NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 55 Number 1, April 2024 Pg. 145-151
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

Breed Response to Different Dietary Energy-Protein Ratios in Weaner Pigs in the Tropics

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Abstract

The study was conducted to determine response of the Pig breed to three dietary energy-protein ratios (EPR) in feed. A total of 27 weaned piglets, eight weeks old, of three breeds consisting of 9 piglets per breed, were used in a four-week feeding trial. Three piglets were randomly allocated from each breed to pen and replicated thrice. Two standard EPR diets: 151:1 and 163:1, were compared with the existing farm diet of 123:1. Pigs were fed at 5% of previous week's body weight to prevent excessive feeding. Water was provided ad-libitum with automatic waterers. Traits examined were average daily feed intake (ADI, g/day), average daily gain (ADG, g/day), feed efficiency ratio (FER, %), and economic efficiency of meat production (EEM, ₦/Kg), body length (BL, cm), neck circumference (NCF, cm), heart girth (HGH, cm), pouch girth (PGH, cm), wither's width (WTW, cm), Withers to tail length (WTL, cm), Canon bone circumference (CBC, cm) and height at wither (HTW, cm). The Completely Randomized Design in factorial treatment arrangement was used. The General Linear Model (GLM) procedure of SAS® version 8.0 along with Dunette's Test $_{(\alpha=0.05)}$ was employed. Landrace performed best on productivity and body traits (P <0.05). EPR 163:1 diet produced most superior body development as ADG, FER, NFC, WTL, HGH, PGH, and HWT were significantly (P <0.05) higher than on other diets. Interaction of breed and EPR revealed that Large white reported highest ADG and FER at least EEM on diet 123:1. Landrace and Camborough produced superior ADG and FER on 163:1 EPR diet (P <0.05). Breeds expressed best body traits development on the 151:1 diet.
***Keywords: Camborough, body conformation traits, economic efficiency of meat production, feed efficiency ratio, Landrace, Large white*.**

Introduction

During extension work, commercial pig farmers in Ikorodu, Lagos State observed that weaner pigs on their farms suffered from nutritional deficiency or performance depression at the weaner-grower transition period of 10–12 weeks of age. They showed signs of emaciation and low body weight. They desired an appreciable body weight and good diet for their pigs at the weaner-grower transition phase. This would enable them to overcome or mitigate signs of emaciation, low live weight, and loss of weight being encountered. Researchers' study of their nutritional program and interviews revealed that feed offered to pig was deficient in methionine, vitamin-mineral premix, and dietary energy, but contained excess crude protein. Increased protein consumption by farm animals causes high feed costs and high release of nitrogen and odour into the environment (Liu, 2015, Wang *et al*., 2018, Mpendulo *et al*., 2018;). Reduction of protein in the diet of pigs reduces nitrogen in the excreta (Hlatini *et al*., 2020), which contributes to the emission of ammonia and nitrite gases (Hansen *et al*., 2014); but low-protein diets will maintain gut health and influence intestinal morphology and microbiota (Wang *et al*., 2018) positively. In addition, pig feed had an extremely high level of the palm-kernel meal. So, it was necessary to reverse the persistent and recurrent nutritional deficiency, and performance depression, observed at the 10 to 12-week transition period in (Ikorodu) pig farms. Thus, the study was conceived as an extension service to Ikorodu Pig Farmers Association, to serve as a demonstration experiment to teach the farmers on pig management, and guide them naturally to adopt standard nutritional diets. Thus, the result of the trial could assist farmers in the environment to rear pigs that would attain optimum genetic potential in performance. This study was designed to evaluate breed (Large white, Landrace, and Camborough) response to different dietary energy-protein ratio feeds in weaner pigs. It was hypothesized that higher energy-protein ratio (EPR) diets shall produce better performance than existing farm diets in pigs. That is, breeds will respond positively to increasing EPR in diets. Information obtained would assist pig farmers in formulating appropriate breedspecific diets to optimize weaner productivity and body conformation.

Materials and Methods

Experimental Site: The research was carried out on Onabanjo Pig farm, Lagos State Farm Settlement, Ikorodu, Nigeria. Daily temperature varies from 74°F to 92°F, average rainfall was 86.76mm and humidity was 78%. Ikorodu is located on latitude 6.60853 N; longitude 3.54079 E and altitude 27m ASL.

Experimental Animals: The experimental animals consisted of twenty-seven (27) weaner-piglets comprising three breeds, namely Large white, Landrace, and Camborough, with 3 replicates per breed and 3 pigs per replicate. The pigs had an initial average weight of 9.2 ± 0.121 kg, and the experiment lasted from 57th-day (9th week) to 112th-day (12th week) of age. Piglets used for this experiment were weaned at the end of 8th-week (56 days of age). The weaners were tagged for identification, weighed and randomly distributed, at three animals within breed per pen. Each breed was replicated three times, making nine piglet-weaners per breed for the trial.

Housing and Pens: The animals were housed in an open-sided, medium-walled, flow-through house, with an East-West orientation. Dimensions of the pens were 2.4m x 3.0m (Length x breadth, m^2), with the rough cemented floor, covered with roofing sheet, and equipped with a masonry feeder and pacifier-type water drinker with free access to water.

Feeding and Provision of water: The phase-feeding method was adopted for the weaners at 9-12 weeks of life. Two dietary energy-protein ratio diets were compared with the Farm diet. The two standard diets were formulated based on standard nutrient requirements (NRC, year), at least cost. The diets were compounded from conventional ingredients available to the farmer to provide graded levels of energy-protein ratio (EPR) during the feeding trial (Table 1). All pigs were offered diets at quantities equaling 5% of the previous week's body weight. The split-feeding method was adopted daily to mitigate heat stress during the hot afternoon period. Pigs were fed ¼ of the daily ration at 9.00 am, and the remaining ¾ of the daily ration at 4.00 pm daily. Water was provided to piglets *ad libitum* throughout the experimental period with automatic waterers.

Treatment and Experimental Design: **The experimental design was a factorial in Completely Randomized Design (CRD). Factors in the experiment were breed (three) and energy-protein diets (three).**

Statistical model: $Y_{ijk} = \mu + B_i + E_j + BxE_{ij} + \quad_{ijk}$

Where,

.i = Levels of breed (breed = 1 - 3)

.j = Levels of Energy protein ratio (E = 1-3)

.k = Levels of replicate (replicates = 1 to 3)

Y_{ijk} = Observation of a trait in breed i, EPR $_j$ and replicate k.

μ = General or overall mean

B_i = Effect of breed $_i$ (i = Large white, Landrace, Camborough)

E_j = Effect of energy-protein ratio $_j$ in diet (j= 1:123, 1:151, 1:163 in weaners)

BxE_{ij} = Effect of interaction of breed $_i$ and Energy-protein ratio $_j$.

$_{ij}$ = Random error component committed haphazardly committed NID ~ (0, δ^2) in breed i, EPR $_j$ and replicate k.

Data collection: Variables collected on production included age (weeks), Sex (M/F), daily diet intake (DDI) and weekly body weight (kg). The DDI was used to estimate average daily diet intake (ADI). Body weight was recorded initially at the end of the 8th week and served as the weaning weight for each animal**.**

Derived Production Traits: Total weekly feed intake (Kg): as the sum of daily feed intakes for the week. Average daily diet intake (ADI, g/day) as the total weekly diet intake in a Pen / (Number of Pigs x 7). Body weight gain (Kg) as the Final weight - Initial weight (Kg). Average daily Gain (ADG, g/day) as Body weight gain on diet / No of days on Diet. Feed efficiency ratio (FER, g/g) as Weight gain on diet (g) / Total diet intake (g). Economic efficiency of meat production (EEM, ₦/Kg) = Cost of amount of diet consumed (₦/Kg) x Diet efficiency ratio.

Body conformation traits: Body morphometric or conformation measurements were taken every week with the collaboration of two other assistants, before feeding as follows. Body length or Withers to Tail length (WTL, cm) = Linear distance from the point of withers or shoulders to the starting point of the tail, i.e., from withers to the starting point of the tail. (cm). Neck Circumference (NCF, cm) = Distance around the mid-neck of the pig. Heart or chest girth/Thorax diameter (HGH, cm) = This is taken as the distance round the barrel of the pig behind the fore-legs. Pouch girth or Flank to flank length (PGH, cm) = Distance around the barrel before the hind legs. Wither's (Shoulder) width (WTL, cm) = This is taken as the lateral linear distance from one side to the other across the withers or shoulders.

Height and leg conformation traits: Height at the withers/shoulders (HWT, cm): This was taken as a linear distance from the ground level to the top point of the shoulder. Cannon Bone Thickness or Circumference (CBC, cm) was taken as the measurement of the bone circumference of the fore-limb (the two front legs), between the knee joint and the pastern. This is obtained by taking measurements of the right and left cannon bone measurements, adding them, and dividing by 2.

Measuring Devices: A digital electronic scale (model no. CH-302, precision = 1g, capacity= 5kg, Yongkang, China) was used to weigh feeds. Pigs were weighed weekly on a digital hook balance (name: ONDYNE, model no: 6017319, capacity=300kg, Sensitivity= 0.1kg, manufacturer: Avery Nigeria limited) and hanged on a roof rafter. Weaners were restrained using a weighing sack which safely supported the entire body and confined the movement of animals during weighing. Circular body measurements were performed using measuring tape for circumferences, and a modified wooden caliper (sensitivity =0.01cm) was used to measure the vertical and linear dimensions (cm) of the pigs.

Statistical procedures and data analytical methods: The data generated were subjected to the General linear model (GLM) procedure of SAS® version 8.0 (1998), to determine significant differences $_{(\alpha=0.05)}$ among the treatments. The means were separated using Dunette's Test for comparing treatments with a control at a 5% level of significance.

Results

Table 2 reveals that the breed had a significant (*P* <0.05) effect on the productive performance of weaners. Large whites had the lowest average daily intake (ADI, Kg/d), and lowest economic efficiency of meat production, but the highest FER (*P* <0.05). Landrace recorded the highest ADI, ADG (Kg/d), EEM (₦/Kg), and highest body conformation traits (*P* <0.05) among the three breeds. Camborough breed was statistically similar (*P* >0.05) to Landrace in ADI, ADG, and FER, but with lower EEM. Camborough piglets were similar in dimensions to Landrace piglets on body conformation traits, but piglets in both breeds were higher than Large white piglets (*P* <0.05) in all body traits investigated. The effect of the energy-protein ratio (EPR) in the diet was also significant (*P* <0.05) on all productive performance and conformation traits considered. The 123:1 EPR diet produced the lowest performance and conformation trait values. The 151:1 diet was better on ADI and highest EEM, while the 163:1 EPR diet exposed the best performances on ADI, ADG, FER, NCF, WTL, CBC, HGH, PGH and HWT (*P* <0.05). Table 3 shows a significant (*P* <0.05) interaction between breed and EPR levels on performance and body traits of weaner piglets. The Large white breed had better ADG, FER, and least EEM on diet 123:1 EPR; and recorded the least and best ADI on the 163:1 EPR diet. Whereas, NCF, HGH, PGH, HWT, and WTW were highest on the medium EPR diet 151:1 (*P* <0.05). The Landrace piglets reported the lowest EEM, and highest PGH and WTW on the 123:1 EPR diet. ADI was similar for the three diets; but the best ADG, FER, NCF, and HWT were obtained on the 163:1 diet (*P* <0.05). Camborough breed consumed the least diet, and recorded the least ADI, ADG, and FER on the 123:1 EPR diet. The best performance in body conformation traits NCF, HGH, PGH, HWT, and WTW (cm) were obtained from feeding with 151:1 EPR diet (*P* <0.05) and displayed highest values. The breed displayed best ADG, FER, and least and best EEM on the highest 163:1 E:P diet.

Discussion

Effect of breed on performance and body conformation traits of weaner pigs: The significant effect of breed obtained on performance and body conformation traits of weaners at 9 to 12 weeks of age in the present study is in line with the report of Kouamo *et. al.* (2015) who found differences among Large white, Duroc, Landrace, and Local breeds of pigs on birth weight and weaning weight. In the present study, the differences observed in ADI, ADG, FER, and EEM among breeds could be due to differences in genetic constitution of the breeds. The breed effect is important for identifying efficient breeds for production and breeding in the tropics. The lowest ADI and highest FER observed in Large white pigs revealed an efficient breed with capacity for low feed intake and low economic cost of meat production (EEM), along with higher feed efficiency than the other two breeds. The high feed efficiency ability meant that Large white was able to convert less quantity of feed to more meat than Landrace and Camborough. Large white also reported the lowest conformation trait values of the three breeds and thus could be less prone to fat deposition, and less endowed in body conformation to Landrace and Camborough breeds. Gilbert *et al.* (2012) demonstrated that selection for feed efficiency and lean growth is associated with lower feed intake capacity in pigs. Tang *et al.,* (2008) showed that Large White and Swedish Landrace had a more efficient feed conversion rate (FCR, 3.06 vs. 3.29) than Tongcheng pigs. The Landrace pig which revealed the highest average daily feed intake, average daily gain, and economic efficiency of meat production, reflected superior growth rate, higher efficiency of meat production, and better development of conformation traits. The high ADG of Landrace pigs could be due to their genetic constitution for growth above the other breeds studied. This accounted for the better overall performance in body conformation traits above other breeds. The similarity of the ADI, ADG, FER, and body conformation traits of the Camborough breed with Landrace revealed that the breed probably had similar feeding ability, growth, and feed efficiency potentials with the Landrace. This similarity in genetic attributes for the above traits in the Camborough breed compared to the Landrace could be due to a similar genetic background. Čandek-Potokar (2019) reported that the estimated theoretical intake at a certain body weight (BW) should be based on the assumption that voluntary feed intake equals approximately 3–4 times the metabolizable energy (ME) needs for maintenance (106 kcal ME per kg $BW^{0.75}$ per day) in the pig. Type of breed is an important factor that affects the growth potential of pigs (Souphannavong and Sringarm, 2016). For the post-weaning growing period, Čandek-Potokar (2019) reported a feed intake between 0.5 and 1.8 Kg/pig/day with a pooled average of 1.2 Kg/pig/day. At this early stage of growth, pigs are normally fed *ad-libitum* (Čandek-Potokar, 2019). Values 1.6–1.8 Kg/pig/day had been reported for Iberian and Sarda breeds of pig (*Nieto et al., 2003;* Fruttero, 2023) and could be indicative of the capacity of natural *ad-libitum* intake of pigs at this stage of growth. The post weaning ADG of 121-161 g/day in the present study was lower than the reported growth rate of 404-416 g/day for the Iberian pig (Čandek-Potokar, 2019). Tang *et al.,* (2008) reported that Swedish Landrace and the British Large White pigs had advantages over the Tongcheng pigs in growth rate and feed conversion ratio (FCR). They also submitted that British Large White and Swedish Landrace had higher ADG (877.04 vs. 813.95, g/day) than Tongcheng pigs. However, the measurements of Tang *et al.,* (2008) spanned from birth to marketing.

Effect of Energy-Protein ratio on performance and body conformation traits of weaner pigs: The energy-protein ratio is important for efficient production performance and utilization of available feed resources by farm animals. Increased protein consumption by mammals leads to high feed cost and high nitrogen release into the environment (Liu *et al.,* 2015). The energy-protein ratio (EPR) 123:1 diet led to the highest feed consumption as individual pigs attempted to meet body maintenance and growth requirements for energy and protein. The consumption of diet was at lower economic cost to the producer, but it produced the least body conformation values in the three breeds evaluated. This EPR diet 123:1 could be the least efficient for body development of the three diets evaluated. The 151:1 EPR diet produced the lowest and most desirable consumption level but at a high and undesirable economic cost. The lowest feed consumption obtained on the 151:1 EPR diet could be that the metabolizable energy and protein needs of pigs for maintenance and growth were met by the low mean voluntary feed intake observed. The high economic efficiency of meat production produced by this diet revealed that it was not economical for continuous feeding, although the body conformation values were better and improved than that obtained on the 121:1 EPR diet. The 163:1 EPR diet unveiled the best ADG, FER, body conformation traits at slightly lower economic cost. It thus displayed the highest growth rate, highest feed conversion to body weight and meat, and best body conformation traits of the three diets. Meat production of pigs on a 163:1 EPR diet was at an economic cost that could give higher meat yield and income to the farmer on all breeds evaluated. Results further showed that conformation traits increased almost linearly with successive EPR diets from the lowest 123:1 to the highest 163:1 ratio evaluated. The CP level of the 163:1 diet was close to 154.4 g/Kg of protein in the diet that reported ADI, ADG, and FCR of 1.22, 0.27 (Kg/d), and 2.63 (Hlatini, *et al.,* 2021).

Interaction of breed and Energy-protein ratio in the diet on performance of weaner pig breeds: Interaction of breed and energy-protein ration was highly important in the study. Weaner Large white pig breed produced acceptable ADG, FER, at lowest economic cost on the 123:1 EPR diet, but the least and good average daily consumption (ADI) on the 163:1 EPR diet. However, the Large white pig breed reported better body weight gain on the low EPR (123:1) diet, but the more consistent differential body development was observed on the medium EPR (151:1) diet with NCF, HGH, PGH, HWT, and WTW. Increasing the EPR content of feed from 151:1 to 163:1 decreased feed consumption as the EPR requirement of the breed was easily satisfied by the diet; also the cost of meat production decreased by ₦139.40/Kg of meat. This decrease in average daily intake on the high-calorie-protein diet could be due to the high energy density of the diet which easily meets the body's EPR requirement. Therefore, the Large white breed could perform profitably well on a low-density EPR diet with higher efficiency in meat production than the other two breeds. In addition, the Landrace breed produced the lowest and better economic efficiency of meat production on the low (123:1) EPR diet and the lowest feed consumption on the 153:1 EPR diet. This revealed that an increase of the EPR to 153:1 in the diet decreased feed consumption. Further increase of the EPR to 163:1 in diet produced better daily gain and increased feed efficiency to 41%. The diets produced differential results in Landrace pig. While the low-density diet supported PGH and WTW development, the 163:1 EPR diet supported the best development of NCF and HWT. The Landrace pig seemed to require high high-density (163:1) EPR diet to exhibit its optimum genetic ability allowed by diet. This occurred only with a slight increase in the economic cost of meat production (₦41.14/Kg) than the 123:1 EPR diet. There was no special or economic advantage in feeding the medium EPR (153:1) diet to the Landrace pig. The Camborough breed consumed the least feed on the 123:1 EPR diet. This breed revealed better body conformation traits development and response to the 151:1 EPR diet on NCF, HGH, PGH, HWT, and WTW. This makes the medium (151:1) EPR diet good for body conformation development in Camborough. The revelation of the best ADG, FER, and good economic efficiency of meat production on a 163:1 EPR diet meant that the breed requires a high-energy density diet for optimum daily gain, and optimum feed efficiency, at an optimum economic cost. Common between Large white and Landrace breeds was the revelation of least economic (high) efficiency of meat production on the low EPR diet of 123:1, while Camborough showed the best economic efficiency on the 163:1 diet. Both the Landrace and Camborough breeds produced better daily gain and feed efficiency on the high-density (163:1) EPR diets. Similarly, both Large white and Camborough breeds revealed better body conformation development on the medium EPR diet, thus making the medium EPR diet suitable for body development in Pigs. The two traits of wither length and cannon bone circumference did not respond to breed differences among pigs. These two traits could be used for characterization as indicators of growth and development in pigs.

Results from present study are in line with Liu *et al*. (2015) who reported significant interaction of breed with diet on body traits. Energy-protein ratio (EPR) in pig diet can have a significant impact on growth, feed efficiency, and carcass composition. Several studies have reported that increasing the dietary EPR can improve the growth performance and body traits of pigs (Dong *et al.,* 2020; Liu *et al*., 2017; Liu *et al*., 2015). Economic efficiency of meat production refers to the production of meat at the least cost, making meat production cheaper for both the farmer producer and consumers. It refers to an economic state in which diet is optimally formulated and allocated to each breed in the best way to minimize waste, inefficiency, and cost of production. It also indicates and stimulates further improvement in the management of feed resources, managerial performance, farm-work practices, and use of other farm inputs. The cost of feeding remains an important constraint for sustainable pig production. Feed is a major limiting factor in the pig industry, and accounts for over 70% of the total cost of pig production. Skilled managerial input is needed to utilize locally available and cheaper ingredients to cut down production cost costs. Attempts at increasing the productivity of pigs through an adequate EPR diet could yield commensurate economic efficiency of meat production in breeds.

Conclusion

While Large white weaners performed better in feed efficiency with lowest economic efficiency of meat production than other breeds, the EPR diet 163:1 produced the better average daily gain, feed efficiency, acceptable economic efficiency of meat production and good body traits development. Interaction of pig breed with energy-protein ratio revealed that Large white could be sustained on EPR 123:1 diet, but Landrace and Camborough breeds require higher energy diet (EPR 163:1). The medium EPR 151:1 diet produced best body traits development, yielding optimum body conformation in breeds.

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Table 1: Percent ingredient composition of experimental diets fed to weaner pigs from 8-12 weeks of age

Ingredients	Diet 1	Diet 2	Diet 3(Farm)	Nutritional Standard
Broken yellow maize	11.00	10.00	9.59	
Broiler Starter	25.00	15.00	23.98	
Soyabean meal	10.00	5.00	9.59	
Dry PKC	11.00	23.00	45.49	
Sprouted barley (Malt)	41.20	45.21	9.59	
Bone meal	1.00	1.03	1.01	
Salt	0.32	0.30	0.30	
Methionine	0.27	0.26	0.25	
Pig MV Premix	0.21	0.20	0.20	
Total	100.00	100.00	100.00	
Calculated Nutrient composition				
Energy (Kcal/kg ME)	2642.00	2555.50	2520.95	2400-26000
Protein (%)	17.49	15.73	20.46	18.00
Ether Extract (%)	4.41	5.49	9.32	3.00
Crude fibre (%)	6.20	7.45	10.30	3.40
Calcium (%)	0.71	0.62	0.79	0.45
Phosphorus (%)	0.43	0.41	0.59	0.30
Lysine (%)	2.90	3.16	2.26	1.20
Methionine (%)	2.51	2.88	1.51	0.25
ME:CP Ratio	151.06	162.51	123.19	133.33-144.44
Naira/kg	117.28	105.70	132.77	

Premix vitamin/mineral/ kg of product: Folic Acid 106.00 mg; Pantothenic 2,490 mg; Antifungal 5,000 mg; Antioxidant 200 mg; Biotin 21 mg; Coccidiostat 15,000 mg; Choline 118,750 mg; Vitamin K3 525.20 mg; Niacin 7,840 mg; Pyridoxine 210 mg; Riboflavin 1,660 mg, Thiamine 360 mg; Vitamin A 2,090,000 IU; Vitamin B12 123,750 mcg; Vitamin D3 525,000 IU; Vitamin E 4,175 mg. Cu 2,000 mg; I 190 mg; Mn 18,750 mg; Se 75 mg; Zn 12,500 mg.

Table 2: Effect of breed and energy-protein ratio on productivity and body traits of weaner pigs at 9 to 12 weeks of age

variation sources	*Breed*				*Energy-Protein ratio*				*P*	
Traits	Large white	Landrace	Cambro	SEM	123:1	151:1	163:1	SEM	Breed	EPR
ADI (Kg/d)	0.460^{b}	0.690^{a}	0.650^{a}	0.023	0.660^{a}	0.560^{b}	0.580^{b}	0.260	0.0001	0.0052
ADG (Kg/d)	0.121^{b}	0.161^{a}	0.148^{a}	0.454	0.200^{b}	0.210^{b}	0.230^{a}	0.050	0.0500	0.0500
FER (%)	26.30^{a}	23.33^{b}	22.76^{b}	0.064	30.76^{b}	37.86^{a}	40.17^{a}	0.110	0.0500	0.0500
EEM (₦/Kg)	845.96^{c}	976.53^{a}	914.14^{b}	0.058	537.93^{b}	750.39^{a}	587.24^{b}	0.145	0.0500	0.0500
NCF (cm)	14.74^{b}	17.01^{a}	16.78^{a}	0.236	15.53^{b}	15.99^{b}	17.01^{a}	0.267	0.0001	0.0001
WTL (cm)	19.59^{b}	21.98^{a}	21.24^{a}	0.362	19.96^{b}	21.11^{a}	21.74^{a}	0.375	0.0001	0.0013
CBC (cm)	9.93^{b}	11.30^{a}	10.97^{a}	0.207	10.33	10.81	10.86	0.220	0.0001	0.0445
HGH (cm)	19.14^{b}	21.37^{a}	21.11^{a}	0.277	19.74^{b}	20.49^{b}	21.39^{a}	0.298	0.0001	0.0001
PGH (cm)	20.09^{b}	22.26^{a}	22.08^{a}	0.268	20.70^{b}	21.41^{b}	22.31^{a}	0.289	0.0001	0.0001
HWT (cm)	11.66^{b}	13.04^{a}	12.66^{a}	0.211	20.01^{b}	21.47^{ab}	21.88^{a}	0.221	0.0001	0.0107
WTW (cm)	9.51^{b}	10.86^{a}	10.49^{a}	0.193	9.80	10.47	10.59	0.203	0.0001	0.0060

NOTES: ADI= Average daily diet intake, ADG = Average daily gain, FER = Feed efficiency ratio, EEM = Economic efficiency of meat production, NCF = Neck circumference, WTL = Withers to tail length, CBC = Canon bone circumference, HGH = Heart Girth, PGH = Pouch Girth, HWT = Height at the Withers, WTW = Withers width, Values across rows with different superscripts are significantly different ($p<0.05$).

Table 3: Effect of interaction of breed and energy protein ratio on productivity and body traits of weaner pigs at 9 to 12 weeks of age

Breed	Large white			Landrace			Cambro			
EPR	123:1	151:1	163:1	123:1	151:1	163:1	123:1	151:1	163:1	*P*
ADI (Kg/d)	0.450^{c}	0.570^{b}	0.353^{d}	0.689^{a}	0.679^{a}	0.699^{a}	0.604^{b}	0.719^{a}	0.619^{ab}	0.0337
ADG (Kg/d)	0.196^{e}	0.186^{f}	0.153^{g}	0.234^{c}	0.216^{d}	0.284^{a}	0.181^{g}	0.232^{c}	0.265^{b}	0.0500
FER (%)	43.56^{a}	32.63^{e}	43.34^{b}	33.95^{e}	31.81^{e}	41.00^{d}	30.00^{f}	32.26^{e}	42.81^{c}	0.0500
EEM (N/Kg)	432.65^{e}	706.34^{b}	566.94^{d}	561.37^{d}	763.55^{a}	602.51^{c}	625.75^{c}	753.14^{a}	567.16^{cd}	0.0500
NCF (cm)	14.90^{d}	16.27^{c}	13.07^{e}	16.90^{b}	17.00^{b}	17.13^{b}	16.17^{c}	17.77^{a}	16.40^{c}	0.0001
WTL (cm)	20.67	20.63	17.47	21.87	22.56	21.50	20.80	22.03	20.90	0.0562
CBC (cm)	10.50	10.33	8.97	11.22	11.20	11.47	10.70	11.03	10.57	0.0763
HGH (cm)	19.33^{d}	20.57^{c}	17.53^{e}	21.53^{b}	21.30^{b}	21.27^{b}	20.60^{c}	22.30^{a}	20.43^{c}	0.0087
PGH (cm)	20.20^{f}	21.53^{e}	18.53^{g}	22.40^{e}	22.20^{c}	22.17^{d}	21.63^{e}	23.20^{a}	21.40^{e}	0.0093
HWT (cm)	12.13^{c}	12.30^{c}	10.53^{d}	12.93^{b}	13.07^{ab}	13.13^{a}	12.33^{c}	13.27^{a}	12.37^{c}	0.0274
WTW (cm)	9.90^{c}	10.00^{c}	8.63^{d}	11.07^{a}	10.63^{b}	10.87^{b}	10.43^{bc}	11.13^{a}	9.90^{c}	0.0410

NOTES: EPR = Energy-protein ratio, ADI= Average daily diet intake, ADG = Average daily gain, FER = Feed efficiency ratio, EEM = Economic efficiency of meat production, NCF = Neck circumference, WTL = Withers to tail length, CBC = Canon bone circumference, HGH = Heart Girth, PGH = Pouch Girth, HWT = Height at the Withers, WTW = Withers width, Values across rows with different superscripts are significantly different ($p<0.05$).