Growth Parameters And Electrolytes' Status Of Growing Pigs Fed Graded Levels Of Crude Oil-Containing Diets

Ntinya C. Johnson, Joy A. Okejim , Annie O. Amakiri

Department of Animal Science, Rivers State University, Port Harcourt, Nigeria. Department of Vocational Studies, Federal College of Education (Technical) Omoku, Nigeria.
N. C. Johnson corresponding author *(ntinya@alumni.uoguelph.ca)*

Abstract: This study was designed to investigate the effects of graded levels of crude oil consumption on the growth performance and electrolytes in growing pigs. 24 growing pigs weighing on average 9 ± 1.4 (mean ± SD) kg body weight (BW) were used in the study. There were four crude oil dietary treatments as: 0g (control group), 10g, 15g and 20g crude oil/kg of diet. Animals were weighed to obtain their initial BW and randomly assigned to their individual pens and allowed 14-d to adapt to their new environment after which they were presented with their experimental diets. There were 4 pigs per treatment. Animals were fed at 5% of their BW for 4 weeks after which all animals were weighed again to obtain their final BW for determining average daily feed intake (ADFI), average daily gain (ADG) and feed efficiency (FE). Blood samples were collected humanely from all animals into tubes and immediately snap frozen for electrolyte analyses: sodium (Na^+), potassium (K^+) and chloride (Cl^-). There were no differences ($P > 0.05$) in the ADFI of diets 1 to 3. Diet 4 ADFI was significantly ($P < 0.05$) lower compared with diets 1 to 3. The ADG of diets 1 and 2 were similar ($P > 0.05$). The ADG of diets 3 and 4 were significantly ($P < 0.05$) lower compared with those of diets 1 and 2 while diet 4 demonstrated the lowest ADG. The FE mirrored ADG. Na^+ serum levels were similar ($P > 0.05$) for diets 1 and 2 but animals on diets 3 and 4 had similar levels that were significantly ($P < 0.05$) lower than those of diets 1 and 2. K^+ and Cl^- serum levels also mimicked those of Na^+. It was concluded that the threshold of crude oil ingestion for pigs lies between 10g and 15g/kg of diet because beyond the 10g/kg diet level ADFI, ADG and FE were impeded. Similarly, beyond the 10g crude oil/kg of diet Na^+, P^+ and Cl^- sera levels were compromised.

Key words: Growth parameters, Electrolytes, Crude Oil and Pig.

1 Introduction

We have shown previously that growing pigs can tolerate up to 10g of crude oil/kg of diet without any obvious deleterious effects on feed intake, growth parameters and electrolytes, such Na^+, K^+) and Cl^- [11]. However, there are data in the literature demonstrating some toxicological effects of crude oil-contaminated diets on feed intake, weight gain and feed efficiency in various animals and livestock studies. [3] and [12] showed that ingestion of crude oil contaminated feeds reduced average daily feed intake, growth rate and feed efficiency in broiler chickens. In these studies the workers further demonstrated that the severity of the effects of crude oil on the growth parameters increased as the level of dietary crude oil also increased.Again, [7] observed a decline in feed intake and severe depression in growth rate of birds fed crude oil-contaminated feed. Depression in growth rate was also observed to increase as dietary crude oil content increased. With these observations, they concluded that retardation in body weight gain was an obvious visible effect of the consumption of crude oil-contaminated diet. [4] also observed reduced feed intake and reduction in organ weights of rabbits exposed to crude oil contaminated forage. Again, these patterns of effects due to crude oil ingestion have also been shown in goats; suppression of growth and in addition distortions in blood cell parameters, including reductions in organs' weights of the animals [8 – 9]. To our knowledge there is paucity of similar data on swine in the literature apart from the study of [11]. Therefore, the objectives of this study are to investigate the effects of graded levels of crude oil-contaminated feeds beyond the levels previously used in [11] on growth parameters and electrolytes in the growing pig.

2 Materials AND METHODS

Animals and their Management

Twenty four growing pigs weighing on average 9 ± 1.4 (mean ± SD) kg body weight (BW) were purchased from Cape Farms, Irete, Imo State, and humanely transported to the animal wing of the Rivers State University. On arrival here, the animals were weighed to obtain their initial BW and randomly allotted to their individual pens. Prior to their arrival the pens were cleaned thoroughly with detergents/hypochlorite, disinfected and then allowed to dry. Furthermore, the animals were allowed 14-d to enable them to completely acclimatize to their new environment. During this period, they were injected with a broad spectrum antibiotic (amoxyciline) intramuscularly and seen to be in good health and fed similar grower diet. At the end of the acclimatization period, the animals were offered their experimental diets at 5% of their BW (as-fed basis) twice daily at 09:00h (half of the daily meal) and 16:00h, respectively according to the method of [5]. Water was provided ad libitum via low water pressure nipples. Pens were constantly washed and cleaned throughout the experimental duration. There were four animals per dietary treatment group.

Crude Oil Management and Dietary Experimental Diets

The crude oil type used in this study was the Bonny Light obtained from the Nigerian Agip Oil Company Limited. Prior to using the crude oil in contaminating the diets, the crude oil was exposed to sunlight for 24 h in shallow pans to enable the evaporation of the light volatile fractions to ensure a stable product that feigns its natural form during pollution according to the method of [13]. Six corn-soybean meal-based diets formulated to be isocaloric and

isonitrogenous to meet or exceed the [10] recommended nutrient requirements of growing pigs of 10 – 20 kg BW were used in the study. The diets were really planned from the beginning to contain crude oil at 0g crude oil (control diet), 10g, 15g, 20g and 25g of crude oil/kg of diet, respectively as to have five dietary treatment groups. However, the 25g crude oil/kg of diet has to be expunged from the study as there was feed refusal in that group after 3-d of study; this resulted in the scaling down of the treatment groups in the study to four groups as: 0g, 10g, 15g and 20g crude oil/kg of diet, respectively. The experiment lasted for 4 weeks.

Experimental Procedure, Data Collections, Design and Analyses

Individual pen feed disappearance was monitored daily as a measure of feed intake relative to BW again. Thus, at the end of the study period, all animals were re-weighed to obtain their final BW. The difference between the final and initial BW represents weight gained during the study period. Thus, ADFI was obtained as the total amount of feed consumed by pig divided by the number of days of the experiment. ADG was determined by computing the weight gain by each pig at the end of the trial and divided by the number of days of study. FE was determined by dividing the ADG by ADFI, respectively. Blood samples were also humanely collected into tubes and immediately snap frozen for analyses of the electrolytes. Electrolytes were analysed by the flame photometric and spectrophotometric methods according to [2]. The experimental data were analyzed as a CRD. Data were subjected to analysis of variance (ANOVA) using PROC GLM of SAS (SAS Inst. Inc., Cary, NC) according to the experimental model: $Yij = \mu + D_i + Eij$; where Yij is the observation, μ = overall mean common to all treatments, D_i = the effect of the i^{th} diet and E_{ij} = the error term. Means were compared using Tukey's test and α-level of 0.05 was used for all statistical comparisons to represent significance.

3 Results And Discussion

The results of the effects of feeding graded levels of crude oil-contaminated diets on growth parameters are shown in Table 1.

Table 1. *Growth Parameters of Pigs Fed Graded Dietary crude Oil-Contaminated Diets*

	DIETS					
Item	Diet 1 n = 4	Diet 2 n = 4	Diet 3 n = 4	Diet 4 n = 4	SEM	P-value
ADFI (kg/d)	1.15^a	1.16^a	1.12^a	0.90^b	0.02	0.045
ADG (g/d)	648.5^a	646.6^a	481.6^b	164.6^c	2.53	0.001
FE	0.56^a	0.56^a	0.43^b	0.18^c	0.03	0.002

Means with different superscripts within the same row are significantly (P < 0.05) different

As shown in Table 1, the ADFI of diets 1 to 3 were similar as there were no significant (P > 0.05) differences between them. However, the ADFI of diet 4 with the highest dietary crude oil intake had a significantly (P < 0.05) lowered ADFI compared with diets 1 to 3, respectively. In the ADG, although the ADFI were similar from diets 1 to 3, they did not gain weight at the same rate. Consequently, the ADG of diets 3 and 4 were significantly (P < 0.05) lower compared with those of diets 1 and 2 with diet 4 demonstrating significantly (P < 0.05) lowest ADG with diet 3 ADG being the medium between diets 1 and 2 versus diet 4, respectively. The effects of dietary crude oil consumption on the ADG were mirrored in the FE (Table 1). The effects of consuming graded levels of dietary crude oil on serum electrolytes are shown in Table 2.

Table 2. *Na^+, K^+ and Cl^- of Pigs Fed Graded Dietary crude Oil-Contaminated Diets*

	DIETS					
Item	Diet 1 n = 4	Diet 2 n = 4	Diet 3 n = 4	Diet 4 n = 4	SEM	P-value
Na^+ (mmol/l)	139.2^a	138.8^a	129.5^b	125^b	6.62	0.034
K^+ (mmol/l)	4.4^a	4.4^a	3.1^b	2.5^b	0.36	0.022
Cl^- (mmol/l)	105.0^a	104.6^a	90.5^b	89^b	4.02	0.031

Means with different superscripts within the same row are significantly (P < 0.05) different

As shown in Table 2, the serum sodium ion concentration was similar for diets 1 and 2 as there were no significant (P > 0.05) differences between them. However, as dietary crude oil content increased to 15g/kg of diet the serum sodium ion significantly (P < 0.05) reduced compared with diets 1 and 2. The same scenarios were also observed for potassium and chloride ions, respectively.As previously given in the materials and methods section, this study was initially planned to include the ingestion of 25g crude oil/kg of diet. However, this treatment group was expunged from the study as the animals in this treatment group demonstrated feed refusal three days into study. This finding in this study is in agreement with the findings of [12] that observed feed refusal when crude oil was above the threshold for the animal. In that study, performance of the animals were also compromised as there was depression in growth especially as the dietary crude oil level increased. In this current study, as the dietary crude oil intake increased to 15g/kg of diet and above, there were significant reductions in feed intake, depressed growth rate and reduction in feed efficiency. These findings are in agreement with those of [3] and [7]. These observations become practical when viewed in real terms and their implications to the swine farmer. Accordingly therefore, although there were no significant differences in feed intake between the 0g, 10g and 15g crude oil/kg of diet treatment groups the feed intake of the 20g crude oil/kg of diet treatment group was significantly lowered compared with the first three treatment groups. This finding was expected as pigs are very selective in their acceptance of feed type [10]. This might be related to the pig highly developed tasted buds and more so coupled with their ability to associate feed type with the comfort or discomfort experienced postprandial as a consequence of its ingestion [10]. Furthermore, although the ADFI was similar for treatments 0g, 10g, and 15g, they gained at different rates with the 0g and 10g groups being the best

gainers in weight gain compared to the rest of the treatment groups. Consequently, while animals on the 0g and 10g groups gained 648.5g and 646.6g per day, respectively; animals in groups of 15g and 20g gained 481.6g and 164.6g per day, respectively. This translated into a difference in ADG of about 25.73% and 74.67%, respectively for the control over the 15g and 20g groups, respectively. In respect to this finding in this study, from the standpoint of practical swine production crude oil contamination of our eco-system can result in significantly reducing the profit margin of the hog farmer, especially in areas where crude oil pollution seems to be endemic, such as the Niger Delta Area of Rivers State, Nigeria [1; 6 and 14]. This trend is also similar with the FE. While the FE of 0g and 10g crude oil/kg diet treatment groups were 56%, respectively; those of 15g and 20g crude oil/kg treatment groups were significantly lowered by the differences of 23.21% and 67.86%, respectively. Again, from practical swine production implication, the reduction in FE to this magnitude had very grave consequences on the part of the hog farmer.Dietary crude oil ingestion beyond 10g/kg of diet significantly reduced all the serum electrolytes' concentrations. These are indications that ingestion of dietary crude oil beyond 10g/kg of diet can dispose growing pigs to grave health conditions and thus trigger the sudden death syndrome often observed with growing pigs in the commercial production setting [10]. This is also the first study on these electrolytes with growing pigs. Thus there were no data in the literature to compare our findings with.

4 Conclusion

Growing pigs can ingest dietary crude oil up to 10g/kg of diet without feed rejection, suppression of growth and feed efficiency. However, beyond this level, there would be reduced feed intake and consequently lead to suppression of growth and feed efficiency. Furthermore, it will compromise animal health due to reduced levels of sera electrolytes and consequently resulting in huge economic losses primarily due to reduced growth rate on the part of the hog farmer.

5 References

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