigs, haematological indices, quantitative feed restriction

Introduction

In recent years, it has become imperative that effective management of feeding techniques may assist in the reduction of problems connected with livestock feeding strategies. Increase in body fat deposition, high incidence of metabolic and skeletal disorders and high mortality are among the challenges associated with modern strains of livestock due to their inherent traits of improved metabolic rate and fast growth rate. Feed restriction is one of the commonest management practices used in minimizing these problems. It involves denying pig full access to feed required for normal tissue development with the aim of improving feed utilization efficiency (Mahmood *et al.*, 2007). According to some researchers, livestock subjected to restricted feeding programme showed evidence of physiological stress and increased incidence of abnormal behaviours (Mench, 2002; Njoku *et al.* 2015). These stress conditions and clinical status of livestock can be measured through the blood profile of the animal.

Blood has been defined as an essential circulatory tissue, composed of cells floating in a fluid intercellular medium with the principal task of maintaining homeostasis (Isaac *et al.*, 2013). Haematological components are valuable in monitoring stress due to feeding methods adopted and type of feed ingredients used in compounding the ration coupled with factors affecting the health condition of domestic livestock (Oyawoye and Ogunkunle, 2004). However, it was reported that physiological indices of stress were higher in feed restricted domestic animals than their counterparts fed *ad libitum* (Njoku *et al*., 2015; Obasa *et al*., 2016). These physiological indices of stress were found to be positively interconnected with the intensity of feed restriction imposed on livestock (Eberhard *et al*., 2007). Evidence of physiological stress and increased incidence of abnormal behaviours in restricted fed farm animals were reported by Mench (2002). Pigs on limited feed offered exhibited certain behaviours that were in variance from their counterparts on free access feeding regimen (Bratte, 2011; Adeyemi *et al*., 2015). The duration and severity of feed restriction in livestock production has turned out to be an important concern of animal welfare because feed restriction imposes stress on the animal (FAWC, 1998). Only a handful of information exist in the literature evaluating the haematological and behavioural responses of growing pigs reared in hot humid tropical environment when subjected to feed rationing. To this effect, this study was carried out to assess the haematological and behavioural responses of growing pigs managed under tropical environmental conditions to quantitative feed restriction.

Materials and Methods

Animal Use and Care

The study protocols involving the use of pigs were in accordance with the animal welfare requirements for care and management of experimental animals and in line with the Animal Welfare Committee guidelines of the Federal University of Agriculture, Abeokuta, Nigeria (FUNAAB, 2013).

Experimental Site

The study was carried out in the Piggery Unit of the Teaching and Research Farms Directorate (TREFAD) of Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The farm is located within latitude 7° 10′ N, longitude 3° 2′ E and altitude 76 mm above sea level. It is situated in the derived savannah zone of South-Western Nigeria with mean annual rainfall of about 1037 mm and temperature of about 34.7 °C. The relative humidity range in the rainy season (late March-October) and dry season (November-early March) is 63-96% and 55-82%, respectively with an annual mean of 82% (Google Earth, 2019). The seasonal distribution of yearly rainfall is estimated at 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).

Experimental Animals and Management

A total of 48 weaner Large White male pigs of eight wk old with average body weight of 7.15±0.55 kg were randomly allotted to 3 experimental groups in a completely randomized design. The pigs were grouped based on weight equalization to 3 groups (group 1 fed 2.5 kg feed daily, while groups 2 and 3 were offered 2.0 and 1.5 kg feed daily, respectively) of 16 pigs each. The treatment groups were replicated 4 times with 4 pigs per replicate. Pigs in each replicate group were fed and housed together in naturally ventilated pen of floor size measurement of 3 m x 2 m. Fresh clean water was offered without restriction throughout the period of the experiment.

Experimental Design

The 48 pigs were assigned based on weight equalization into 3 treatment groups of 16 pigs per group. The treatment groups consisted of the daily amount of dietary ration offered to each of the pigs. Pigs were offered 2.5, 2.0 or 1.5 kg feed daily until the pigs on replicate attained average body weight of 70 kg. Two frequencies of feeding regimen were adopted daily. Each pig received one half of its daily ration at 08:00 hr and the remaining half at 14:00 hr. Diets were compounded to meet the body requirements of growing pigs. The ration contained 18.60% crude protein and metabolisable energy of 2986.70 kcal/kg as shown in Table 1.

Table 1: Percentage composition of experimental diets

Ingredients	Percentage composition
Maize	45.00
Groundnut cake	20.00
Wheat offal	20.00
Palm kernel cake	12.00
Bone meal	2.00
Grower premix*	0.45
Salt	0.50
Methionine	0.05
Total	100.00
Analysed composition (%)	
Crude protein	18.60
Crude fibre	5.84
Calcium	0.72
Phosphorus	0.34
Metabolizable energy (kcal/kg)	2906.00

*Contained the following per kg diet: Vit A 12600 IU; Vit D 2800 IU; Vit E 49 IU; Vit K3 2.8 mg, Vit B1 1.4 mg, Vit B2 5.6 mg; Vit B6 1.4 mg; Vit B12 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

Haematological Parameters

Two pigs per replicate were selected randomly and bled on the 8th, 14th and 20th weeks of the experiment in order to determine the haematological parameters. The pigs were restrained and bled through the anterior vena cava as described by Boland (1985). About 2.5 ml blood sample was collected into a labelled bottle containing ethylene diamine tetra acetate (EDTA). The samples collected in EDTA bottles were used to determine the haematological parameters: white blood cell count, Haemoglobin, Packed cell volume, Mean Corpuscular Volume, Mean Corpuscular Haemoglobin, Mean Corpuscular Haemoglobin Concentration, Red Blood Cell Distribution Width, Platelet Count, Mean Platelet Volume, Platelet Distribution Width and Platecrit. An auto Haemo-analyser Machine was used in determination of these parameters.

Behavioural Observations

Methodology for behavioural observation was based on modification of the method of Hessel *et al.* (2006). Two digital cameras were installed in each unit and used to capture the various behaviours displayed by the pigs. Observation of the behaviour was made during three 5-minute sessions (0700 hr, 1300 hr and 1800 hr of the 24-hr period at wk 10, 16 and 22 of growing period. Two pigs were carefully picked from each experimental group and marked for study. Constant surveillance of the focal pigs was used to classify the feeding behaviour and evaluate how the amount of feed accessible to pigs affected the behaviour. Behaviours of 12 focal pigs were monitored and recorded; the behavioural traits monitored are listed and defined as follows:

1. Standing behaviour defined as having taken place when the animal adopted an upright position with legs extended.
2. Sitting behaviour defined as when the caudal portion of the body trunk was in contact with and supported by the ground.
3. Feeding behaviour defined as when the pig was standing at the trough with its head down. The head could be either in the trough or in front of the trough when pig was eating spilled feed.
4. Lying sterna defined as when the upright of the chest of pig was in contact with the ground.
5. Lying inclined defined as lying not completely on the side, but with legs partly extended.
6. Lying lateral defined as the pig was on its side with all legs extended.
7. Walking behaviour included any actions in which the pig moved at least 2 steps.
8. Rooting behaviour included pushing and sniffing movements, with the snout at floor level beyond the trough.
9. Nosing behaviour included when pig performed rooting snout movements toward the belly of a pen-mate.
10. Agonistic behaviour defined as physical encounters between at least 2 pigs including head-to-head fights, biting another pig, as well as pushing or knocking another pig with the head. Agonistic behaviour was sub-divided into 2 categories; aggression and displacement. The superior pig of a physical encounter was counted for aggressive behaviour. In addition, fighting pigs, which were not obviously inferior or superior, was also counted for aggressive behaviour. The inferior pig of a physical encounter, which evaded the aggressor without defending or which was pushed away by a superior pig was counted for displacement.

Statistical Analysis

Data obtained were processed by one-way analysis of variance using Statistical Analysis System software package (SAS, 2000). Significantly ($P<0.05$) different means among treatment groups for measured variables were separated using New Duncan's Multiple Range Test as contained in SAS (2000) package.

Results and Discussion

Effect of Feed Restriction on Haematological Indices of Growing Pigs

The effects of feed restriction on haematological parameters of growing pigs are presented in Table 2. All of the parameters considered were not significantly different ($P>0.05$) across the treatment groups, although, the parameters considered were numerically different across the treatments. White blood cell count, red blood cell, haemoglobin, mean corpuscular haemoglobin, mean corpuscular haemoglobin concentration and platelet count decreased numerically with increase in feed quantity offered while packed cell volume, red blood cell distribution width, mean platelet volume and platelet distribution width followed no definite pattern. Highest packed cell volume of 42.07% was noted for the pigs on 2.0 kg feed offered while the pigs on the least feed offered had lower value of 31.40%.

Table 2: Effects of feeding frequency on haematological indices of growing pigs

	Feed quantity offered			
Measurements	1.5 kg	2.0 kg	2.5 kg	SEM
White blood cell count (10^9/l)	26.80	24.65	19.92	5.47
Red blood cell count (10^{12}/l)	7.52	6.27	5.50	1.24
Haemoglobin (g/l)	119.67	103.20	86.00	19.66
Packed cell volume (%)	36.50	42.07	31.40	6.92
Mean corpuscular volume (fl)	57.98	56.68	56.08	1.76
Mean corpuscular haemoglobin (pg)	16.24	15.83	13.50	1.13
Mean corpuscular haemoglobin concentration (g/l)	283.00	281.67	278.80	3.74
Red Blood Cell Distribution Width	17.84	19.07	18.42	0.61
Platelet Count	247.40	218.50	174.20	75.23
Mean Platelet Volume (fL)	8.20	7.53	7.94	0.25
Platelet Distribution Width (%)	15.48	14.92	15.06	0.20
Platetcrit	0.18	0.18	0.14	0.06

Effects of Quantity of Feed Offered on Behavioural Characteristics of Growing Pigs

The effects of quantity of feed offered on behavioural characteristics of growing pigs are presented in Table 3. Standing, sitting, lying inclined, lying lateral and walking were significantly (P<0.05) influenced by quantity of feed offered. Lying inclined and lying lateral increased significantly (P<0.05) with increase in quantity of feed offered while standing and walking decreased with increase in feed quantity offered. The pigs fed 1.5 kg/day exhibited more sitting tendency of 7.29% and 5.21% over the pigs fed 2.00 and 2.50 kg/day, respectively. Lying sterna increased numerically while rooting behaviours decreased numerically with increase in feed quantity offered. Agonistic (aggression/displacement) behaviour decreased numerically with increasing feed quantity offered. Standing behaviour was significantly (P<0.05) different with the highest value of 10.65% noted for pigs fed 1.5 kg feed daily while the least value of 4.17% was documented for pigs fed 2.5 kg feed daily. Feeding behaviour exhibited by the pigs across treatments was statistically similar, although, pigs offered the most quantity of feed spent more time eating than those on restricted feeding. The pigs placed on 2.5 kg feed per day had more feed to contend with than those on 2.0 and 1.5 kg per day. More rooting behaviours were exhibited by the pigs on 1.5 kg per day than those on 2.0 and 2.5 kg per day. Hence, rooting behaviours values ranged from 5.21% (pigs fed 2.5 kg feed daily) to 11.46% (pigs fed 1.5 kg feed daily). Agonistic (aggression and displacement) behaviours decreased with increasing feed quantity offered. Pigs fed 1.5 kg feed daily recorded 9.52% agnostic behaviour which was significantly (P>0.05) similar to 8.04% and 7.14% observed for the pigs fed daily with 2.0 kg and 1.5 kg feed daily, respectively.

Table 3: Effects of quantity of feed offered on behavioural characteristics of growing pigs (%)

	Feed quantity offered			
Measurements	1.5 kg	2.0 kg	2.5 kg	SEM
Standing	10.65[a]	10.19[a]	4.17[b]	0.76
Sitting	7.29[b]	5.21[b]	12.50[a]	1.47
Feeding	6.45	8.89	9.68	2.23
Lying sterna	5.36	9.02	9.82	1.63
Lying inclined	5.77[b]	5.77[b]	13.46[a]	1.36
Lying lateral	5.26[b]	6.58[b]	13.16[a]	2.52
Rooting	11.46	8.34	5.21	1.90
Nosing	7.81	9.38	7.81	2.21
Mounting	8.08	8.04	7.81	1.21
Agonistic	9.52	8.33	7.14	1.54
Walking	11.93[a]	8.52[b]	4.55[c]	0.46

[abc]Means within rows followed by different superscripts are significantly different (P<0.05)

Blood is useful for assessing the health status, clinical evaluation for survey of physiological/pathological conditions and diagnostic and prognostic evaluation of various types of diseases in animals (Obasoyo *et al*., 2005; Alade *et al*., 2005; Amel *et al*., 2006). Deviation in haematological parameters is often used to determine stress due to nutrition and other environmental factors (Afolabi *et al*., 2011). Addass *et al.* (2012) posited that nutrition affects the haematological values of farm animals. In this study, there was no significant variation in the haematological indices. Although, numerical differences were noted as meal size increased, most of the haematological parameters of growing pigs studied remained within the reference range values as indicated by Etim *et al*. (2013) and Coronado (2014) for clinically healthy pigs. The similarities in values of haematological parameters point to the fact that the level of quantitative restriction practiced in this study had no major detrimental effect on physiological well being of the pigs. Franczak *et al.* (2014) observed similarities in haematological values of well fed and undernourished gilts during peri-implantation period. The white blood cell values of pigs on limited feed offered were higher than the recommended reference values by Etim *et al*. (2013) and Coronado (2014). The variation in white blood cell count though not significantly different from the control group could be the response of pigs on limited feed offered to mild stress imposed by insufficient nutrient intake. Braun (2013) enthused that elevated white blood cell count is an indication of infection, immune system disorders, and stress among other factors. Similarly, Bagby (2007) and Dugdale (2011) also opined that a rise in the level of leucocytes may possibly be linked to anaemia, bone marrow tumour, infectious disease, inflammatory, rigorous physical stress, tissue damage along with others. The reduction in levels of packed cell count and haemoglobin with decreasing feed offered validated the tendency of decreasing blood components with appropriate nutrient reduction (Nwanbe and Elechi, 2009). The reduction in packed cell volume and haemoglobin implies amplified blood dilution and declining effectiveness of cellular oxygen transportation leading to lower growth rate observed in most restrict-fed animals compared to their counterparts on full feeding regimen. Awodi *et al*. (2005)

and Chineke *et al*. (2006) stated that the primary function of the erythrocytes is to act as carriers of haemoglobin. The non significant values of MCV, MCH and MCHC measurements in pigs with different levels of feed offered is an indication of balanced diets which meets up with all the nutritional requirements of pigs (Cellmate Wellness Systems, 2002). However, the deviation of the MCH and MCHC values from the reference values could be attributed to haemolytic anaemia caused by limited feed offered. This is in line with the observation of Afolabi *et al*. (2011) that attributed the variation in MCH and MCV values with factors like malnutrition, nutritional deficiencies, and chronic haemolytic anaemia, infectious and chronic diseases.

Meal size and frequency have been reported to vary with different feeding systems (Njoku *et al*., 2012, 2015; Obasa *et al*., 2016). Fagbemi *et al*. (2016) reported that manipulation of feeding level had greater effect on behaviour than any other stimuli. The reasons for feed manipulation include prevention of reproductive problems, reduction of feed costs due to better feed efficiency and less feed wastage (Libret 2008; Njoku *et al*., 2013) as well as modification of pig's behaviour. From this study, it was revealed that increasing the feed quantity offered resulted in a decrease in certain behaviours (standing, rooting, nosing, agnostic behaviour and walking) and an increase in sitting, feeding and lying postures of pigs. The significant increase in the general activity (standing, sitting and walking) of the pigs with decrease in feed quantity offered could be a result of increased feeding motivation which might have come from limited nutrient supply, resulting in hunger (Fagbemi *et al*., 2016), thereby increasing the tendency to perform foraging related behaviour in order to complement the small meal offered. Standing and walking behaviours which are indicative of locomotion typically associated with foraging behaviour (Stolba and Wood-Gush, 1989) were significantly influenced by level of feeding. Sahraei (2012) showed that animals fed *ad libitum* diet inadequate in crude protein spent a greater proportion of test time performing general activity relating to foraging behaviour. It is expected that an increase in feed quantity offered would increase eating behaviour of pigs. The numerical increase with increased feed quantity offered confirmed the findings of Hulbert and McGlone (2006) who did not find any significant difference in duration of feeding in sows fed either a drop or trickle feeding method. Lying behaviours increased with increase in feed quantity offered. The most fed pigs spent more time lying and changing their lying postures more than the less fed pigs. The change in resting behaviour is a reflection of satiety, since increase in resting and quiet behaviours was also reported when sows were offered a bulky diet or high energy diet (Lee *et al*., 2003). Nosing and rooting decreased numerically with increase in feed quantity offered. This decrease could be linked to less foraging motivation and less appetitive foraging behaviour, since a level of satiety could have been attained by the most fed pigs. According to Hessel *et al*. (2006) pigs engaged more rooting and nosing activities when limited feed was offered to them. The reason for the increase in rooting and nosing behaviours according to Hessel *et al*. (2006) was that the pigs were still hungry after a small meal was offered and tended to bridge the time gap with foraging related activities. Gilts whose feed intake were restricted were shown to develop oral stereotype both in tether and loose pens, in contrast to gilts fed large amount of feed, which showed little tendency to develop stereotype (Bergeron *et al*., 2000; D'Eath *et al*., 2009). The present finding differs from Jensen *et al*. (2012) who observed significant increase in rooting behaviour by pigs fed a diet restricted in protein but not energy when compared to the pigs fed a diet sufficient in crude protein and energy. The difference obtained in these findings might be a result of method of restriction. The non significant value obtained in agonistic behaviour is a pointer that competitions leading to agonistic behaviours occur irrespective of feeding level in pigs. When pigs are housed together the tendency of aggression due to social ranking, low space allocation and competition for available resources within the pen house will increase (Jensen *et al*., 2000).

Conclusion

From the results of this present study, it can be concluded that haematological indices of pigs are not affected by meal size. However, meal size influences standing, sitting, lying inclined and lateral, and walking behaviours of pigs. Hence, quantitative restriction can be adopted as management tools to improve some acceptable behaviour of group-housed pigs.

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