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EFFECT OF LEVELS OF ENERGY- PROTEIN VALUE ON GROWTH PERFORMANCE, BLOOD PROFILE AND NUTRIENT DIGESTIBILITY OF WEANED PIGS

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Abstract
There is surplus protein and energy that cannot be digested in diet than required. This study investigated the effect of balancing the concentration of nutrients in pigs' diets aiming at reducing environmental wastage. Eighteen weaned pigs were randomly distributed into three treatments: 22%CP and 3200ME Kcal/kg; 20%CP and 3300ME Kcal/kg; 18%CPand 3400ME Kcal/kg. Each treatment had three replicates and two pigs per replicate. Data were collected on growth parameters, blood profile and nutrient digestibility. Pigs fed treatment 1 had significantly higher ($p<0.05$) average feed intake and average final weight. Significant ($p<0.05$) higher values were observed in cholesterol level and high density lipoprotein level in pigs fed treatment 3. Pigs fed treatment 3 had significantly ($p<0.05$) higher levels of triglyceride and total protein (252.87mg/dL and 7.44mg/dL) compared to those fed with treatment 1 (210.34mg/dL and 5.78mg/dL) respectively. However, low density lipoprotein level increased significantly ($p<0.05$) in pigs fed treatment 1 (11.13mg/dL) compared to treatment 3 (3.14mg/dL). Digestion of crude protein was significantly ($p<0.05$) higher (88.71%) in pigs fed treatment 3 compared with treatment 1 (85.12%). It can be concluded that reducing crude protein level to18% and increasing metabolizable energy level to 3400 Kcal/kg in feed would lead to improved nutrients utilization and absorption in pigs.

Keywords: Growth performance, blood profile, nutrient digestibility, pigs, crude protein, metabolizable energy

Introduction

Newly weaned pigs more often than not, experience nutritional stress, physiological stress, environmental stress and social stress which could lead to low feed intake, poor growth and mortality (Campbell *et al.*, 2013). In swine production industry, providing adequate nutrients has been noted as the most important factor to achieve efficient and profitable production (Jeong *et al.,* 2010). This suggests that insufficient nutrient levels in feed limit potential growth and production of pigs. Pigs do not require specific ingredients in their diets but instead require energy and nutrients such as amino acids, minerals and vitamins obtainable from array of available feed ingredients for use in pig feed (Resse *et al.,* 2000).

Energy in feed is, however, considered as one of the most important factors of feed intake because a high energy level in feed can decrease feed intake while a low energy level can increase feed intake and decrease the deposition of protein (Lewis and Southern, 2001). Low levels of dietary protein are required for optimum growth and efficiency of gain for a protein source with well-balanced amino acid profile (Adesehinwa, 2009). Wellock *et al.* (2008) concluded that decreasing the protein level in feed can decrease the risk of post weaning diarrhea. Opapeju *et al*. (2009) concluded in its findings that pigs fed with low crude protein diets showed fecal consistency score, improved enteric health and growth performance. However, the digestive enzymes of piglets have low activity for digestion of energy and protein from birth to 56 days (Jensen *et al.,* 1997). That means there is much more surplus protein and energy that cannot be digested in diets for piglets than the requirement. This study therefore explored the performance and nutrient utilization of weaned pigs fed varying nutrient (energy and protein) levels.

Materials and Methods

Experimental location

The experiment was carried out at the Piggery Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Nigeria. It lies approximately between longitude N07°26'850" and N07^0 27'087" and latitude E003^{0}53'899" to 003^{0}53'552 (Oluwasemire *et al*., 2012).

Experimental design

Eighteen (Land Race X Large White) weaned pigs were used for a 42-days research. Pigs were randomly distributed into three treatments (T_1: 22% CP and 3200 ME Kcal/kg; T_2: 20% CP and 3300 ME Kcal/kg; T_3: 18% CP and 3400 ME Kcal/kg) with each treatment having three replicates and two pigs per replicate.

Data collection

Data were collected on the growth performance, blood profile and nutrient digestibility of the pigs. Blood samples were collected from the anterior vena cava of each pig and stored in a non-anticoagulant tube. The samples were allowed to clot and centrifuged for about 15 minutes at 6,048 × g at 4°C for plasma separation. At day 35, animals were transferred to metabolic cages for collection of fecal samples. The animals were allowed to adapt for two days and fecal samples were collected daily during the last 3 days of the experiment for digestibility analysis. Samples collected were sun dried and subjected to laboratory analysis. The study lasted for 42-days.

Statistical analysis

Data obtained were analyzed using ANOVA procedure and means were separated using Duncan's Multiple Range Test (Duncan, 1955). The probability value $p< 0.05$ was considered significant.

Results and Discussion

Results

The growth performance of pigs fed experimental dietary treatments is presented in Table 2. Final body weight of weaned pigs fed Diet 1 was significantly higher compared to weaned pigs fed Diet 2 and Diet 3. The average feed intake reduced significantly ($p<0.05$) in pigs fed treatment 3 compared with those fed with other dietary treatments. Average weight gain and gain to feed ratio (feed conversion ratio) were not affected ($p>0.05$) by the dietary treatments. The higher the energy contents of the feed and the lower the crude protein content of the feed the lower the feed intake of the animals. Blood profiles of piglet fed the experimental dietary treatments are represented in Table 3. Cholesterol level was significantly higher ($p<0.05$) in pigs fed treatment 3 compared to those fed treatment 2. However, the values obtained for pigs in treatment 1 are statistically similar to those obtained for pigs in treatments 2 and 3. The level of high density lipoprotein in weaned pigs fed with diet 3 was significantly ($p<0.05$) higher compared to weaned pigs fed with treatment 2 and treatment 1. Treatment 2 compared with treatment 1 for high density lipoprotein. Triglyceride and total protein reduced significantly ($P<0.05$) in pigs fed treatment 1 compared to those fed with the other dietary treatment. The higher the energy content and the lower the crude protein content of the feed, the higher the triglyceride values of the experimental animals. Low density lipoprotein (LDL) reduced significantly ($P<0.05$) in treatment 3 compared to treatments 1 and 2. However, LDL of pigs fed diet of T1 and T2 were not different ($p>0.05$). Total protein for pigs fed treatments 2 and 3 compared with each other but significantly ($p<0.05$) higher than for pigs in treatment 1. Globulin and Albumin were not affected ($p>0.05$) by the dietary treatments. Nutrient digestibility of weaned pigs fed experimental diet is presented in Table 4. Crude protein digestibility of weaned pigs fed treatment 3 was significantly higher ($p< 0.05$) compared to pigs fed treatments 1 and 2. Treatments 1 and 2 were statistically similar. Values obtained for ether extract digestibility were statistically similar ($p>0.05$) across the treatments. Dry matter and crude fiber digestibility were not affected ($p>0.05$) by the dietary treatments. Feeding pattern of weaned pigs fed different protein and energy levels across the week is shown in Figure 1. Pigs fed T_1 consumed the highest amount of feed above 5 kg for the first three weeks after which their feed intake declined to about 5 kg, after which their consumption later rose consistently till end of the sixth week. Also weaned pigs fed T_2 consumed about 4.5 kg for the first week after which their feed intake consistently increased as they increased in age. At the end of week 6 T_2 had the highest feed intake of about 8 kg. Furthermore, weaned pigs fed T_3 consumed about 3 kg of feed in the first week and the voluntary feed intake increased afterwards. Growth pattern of weaned pigs fed different protein and energy values across the week is shown in Figure 2. In all the three treatments, weaned pigs' growth consistently increased over the period of six weeks. Piglets fed T_1 grew from 12 kg in week 1 to 23 kg at the end of sixth weeks. Piglets fed T_2 grew from 11 kg in the first week to 22 kg at the end of sixth week. Also, the Piglets fed T_3 grew from 8 kg in the first week to 18 kg at the end of sixth weeks.

Discussion

Over supplementation of diets with nutrients to ensure an increase in pig performance mostly result in excess amount of nutrients being excreted in the faeces and urine (Portejoie *et al*., 2004). Pigs fed low crude protein diets supplemented with crystalline amino acid have been shown to achieve the same performance as those fed normal crude protein level diet (Kerr *et al*., 2003; Shriver et al., 2003.). Most often, reduction of crude protein, supplemented with amino acid did not hinder growth performance (Figueroa *et al*., 2002; Kerr *et al*., 2003). The aim of reducing crude protein level and increasing metabolizable energy level in this study is to determine the level at which pigs will digest the nutrients in their diet effectively. In the present study, the animals fed with highest crude protein (22%) has the highest final weight when compared with those fed with 20% and 18% crude protein respectively, which is in agreement with the report of Figueroa *et al*. (2002) and Kerr *et al*. (2003), but is in disagreement with the findings of Fang *et al*. (2019) who concluded that high metabolizable energy (ME) levels and low crude protein levels can improve pig performance. Total protein concentration increased when protein utilization by pigs improved (Matthews *et al*., 1998). The total protein concentration in pigs increased as metabolizable energy level in the diet was increased which was in support of the findings of Lin *et al*. (2019) who reported that

protein deposition and utilization are likely to improve when pigs are fed diets with more energy. According to Winnicka (2011), levels of HDL cholesterol in pig's blood should account for at least 40% of total cholesterol concentration, since a decrease in the HDL fraction below this is undesirable. This study shows that cholesterol concentration were above the reference range of (Winnicka, 2011) across the treatments (49% to 56%). A significant increase was noticed in the level of HDL cholesterol and a decrease in the level of LDL cholesterol, which could be explained that higher ME in diet influences a growing level of HDL cholesterol and at the same time it induces a reduction in the LDL cholesterol level in the blood which synced with earlier study of Hanczakowski *et al*. (2009). A significant effect was observed on nutrient digestibility of crude protein and ether extract which was similar to the result observed by Fang *et al*. (2019) who stated that nutrient digestibility increased when dietary crude protein level were decreased without changing the level of limiting amino acids, as well as being in agreement with the findings of Jin *et al*. (1998) who stated that feeding a low crude protein diet with supplemented crystalline amino acid could improve crude protein and dry matter digestibility compared to feeding a high crude protein diet. Weaned pigs fed with low protein diet of 18% CP and high metabolizable energy of 3400Kcal recorded highest protein digestibility, although further research in this respect is recommended.

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Table 1: **Ingredients and gross nutrient composition of experimental diet fed to weaned pig**

Ingredients	Treatment 1	Treatment 2	Treatment 3
Maize	36.02	37.02	37.52
Soybean meal	10.00	10.00	10.00
Groundnut cake	30.00	25.00	20.00
Corn bran	16.00	18.00	20.00
Soya oil	5.50	7.50	10.00
Bone meal	1.00	1.00	1.00
Oyster shell	0.50	0.50	0.50
Salt	0.25	0.25	0.25
Premix	0.25	0.25	0.25
Methionine	0.25	0.25	0.25
Lysine	0.23	0.23	0.23
Total	100.00	100.00	100.00
Calculated nutrients			
ME (Kcal/kg)	3207.94	3293.86	3419.78
CP (%)	21.89	20.00	18.11

Treatment 1: 22% CP and 3200 ME; Treatment 2: 20% CP and 3300 ME; Treatment 3: 18% CP and 3400 ME; CP = Crude Protein; ME = Metabolizable Energy

Table 2: **Effect of different Levels of Protein and Energy in Diet on Growth Performance of Weaned pigs**

Parameters	Treatment 1	Treatment 2	Treatment 3	SEM
Average Initial Weight (kg)	10.42	8.93	8.01	1.22
Average Weight Gain (kg)	12.68	12.55	10.75	0.54
Average Feed Intake (kg)	37.00^{a}	36.25^{a}	30.00^{b}	0.27
Gain: Feed Ratio	2.94	2.92	2.87	0.15
Average Final Weight (kg)	23.10^{a}	21.48^{b}	18.77^{c}	0.31

Treatment 1: 22% crude protein and 3200 ME; Treatment 2: 20% crude protein and 3300 ME; Treatment 3: 18% crude protein and 3400 ME; Means with different superscripts within the same row differ significantly (p < 0.05); SEM = Standard Error Mean

Table 3: Effect of different levels of protein and energy in diet on blood profile of weaned pigs

Parameter	Treatment 1	Treatment 2	Treatment 3	SEM
Cholesterol (mg/dL)	100.21^{ab}	98.70^{b}	104.50^{a}	0.92
HDL (mg/dL)	49.02^{b}	52.12^{b}	60.41^{a}	0.82
Triglyceride (mg/dL)	210.34^{c}	233.91^{b}	252.87^{a}	1.31
LDL (mg/dL)	11.13^{a}	10.39^{a}	3.14^{b}	0.62
Total protein (g/dL)	5.78^{b}	6.81^{a}	7.44^{a}	0.20
Albumin (g/dL)	3.99	4.07	5.06	0.26
Globulin (g/dL)	1.78	2.74	2.24	0.29

HDL = High Density Lipoprotein; LDL = Low Density Lipoprotein; Treatment 1 = 22% crude protein and 3200 ME; Treatment 2 = 20% crude protein and 3300 ME; Treatment 3 = 18% crude protein and 3400 ME; Means with different superscripts within the same row differ significantly (p < 0.05); SEM = Standard Error Mean

Table 4: Effect of different levels of protein and energy in diet on nutrient digestibility of weaned pigs

Parameter (mg/g)	Treatment 1	Treatment 2	Treatment 3	SEM
Dry Matter	87.56	87.66	88.12	0.67
Crude Protein	85.12^{b}	85.27^{b}	88.71^{a}	0.46
Ether Extract	74.71^{ab}	75.15^{ab}	77.47^{a}	0.18
Crude Fiber	51.10	51. 61	51.42	1.42

Treatment 1 = 22% crude protein and 3200 ME; Treatment 2 = 20% crude protein and 3300 ME; Treatment 3 = 18% crude protein and 3400 ME; Means with different superscripts within the same row differ significantly (p < 0.05); SEM = Standard Error Mean

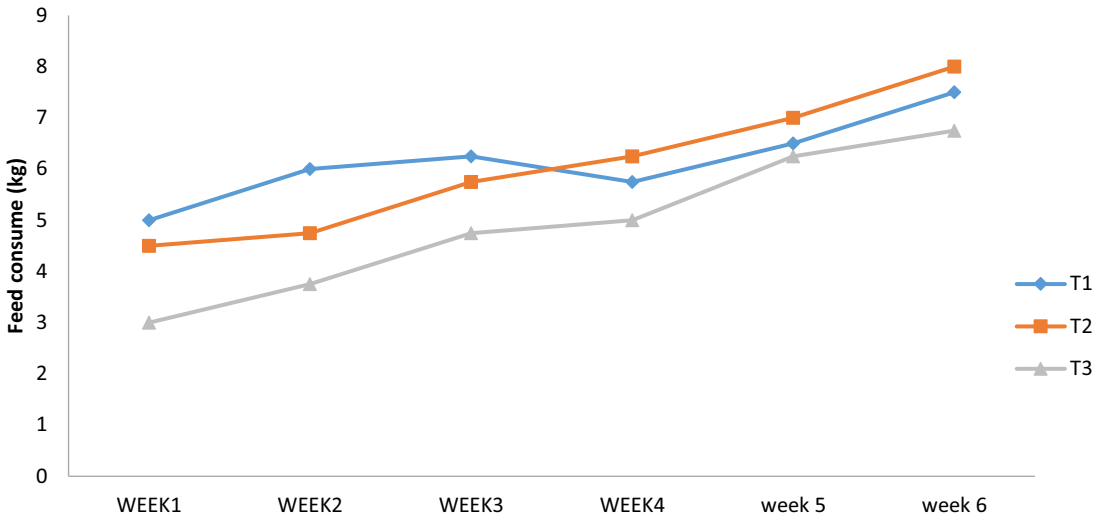

Figure 1. Feeding pattern of weaned pigs fed different Protein and Energy levels

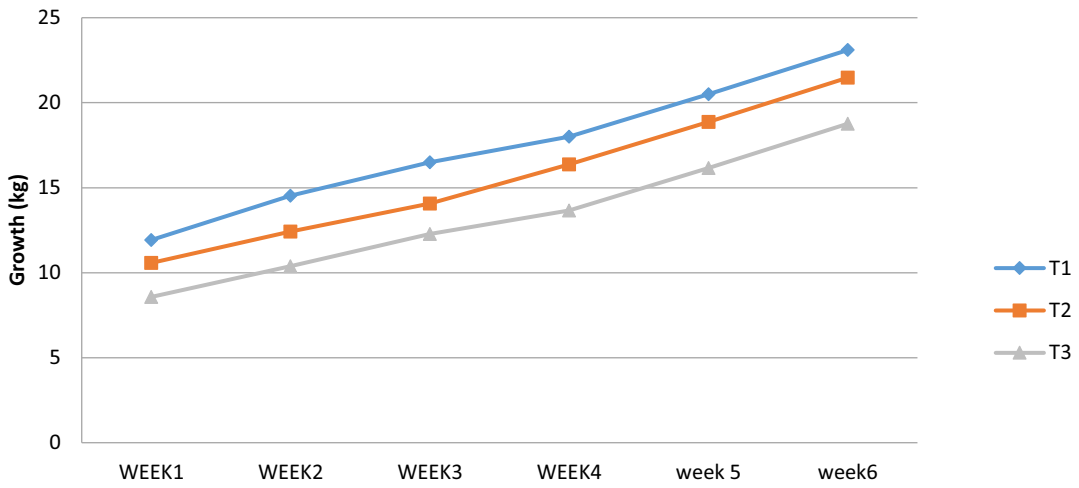

Figure 2. Growth pattern of weaned pigs fed different Protein and Energy levels