Influence of feed energy levels on the growth performance of weaner pigs

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ABSTRACT

Twenty-four (12 males & 12 females) Large White x Landrace crossbred weaned piglets aged 45 days with a mean weight of 5.61 kg were fed four diets ad libitum containing 2934, 3134, 3334 and 3534 kcal digestible energy(DE)/ kg feed for a study period of thirteen weeks. Results show that with increasing energy level in the diet, the Live weight of piglets at the end of the study period of 13 weeks increased from 20.05±2.67 kg to 25.40±2.21 kg and decreased to 23.40±1.43 kg for the 2934 kcal/kg, 3334 kcal/kg and 3534 kcal/kg feed energy levels respectively. Corresponding mean daily weight gain (MDWG) values increased from 161.09±30.32 g/d to 224.37±33.36 g/d before decreasing to 196.27±35.88g/d for the same period while the average weekly feed intake (FI) decreased from 323.57±44.79 g/d (2934 kcal/kg feed energy) to 245.31±15.69 g/d (3534 kcal/kg feed energy). Significant differences ($P<0.05$) were observed between the treatments for the mean FI while for the MDWG higher values ($P<0.01$) were observed for the diet containing 3334 kcal DE/kg than the other diets. The feed conversion efficiency decreased from 2.18±0.14 to 1.11±0.16 before increasing to 1.19±0.18 for the respective feed energy levels. The differences between these values were highly significant ($P<0.01$). The production cost per kilogram of live weight followed the same trend decreasing from 248.99 F. CFA (2934 kcal/kg) to 155.33 F. CFA (3334 kcal/kg) and increased to 202.06 F. CFA (3534 kcal/kg). Considering the management conditions of Malo farm, the diet with the energy concentration of 3334 kcal digestible energy per kilogram of feed with a calorie/ protein ratio of 163.75 may be the optimal diet.

Key words: Feed energy level, Growth performance, Weaner pig.

RESUME

Vingt-quatre porcelets sevrés (12 mâles et 12 femelles) croisés de race Large White x Landrace âgés de 45 jours avec un poids moyen de 5.61 kg ont été nourris sous quatre régimes alimentaires distribuées à volonté contenant 2934 kcal/ kg, 3134 kcal /kg, 3334 kcal/kg et 3534 kcal/kg d'énergie digestible (ED)/kg d'aliment pour une période d'essai de 13 semaines. Les résultats montre qu'avec une augmentation du taux d'énergie dans la ration, les poids corporel des porcelets à la fin de l'essai de 13 semaines ont augmenté de 20,05±2,67 kg à 25,40±2,21 kg avant de baiser à 23,40±1,43 kg pour les taux d'énergie de 2934 kcal/kg, 3334 kcal/kg et 3534 kcal/kg respectivement. Le gain moyen quotidien s'est accrue de 161,09±30,32 g/j à 224,37±33,36 g/j avant de baiser à 196,27±35,88g/j pour la même période tandis que la consommation alimentaire hebdomadaire à baissé de 323,57±44,79 g/j (2934 kcal/kg) à 245,31±15,69 g/j (3534 kcal/kg). Les différences significatives ($P<0.05$) ont été observés entre les traitements pour consommation alimentaire hebdomadaire tandis que pour le gain moyen quotidien les valeurs les plus élevées ($P<0.01$) ont été observés pour la ration contenant 3334 kcal ED/kg comparé aux autres rations. L'indice de consommation a baissé de 2,18±0,14 à 1,11±0,16 avant de passer à 1,19±0,18 pour les taux d'énergie des rations respectifs. Les différences entre ces valeurs étaient hautement significatives ($P<0.01$). Le coût de production d'un kilogramme de poids vif a baissé de 248,99 F. CFA(2934 kcal/kg) à 155,33 F. CFA (3334 kcal /:kg) et est passé à 202,06 F. CFA (3534 kcal/kg). Dans les conditions techniques de la ferme MALO, la concentration énergétique de 3334 kcal d'énergie digestible par kg d'aliment brut avec un rapport Energie/ protéines de 163,75 semble être le niveau optimal.

Mots clés : Taux d'énergie alimentaire, Performances de croissance, Porc sevré.

INTRODUCTION

The gap between the demand and supply of high quality protein-rich livestock products to improve the nutritional status of Cameroonians appears ever widening. Cameroon, as one of the protein-deficient developing countries (FAO, 1995), seeks to become self-sufficient in the production of livestock as well as improve and stabilise rural income emanating from its production and processing. This objective is yet to be fully realised and the threat of protein-nutritional stress dangles on. The shortfall in the national protein production has probably been largely due to large percentage difference between annual population growth rate (3%) and the annual agricultural production and particularly animal production which stands at 1%.

Pig production is an important animal producing sector in Cameroon and contributed in 1995 to about 17.16% of the national meat production (CIRAD-EMVT, 1995).

At this time the population of pigs in the country was estimated at 1.410 million (FAO, 1995), 20% of which was in commercial farms while 80% was attributed to small holder and traditional management (CIRAD-EMVT, 1995).

The foregoing together with high production potential (prolificacy and fecundity) has necessitated the development of a virile pig production industry in Cameroon in-order to meet these challenges. Although a number of management/production variables influence the ability to achieve a high level of productivity in pigs especially under intensive management, nutrition is one of the most limiting variable (Williams et al, 1993). This is especially so with the energy concentration of the feed which is the most important component when considering feeding of monogastric animals (Leclercq, 1985). The energy concentration of the diet for monogastric animals is widely recognised as an important determinant of feed consumption (Eusebio, 1980, Leclercq, 1985, McDonald et al, 1987). If in developed countries, the chemical composition and metabolisable energy of feeds for animals are well known, in tropical countries and particularly Cameroon, data on these variables are limited. As a result feeding standards for formulation of rations for these countries have often depended on those developed in different socio-economic and technical environments.
The present study was therefore designed with the objective to evaluate the effect of various diet energy concentrations on the growth performance of weaner pigs.

MATERIALS AND METHODS

Experimental animals

The study was conducted at Malo farms in Edea which is situated in the forest zone in Cameroon. Twenty-four (12 males and 12 females) Large-white x Landrace crossbred weaned piglets aged 45 days with a mean weight of 5.61 kg were used in the study. The experimental animals were allotted to four treatments of 6 animals per treatment (3 males and 3 females). The males were later castrated at 28 days after weaning.

The experimental house was an open-sided building (2 meters high) with concrete floors divided into two large pens of 6 m^2 each. Each pen was further subdivided into 12 compartments corresponding to a space allocation of 0.5 m^2 per piglet. Two weeks before the study the pens were disinfected twice and the animals were also subjected to a prophylactic programme (Table1) before and during the study.

Feeding studies

Four experimental diets corresponding to digestible energy (DE) levels of 2934,3134,3334 and 3534 Kcal/kg were given to each group ad libitum and their composition are shown in Table 2. The diet containing 2934

Table 1: Prophylactic program used for growth performance of the weaner pigs.

Days	Intervention	Products used
Day 1	Antistress + vaccine against Erysipelas	Stress Vitam + Rouvax
Day 2 &3	Antistress	Stress Vitam
Day 10	Antibiotics against Collibacillus	Colistine
Day 14	Second vaccine against Erysipelas	Rouvax
Day 30	Antibiotics against Collibacillus	Colistine

Table 2: Percentage composition of the experimental diets used for growth performance of weaner pigs.

Ingredients	Feed energy levels(kcal/ kg) 2934	3134	3334	3534
Brewers grain	-	20.0	20.0	20.0
Wheat bran	68.0	30.0	30.0	28.0
Wheat offal	16.0	20.0	07.0	05.0
Fish meal	-	-	-	05.0
Soybean cake	11.0	07.5	07.5	02.5
Palm kernel cake	-	10.5	20.0	18.0
Oyster shell	-	02.5	02.0	02.0
Concentrate 5%	05.0	05.0	05.0	05.0
Palm oil	-	04.5	08.5	14.5
Total	100	100	100	100
Analysed nutrient composition of diets				
Dry matter(%)	87	88	92	88
Digestible energy(kcal/ kg)	2934	3134	3334	3534
Crude protein(%)	20.17	20.51	20.36	20.55
Crude fibre(%)	05.45	05.47	05.46	05.50
Calcium(%)	0.92	0.93	0.96	0.99
Phosphorus (%)	0.73	0.73	0.67	0.65
Nitrogen free extracts(%)	42.78	45.18	43.27	48.57
Cost per kg (Price/ kg in CFA Francs)	114.22	119.20	139.94	169.80

kcal/kg energy level which was the ration normally fed to the animals at the farm was considered as the control diet. The proximate chemical composition determined according to the methods described by A. O. A. C.(1984) is also shown in Table 2. Animals were provided with feed ad libitum as from 9.00 am every morning after an initial adaptation period of seven days.

Data collection and statistical analysis

Live weight measurements of the animals were made weekly for all the treatments using a Cachapuz José Duarte mini-scale (Model-152, Portugal) of capacity 105 kg and sensitivity of ± 50g. The feed consumed was measured indirectly and weekly by weighing the feed given and left-overs. Economic data to evaluate feed cost were also collected and calculated from the prices of the feed ingredients.

Mean values for weekly weight gain, feed consumption for the different sexes were computed from raw data collected during the study which were subjected to an analysis of variance while significant differences between means were separated using the Student-Newman-Keuls procedure(Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Live weight changes

Live weight changes of the animals subjected to the various dietary energy treatments during the study period are shown in Table 3. Results show mean values for live weight change for the period of study (13 weeks) to be between 20.05±2.67kg for 2934 kcal/kg dietary energy and 25.40±2.21kg for 3334 kcal/kg dietary energy.

However, there was a corresponding drop from the 3334 kcal/kg feed energy treatment with a drop in live weight change to 23.40±1.43 kg for the 3534 kcal/kg dietary energy treatment. This suggest that for the management conditions of Malo farms the diet of treatment 3334 kcal/kg dietary energy with an energy level of 3334 kcal/kg is optimal for production. Although this energy level is higher than the energy level of the conventional diet of the farm (2934kcal DE/ kg), this increase has contributed to an increase of 5 kg bodyweight of animals in this treatment as opposed to the conventional diet.

Mean daily weight gain (MDWG)

A comparison for the mean daily weight gain (MDWG) for the different treatments and for the growing pe-

Table 3: Weekly live weight changes of the animals for the various feed energy levels during the study period.

Growth period	Feed energy levels (kcal/kg)				Level of Significance
Weeks	2934 ×± $s.e_t$	3134 ×± $s.e_t$	3334 ×± $s.e_t$.	3534 ×± $s.e_t$	
0	5.44±0.3a	5.64±0.30a	5.66±0.35a	5.71±0.15a	ns
1	5.58±0.15c	5.80±0.39c	6.14±0.33a	6.00±0.33a	*
2	5.89±0.17c	6.13±0.41c	6.63±0.14a	6.36±0.14a	*
3	6.26±0.15c	6.45±0.46b	7.20±0.54a	6.84±0.45ab	**
4	6.79±0.18c	7.06±0.50c	7.94±0.70a	7.54±0.51a	*
5	7.44±0.24c	7.76±0.59c	8.81±0.88a	8.36±0.51a	*
6	8.29±0.25c	8.64±0.64c	9.91±1.09a	9.34±0.51a	*
7	9.33±0.64c	9.69±1.61c	11.22±0.59a	10.58±1.61a	*
8	10.72±0.31c	11.10±0.38c	13.05±0.26a	12.08±0.63b	**
9	12.14±1.98c	12.56±0.43c	15.12±0.39a	13.65±0.76b	**
10	13.77±2.21c	14.21±0.53c	17.48±1.34a	15.61±0.89b	**
11	15.62±2.44c	16.08±0.67c	20.00±1.62a	17.80±1.11b	**
12	17.78±2.61c	18.25±0.77c	22.84±1.92a	20.49±1.26b	**
13	20.05±2.67c	20.66±0.92c	25.40±2.21a	23.40±1.43b	**

ns : non significant ; * : significant (P≤ 0.05); ** : highly significant (P≤0.01).

riod is shown in Table 4. Results show that for the growing period of 13 weeks, the MDWG increased from 161.09±30.32g/day for the 2934 kcal/kg dietary energy to 224.37±33.36g/day for 3334 kcal/kg dietary energy and dropped from 3334 kcal/kg dietary energy treatment to 196.27±35.88g/day for the 3534 kcal/kg dietary energy level. These results are in conformity with what has been observed with the live weight of the piglets. For piglets weighing between 10 to 25 kg, ITCF (1987) recorded weight gains rang-

Table 4: Weekly weight gains of the animals for the various feed energy levels during the study period.

Growth Period	Feed energy levels (kcal/kg)				Level of Significance
Weeks	2934 ×± $s.e_t$	3134 ×± $s.e_t$	3334 ×± $s.e_t$.	3534 ×± $s.e_t$	
1	20.00±20.06c	22.85±9.05c	68.57±13.47a	41.42±14.76ab	**
2	45.71±23.68c	47.14±16.36c	70.00±26.26a	65.71±12.52a	*
3	54.28±25.88c	60.00±16.26c	81.42±16.23a	78.51±23.99a	*
4	77.14±27.95c	87.14±14.88c	105.71±23.60a	100.00±25.41a	*
5	94.28±30.33c	100.00±22.03c	124.28±23.04a	117.14±26.85a	*
6	121.42±32.71c	125.71±30.21c	157.14±40.12a	140.00±28.75a	*
7	148.57±33.30c	150.12±32.72c	187.14±54.22a	177.14±29.90a	*
8	198.57±35.40c	201.42±37.47c	241.42±42.65a	214.28±42.90b	**
9	202.85±49.84c	208.57±25.69c	295.71±48.84a	224.28±45.34b	**
10	232.85±33.36c	235.71±33.39c	337.14±43.32a	280.00±36.22b	**
11	265.71±33.36c	267.14±30.39c	360.00±44.76a	312.85±42.57b	**
12	308.57±27.20c	310.00±28.96c	405.71±44.99a	384.28±52.25b	**
13	324.28±21.16c	344.28±26.32c	480.10±44.64a	415.72±50.96b	**
Overall mean (1 to 13 weeks)	161.09±30.32	166.16±24.90	224.37±33.36	196.27±35.88	

ns : non significant ; * : significant (P≤ 0.05); ** : highly significant (P≤0.01).

ing from 103 to 106g/day for energy levels between 3113 to 3253 kcal DE/kg. These figures are lower than those reported in this study probably because of the low energy levels associated to their diets.

With higher energy levels (3694 to 3798 kcal DE/kg) Endeley, (1991) obtained daily weight gain (kg/day) ranging between 0.31 to 0.42 kg per day which were higher than those of this study. This association between increase in weight gain with a rise in energy level of the diet has also been reported by Iyayi et al.,(2001) for the same crosses of Landrace X Large White growing pigs at Ibadan, Nigeria.

Results of this study are however similar to those reported by SEREP-INRA, (1979). For this report, the MDWG varied from 278g/day for an energy level of 3300 kcal to 276g/day for 3500 kcal DE/kg.

Feed intake (FI)

The effect of energy levels on the feed intake for the period of study is shown in Table 5. For the study period, (13 weeks) the mean feed intake (FI) dropped from 323.57±44.79g/day (2934 kcal/kg) to 245.31±15.69g/day for 3534 kcal/kg dietary energy treatment. Since animals eat to satisfy their energy requirement, the increase in energy concentration of the diet permitted a drop in the mean FI within the period of the study (13 weeks) by approximately 77g/day. Similar observations were made by Endeley, (1991) who recorded increases in feed intake for Large White / Landrace crosses with increasing energy in the diet up to a certain dietary energy level that is from 3682 kcal DE/kg (0.95 kg/day) to 3740 kcal DE/kg(0.93 kg/day) when the feed intake declined.

Elsewhere, SEREP-INRA (1979) found mean FI varying from 371g/day for 3300 kcal DE/kg of feed to 367g/day for 3500 kcal DE/kg of feed. This is in agreement with the fact that before the optimal level of energy in the diet, a strong increase in feed intake is usually observed. The animal tends to consume more of the diet with the sub-optimal energy concentration, so as to cover its energy requirements. Significant differences ($P<0.05$) were observed between the treatments for the mean FI. This influence of increasing feed intake with a drop in the energy level of the diet has also been observed by King et al.,(2000).

Feed conversion efficiency (FCE)

Mean values for the feed conversion efficiency (FCE) for different treatment diets for the period of study are shown in Table 6. Results show that the mean FCE for the period of study dropped from 2.18±0.14 for the 2934 kcal/kg dietary energy to 1.11±0.16(3334 kcal/kg) before rising to 1.19±.018 for the 3534 kcal DE/

Table 5 : Weekly feed intakes of the animals for the various feed energy levels during the study period.

Growth Period	Feed energy levels(kcal/kg)				Level of Significance
Weeks	2934 $\bar{x}\pm$ s.e$_t$	3134 $\bar{x}\pm$ s.e$_t$	3334 $\bar{x}\pm$ s.e$_t$.	3534 $\bar{x}\pm$s.e$_t$	
1	89.68±28.40a	73.31±8.45b	69.25±7.72b	50.00±6.87c	**
2	99.37±30.99a	81.56±7.41b	72.06±9.16c	59.18±3.68c	**
3	123.43±39.52a	109.12±7.02ab	82.50±11.50c	78.67±5.35c	**
4	152.00±38.24a	137.12±9.13ab	110.68±14.70c	105.93±7.27c	*
5	190.06±41.69a	167.75±12.13b	148.37±19.74c	136.31±9.22c	**
6	230.75±44.34a	209.12±16.04b	165.25±26.69c	152.75±11.53c	**
7	278.12±45.77a	255.18±21.78b	233.06±32.88c	230.12±13.70c	**
8	332.25±50.46a	307.50±26.78b	284.37±39.85c	272.06±16.42c	**
9	393.00±51.98a	364.12±32.37b	339.81±45.33c	324.43±20.38c	**
10	460.37±53.12a	426.18±36.88b	391.37±49.75c	377.06±24.10c	**
11	534.94±52.70a	494.31±41.65b	420.62±50.66c	414.68±27.13c	**
12	618.69±53.07a	561.06±46.07b	489.00±51.17c	476.62±29.57c	**
13	697.37±51.98a	631.56±47.41b	526.44±47.65c	511.50±28.85c	**
Overall mean (0 to 13 weeks)	323.57±44.79	293.58±24.08	256.96±31.29	245.31±15.69	

* : significant ($P\leq 0.05$); ** : highly significant ($P\leq 0.01$).

a, b, c means bearing the same superscripts within the same row do not differ significantly ($P\geq 0.05$).

Table 6: Weekly feed conversion efficiency for the various treatments during the study period.

Growth period	Feed energy levels(kcal/kg)				Level of Significance
Weeks	2934 $\bar{x}\pm$ s.e$_t$	3134 $\bar{x}\pm$ s.e$_t$	3334 $\bar{x}\pm$ s.e$_t$.	3534 $\bar{x}\pm$s.e$_t$	
1	4.48±0.23a	3.20±0.15b	1.00±0.21c	1.20±0.24c	**
2	2.17±0.21a	1.73±0.11b	1.02±0.17c	0.90±0.22c	**
3	2.27±0.16a	1.81±0.14b	1.01±0.12c	1.00±0.19c	**
4	1.97±0.13a	1.57±0.17b	1.04±0.31c	1.05±0.14c	**
5	2.01±0.13a	1.67±0.18b	1.19±0.08c	1.16±0.19c	**
6	1.90±0.11a	1.66±0.18b	1.05±0.11c	1.09±0.22c	**
7	1.87±0.13a	1.69±0.12b	1.24±0.24c	1.29±0.18c	**
8	1.67±0.13a	1.52±0.10ab	1.17±0.18c	1.26±0.24c	**
9	1.93±0.13a	1.74±0.10ab	1.14±0.21c	1.44±0.21c	**
10	1.97±0.12a	1.80±0.10ab	1.16±0.17c	1.34±0.12c	**
11	2.01±0.11a	1.85±0.12ab	1.61±0.21c	1.32±0.15c	**
12	2.00±0.12a	1.80±0.31b	1.20±0.19c	1.24±0.41c	**
13	2.15±0.12a	1.83±0.16b	1.09±0.22c	1.23±0.17c	**
Overall mean (0 to 13 weeks)	2.18±0.14	1.83±0.13	1.11±0.16	1.19±0.18	

** : highly significant (P≤0.01).

a, b, c means bearing the same superscripts within the same row do not differ significantly (P≥0.05).

kg diet. The differences between these treatments were highly significant (P<0.01). An increase in feed efficiency from the 2934 kcal/kg feed energy level to the optimal 3334 kcal DE/kg energy level treatment was observed. These results are in conformity with the results of Holnes (1994) who recorded feed efficiencies varying between 4.0 and 2.7 for dietary energy levels varying between 3100 and 3300 kcal DE/kg of feed respectively for heavier growing animals(50-60kg). Agbede et al., (1988) recorded relatively higher feed efficiencies (3.27-3.58) with weaner pigs of the Large White/ Landrace crosses in Dschang for dietary energy levels ranging between 2.886 and 3.498 kcal DE/kg. The feed conversion efficiencies in this study are slightly higher than the range of 2.42 to 2.72 reported by Endeley, (1991) for Large White/ Landrace crosses. SEREP-INRA (1979) found constant feed efficiency values for dietary energy levels varying between 3300 kcal/kg and 3500kcal/kg of feed.

More recently, Iyayi et al.,(2001) observed an increase in the feed conversion ratio with increasing metabolisable energy levels. The above results seem to indicate the fact that factors other than the energy concentration of the diet also affect the feed efficiency.

Production cost

The production cost (Table 7) for one kilogram live weight of piglets from this study dropped from 248.99 Francs CFA for the 2934 kcal DE/kg treatment to 155.33 francs CFA for the 3334 kcal DE/kg treatment.

However, beyond the 3334 kcal DE/kg treatment, the production per kilo of meat rose to 202.06 francs CFA (3534 kcal DE/kg).

Meanwhile, the cost of production per kilogram of feed (Table 7) increased from 114.22 Francs CFA for the 2934 kcal DE/kg treatment to 169.80 Franc CFA for the 3334 kcal DE/kg ration. This suggests that under the management conditions of Malo farms, the ration containing an energy level of 3334 kcal DE/kg was optimal for production. This energy level is however higher than the feed energy level (2934 kcal DE/kg) of the diets currently used at Malo farms (2934 kcal DE/kg). Adoption of the diet containing 3334 kcal DE/kg permitted the increase in the price of feed to 26 francs CFA per kg and a drop in the production cost per kg of live weight of piglets to 94 francs CFA.

Table 7 : Cost per kilogram live weight for the various feed energy levels.

Feed energy levels(kcal/kg)	2934	3134	3334	3534
Price per kg feed (F.CFA)	114.22	119.20	139.94	169.80
Feed conversion efficiency	2.18	1.83	1.11	1.19
Cost per kg live weight (F.CFA)	248.99	218.13	155.33	202.06
Difference(F.CFA)	+93.66	+62.80	-	+46.73

The study clearly shows that an increase in the feed energy level of the diet beyond 3334 kcal/kg significantly depressed the MDWG. The feed intake was also affected although the values were comparable. Corresponding values for the feed conversion efficiency and cost per kg of meat have prompted the ranking of the diets in the following order of preference; 3334 kcal DE/kg, 3534 kcal DE/kg, 3134 kcal DE/kg and 2934 kcal DE/kg as a function of their availability and the cost of the sources of energy.

CONCLUSION

Energy, protein, vitamin and mineral needs of weanling pigs are all critical. Of these, optimal caloric density is arguably the most difficult to achieve. For this reason, energy content of weaner pig diets is often performance limiting.

Results of the present study show a favourable performance for the feed containing 3334 kcal/kg of digestible energy in the diet. The feed conversion efficiency value and the advantage of lowest feed cost per kg of live weight produced associated to this dietary energy level is indicative of the economic usefulness of this diet to the management of Malo farms in particular and probably the Edea region in general.

However, a more detailed study on the combination of factors (e g Energy/protein ratio, Calcium/Phosphorus ratio) which affect production and production cost at the farm level is recommended.

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