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THE REQUIREMENTS OF CRUDE PROTEIN BY LARGE WHITE BREEDING SOWS AND PIGLETS IN GHANA

S.W.A. RHULE, P. ASIEDU*

Council for Scientific and Industrial Research (CSIR), Animal Research Institute, P. O. Box AH 20, Achimota, Ghana

*E-mail: pierroboakye@yahoo.com

ORIGINAL ARTICLE

ABSTRACT: *Eighteen Large White gilts at an average initial live weight of 100.39kg were distributed by completely randomized block design over three treatments. There were three cereals-based diets with three different calculated levels of crude protein (CP) namely control breeder diet, Diet 1 (13.16% CP), Diet 2 (12.56% CP) and Diet 3 (12.01% CP) with corresponding lactation diets namely control lactation Diet 1 (LD1) (16.00% CP), Diet 2 (LD2) (14.50%CP) and Diet 3 (LD3) (13.20%CP). Additionally there were three creep diets comprising control Diet 1 (CD1) with 23.01%CP, Diet 2 (CD2) with 21.46% CP and Diet 3 (CD3) with 20.00% CP. The average live litter size of sows were 8.50, 8.40 and 6.67 on Diets 1, 2, and 3 respectively (P>0.05). The number of piglets weaned decreased with decreasing CP in the diet being 7.83. 7.80 and 5.33 on Diets 1, 2 and 3 respectively but were not found to be significantly (P>0.05) different. The average birth weights of the piglets were similar at 1.45, 1.34 and 1.40 kg on Diets 1, 2 and 3 respectively (P>0.05). The milk yield by the sows at 28 days of lactation were found to be 3.06, 3.03 and 5.44kg/day on LD1, 2 and 3 and significantly (P<0.05) different being higher on the lowest CP diet. There was inconsistency with the milk yield at 42 days of lactation with significantly (P<0.05) different values of 4.87, 8.33 and 3.60kg/day on lactation with lactation diet 1, 2, and 3 respectively. It was observed that live weight gains by the sows during gestation significantly (P<0.05) increased with decreasing CP levels in the diets and were 30.3, 36.3 and 34.0 kg on Diets 1, 2 and 3 respectively. The ADGs of the piglets on the creep diets were 0.22, 0.17 and 0.19 kg/day on CD1, CD2 and CD3 respectively, and found to be significantly (P<0.05) different. The study indicated that decreasing levels of CP in the diet at gestation could affect the reproductive performance of the Sow. Decreasing CP in the lactation diet significantly affected sow performance adversely. Whereas a decrease of 1.5% CP in the lactation diet gave similar performance in the sow as the control 3.0% decrease in the CP markedly reduced the performance. Decreasing CP in the creep diets significantly reduced the ADG of the piglets. It was shown that 1.5% reduction in the CP in the creep diets significantly decreased the average daily gain of the piglets compared to that on the control.*

Key words: *Average Daily Gain, Birth Weight, Dietary Protein Requirement, Large White Gilts, Milk Yield, Weaning Weight.*

INTRODUCTION

Requirement for nutrients depends on the physiological, genetic, environmental and other factors such as expected production levels (Wang and Fuller, 1989, Cromwell et al., 1999, Cole and Sprent, 2001). Most standards used in Ghana have been determined in US and Europe. The humidity and temperature in the various ecological zones could greatly modify the requirements for CP as determined in the temperate areas.

All nutrients including CP provided in excess of requirements are excreted in the feaces and urine into the soil and eventually into water bodies. Their accumulation would be detrimental to the proper balance of the soil. It is very essential that this excretion of excess nutrient is reduced to a great extent for sustainable soil balance and fertility.

The cost of feedstuffs for pigs is escalating by the day. The cost of production is raising making pork products expensive to the extent of being unaffordable to the majority of Ghanaians. It is important to reduce the cost of the feed by insuring that only the required quantities of the nutrients and in the appropriate balance are provided the pigs as any excess is wasted and only goes to increase feed cost. Scarcity apart from the high cost of feed for pigs emphasizes the most efficient use of all available feedstuffs. This would require the minimum levels of nutrients from feedstuffs for maximum production within an environment (Azian et al., 1994). Most studies on pigs in Ghana and generally in the tropics have been on grower–finisher pigs with resultant dearth of information on the requirements of the breeder sows and the pre-weaner piglets.

This study was undertaken to determine the requirement for CP by the breeder and lactating Large White sows and suckling piglets in southern Ghana.

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MATERIALS AND METHODS

Animals

Eighteen Large White gilts at an average live weight of 90 kg were used for the study. They were distributed by completely randomized design and constituted into three groups of six gilts each. The groups had similar total weight. Each group was randomly assigned to a treatment.

Treatments

There were three treatments made up of a standard pig breeder diet (NRC 1979), Diet 1 and two other diets with differing CP levels, Diet 2 and Diet 3. All the diets were cereal-based and isocaloric. The compositions of the breeder diets are shown in the Table 1. Each diet had a corresponding lactation diet as shown in the Table 2 and a creep diet as shown in Table 3.

Table 1 - Composition of cereal-based pig breeder diet (%) Diets

Ingredient	1 (Control)	2	3
Maize	48.56	49.54	58.2
Wheat bran	45.27	45.86	37.2
Fishmeal	1.00	1.00	1.00
Soya bean meal	2.57	1.00	1.00
Oyster shell	1.90	1.90	1.90
Salt	0.50	0.50	0.50
Premix[1]	0.20	0.20	0.20
Total	100.00	100.00	100.00
Calculated composition			
Crude protein	13.16	12.56	12.01
Determined composition			
Moisture	12.47	12.80	12.39
Crude protein	14.47	13.36	12.02
Ash	4.78	4.82	4.12
Ca	0.35	0.39	0.38
P	0.44	0.01	0.01

Table 2 - Composition of cereal-based pig lactation diet (%) Diets

Ingredient	1 (Control)	2	3
Maize	47.10	48.10	48.56
Wheat bran	38.80	41.80	45.27
Fishmeal	3.80	2.19	1.00
Soya bean meal	7.70	5.31	2.57
Oyster shell	1.90	1.90	1.90
Salt	0.50	0.50	0.50
Premix	0.20	0.20	0.20
Total	100.00	100.00	100.00
Calculated composition			
Crude protein	16.00	14.54	13.20
Determined composition			
Moisture	12.00	11.54	12.29
Crude protein	16.54	15.27	13.40
Ash	5.30	5.14	4.81
Ca	0.80	0.36	0.30
P	0.01	0.01	0.01

Table 3 - Composition of cereal-based pig creep diets (%) Diets

Ingredient	1 (Control)	2	3
Maize	45.91	47.93	49.73
Wheat bran	21.26	23.00	24.73
Fishmeal	11.81	10.12	8.54
Soya bean meal	19.22	16.95	14.80
Oyster shell	1.10	1.30	1.50
Salt	0.50	0.50	0.50
Premix	0.20	0.20	0.20
Total	100.00	100.00	100.00
Calculated composition			
Crude protein	23.01	21.46	20.00
Determined composition			
Moisture	11.68	10.86	11.59
Crude protein	23.67	21.74	20.01
Ash	6.02	5.45	4.73
Ca	0.72	052	0.53
P	0.01	0.01	0.004

[1]Premix: Vit.A, 12,000,000 IU; Vit.E, 15000 mg; Vit.B1, 1500 mg; Niacin 30,000 mg; Vit.B6, 1500 mg; Vit.D3, 4500,000 mg; Vit. K3, 3,000 mg; Pantothenic acid, 12000 mg; Vit.B12, 10,000 mg; Vit. B2,6000 mg; Folic acid, 800 mg, Iron, 60,000 mg; Copper 75,00 mg; Iodine, 750 mg; Manganese, 130,000 mg; zinc, 70,000 mg; Selenium, 300mg; Calcium, 17.50%, Lysine, 1,330 mg; Methionine, 1,075 mg; B-Corotenic acid, 350 mg.

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Measurement

The gilts were individually–housed and fed the pig finisher diet before being mated. The gilts were fed the respective breed treatment diets after service. Each was fed once- daily 2.0 kg of the breeder diet wet with a feed-to-water ratio of 1:2. Water was provided ad-libitum. The gilt after being mated was weighed at 8:00 am the next morning before feeding. The gilt was fed the breeder diet during gestation.

The next morning on parturition, each sow was weighed at 8:00am before feeding. The piglets were also weight. The sow was then fed once- daily 4.0 kg of the corresponding lactation diet until weaned at forty- two days.

The piglets were weighted at fourteen days of age. The piglets were fed the creep diets at two weeks of age. The litters of two sows on each dietary treatment (breeder/lactation) were assigned to one of the creep diets so that there were six litters on each creep diet. The piglets were weaned from the sows at forty- two days of age. The milk production by each of the sows was determined on the second, fourth and sixth week of the lactation period. The piglets were, for each determination, separated from the sow for about two hours using wood partition. They were then allowed to suckle the sow for about half an hour then separated again. This was repeated five times on the day each time with the litter being weighed before and after suckling. The piglets were weaned at six weeks of age. The sows and piglets were weighed at weaning. The sows were observed for the period of return to oestrus.

Parameters

The parameters considered in the study were litter size, average birth weight of piglets, sow live weight change during gestation, sow live- weight change during lactation, average daily live weight gain of the piglets on only sow milk, average daily live weight gain of the piglet on the creep diets, the number of piglet weaned per sow, the average weaned weight of the piglets and the days for post weaning oestrus by the sows.

Analysis

Samples of the diet were chemically analyzed according to the methods of AOAC 2006. Data was analyzed by ANOVA using SPSS (version 16.0) and LSD was used to determine differences between means. Differences were considered significant at $P < 0.05$.

RESULTS

The determined compositions of the breeder diet are shown in Table 1 (ii). The determined compositions of the lactation diets are shown in Table 2(ii). The CP of LD1 was 0.54% higher than the calculated value with that of LD2 being 0.73% higher. LD3 had similar CP to the calculated. The ash values indicated a decreasing trend in LD2 and LD3 compared to LD1. There was a marked difference in the Ca level in LD1 compared to LD2 and LD3.

The compositions of the creep diets fed to the piglets are shown in Table 3 (ii). The CP of CD1 was 0.6% higher than the calculated value with that of CD2 being 0.28% higher. Crude Protein of CD3 was similar to the calculated value. Ca level in CD1 was higher than CD2 and CD3 which were similar.

The reproductive performances of the sows are shown in Table 4.

Table 4 - Reproductive performance of sows on different crude protein levels

Parameters	Diets Treatment			SEM	SIG
	1	2	3		
Average live litter size of sows	8.50	8.40	6.70	0.61	NS
Average birth weight of piglets	1.45	1.34	1.40	0.057	NS
Average number of piglets weaned	7.83	7.80	5.33	0.64	NS

SIG: level of significance, NS: not significant. (P >0.05), * Significant (P<0.05), SED: standard error of differences of means

The average litter sizes of the sows were not found to be significantly (P>0.05) different on the diets. However, those of Diets 1 and 2 were similar and higher than that of diet 3. The average birth weights of the piglets were not significantly (P>0.05) different on the diets. The average numbers of piglets weaned were found to be similar on diet 1 and 2 but relatively higher than on Diet 3.

The average daily milk yields by the sows on the lactation diets with different protein level are shown in Table 5. The milk yield at 14 days of lactation was significantly (P<0.05) higher on LD1 than LD2 and LD3 which were similar. At 28 days of lactation the milk yields by the sows were found to be significantly (P<0.05) different being similar on LD1 and LD2 and higher in LD3. The milk yields at 42 days of lactation were significantly (P<0.05) different on the diets being highest on LD2 compared to LD1 and lowest on LD3.

Table 5 - Average daily milk yield by sows on lactation at various crude protein levels

Parameters	Diets Treatment			SEM	SIG
	1	2	3		
Average sow milk yield at 14 days (kg/d)	7.14	3.66	3.76	0.82	*
Average sow milk yield at 28 days (kg/d)	3.06	3.03	5.44	0.68	*
Average sow milk yield at 42 days (kg/d)	4.87	8.33	3.60	1.11	*

SIG: level of significance, NS: not significant. (P>0.05), * Significant (P<0.05), SED: standard error of differences of means

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Live weight gains by the sow were significantly (P<0.05) different being highest on LD2 and lowest on the LD1 (Table 6). Live weight loss by the sows during lactation is shown in Table 6. It was significantly (P<0.05) high on LD3 and lowest on LD1. The numbers of days taken by the sows to return to oestrus as shown in table 6 were similar on LD1 and LD2 and significantly (P<0.05) shorter compared to that on LD3.

Table 6 - Average live weight changes in sows at various crude protein levels

Parameters	Diets Treatment			SEM	SIG
	1	2	3		
Live weight gain by sows during gestation (kg)	30.33	36.20	34.00	4.22	*
Live weight loss by sows during lactation (kg)	13.60	19.00	21.60	0.69	*
Period to post-weaning oestrus by sows (days)	6.80	7.20	9.20	0.73	*

SIG: level of significance, NS: not significant. (P >0.05), * Significant (P<0.05), SED: standard error of differences of means

The average live weight of the piglets at age 14, 28 and 42 days are shown in Table 7.
There were not found to be significant (P>0.05) different at each period, there were trends of decreasing live weight from LD1 to LD3.

Table 7 - Average live weight of piglets (kg)

Parameters	Diets Treatment			SEM	SIG
	1	2	3		
Live weight of piglets (14 days)	4.60	4.57	3.81	0.22	NS
Live weight of piglets (28 days)	7.18	6.92	6.71	0.28	NS
Live weight of piglets (42 days)	9.22	9.29	9.01	0.51	NS

SIG: level of significance, NS: not significant. (P >0.05), * Significant (P<0.05), SED: standard error of differences of means

The average daily gains in live weights (ADGs) of the piglets are shown in Table 8. ADGs on LD1 and LD3 were similar and not significantly higher than on LD2 at age 14 days on only the sows' milk. The overall ADGs of the piglets were not significantly (P>0.05) different for the sows on LD1, LD2 and LD3. The ADGs of the piglets on the creep diets were not found to be significantly (P>0.05) different being high on CD1 and low on CD2.

Table 8 - Average daily gain of piglets on diets (kg/d)

Parameters	Diets Treatment			SEM	SIG
	1	2	3		
Overall ADG of piglets on lactation diets	0.18	0.19	0.21	0.011	NS
ADG of piglets on creep diets	0.22	0.17	0.19	0.011	NS
ADG of piglets on only Sows milk (14 days)	0.22	0.18	0.22	0.020	NS

SIG: level of significance, NS: not significant. (P >0.05), * Significant (P<0.05), SED: standard error of differences of means

The interactions of the lactation diets and the creep diets are shown in Table 9.The effects of the creep diets on the ADGs of piglets on LD1 were not found to be different significantly (P>0.05). The ADGs of piglets of sows on LD2 were found to have been influenced by the creep diets although the differences were not significant (P>0.05). Relatively, however, the ADGs were higher on CD1 compared to those on CD2 and CD3 which could be considered similar. Although not found to be significantly (P>0.05) different ADGs of the piglets of sows on LD3 were similar on CD1 and CD3 but higher than that on CD2.

Table 9 - Interactions of Lactation and Creep Diets on Average Daily Live weight Gain of Piglets

Parameters	Diets Treatment			SEM	SIG
	1	2	3		
Piglets ADG on lactation diet 1	0.19	0.19	0.17	0.010	NS
Piglets ADG on lactation diet 2	0.27	0.17	0.17	0.026	NS
Piglets ADG on lactation diet 3	0.23	0.15	0.23	0.016	NS

SIG: level of significance, NS: not significant. (P >0.05), * Significant (P<0.05), SED: standard error of differences of means

DISCUSSION

The CP in Diet 1 was 1.31% higher than the calculated value of 13.16% whilst that of diet 2 was 0.8% higher than the calculated value of 12.56%. The CP in Diet 3 was the same as the calculated value of 12.01%. The determined values of all the control diets could be considered similar to the recommendations of (ARC 1981, Grandhi 1994, Jones and Stahly 1995, NRC 1998 and Kusina et al 1999). These values had been established in other environments. The other diets had values close to the calculated values intended to reduce the CP levels. The requirements for nutrients by pigs are influenced by several factors such as temperature, breed, housing and management. All nutrients not used for production by pigs could be excreted into the soil through the faeces and urine. Concerns have been expressed about excretion of the excess nitrogenous and mineral fractions of the diet and the subsequent pollution of ground water bodies.

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The average birth weights of the piglet were not found to be different on the diets and similar to the weight of 1.4kg reported by Phuc and Ogle 2005. Hoang and Nguyen (2001) however found significant difference between the weights of piglets from Mong Cai sows fed on 12% CP and 14% CP diet at gestation.

The litter sizes on gestation Diets 1 and 2 were similar but indicated a decrease with the low CP of diet 3 though not significant, being 8.5, 8.4 and 6.7 on D1, D2 and D3 respectively. The litter sizes on all the diets this were small compared to sizes of 10 to 12 piglet (Hoang and Nhuyen 2001, Phuc and Ogle 2005). This was the first parity of the sows and that might be expected. The number of piglets weaned decreased with reduction in the CP of the diets being 7.8, 7.8 and 5.3 on Diets 1, 2 and 3 respectively, though non-significantly. Hoang and Nguyen (2001) observed a non-significant influence of CP on the litter size weaned. The average number of pigs lost before weaning was higher on diet 3. Low CP in the diet could result in low litter size and piglet birth weight and higher mortality (Shields et al., 1985).

The milk yield by the sows at 14 days of lactation was higher on LD1 which corresponded to D1. Despite the significant differences in the milk yield during the three phases of lactation, it appeared the CP of the diets had no effect on the milk yields in this study. Clowes et al. (2003) found no difference in the sow milk yield by the different protein levels. However Einarasson and Rojkittikhun (1993) obtained milk yields of 7.4 kg/ day on 14% CP diet and 10.5 kg / day on a 16 % CP diet. Sows would mobilize body reserves to maintain milk yield for the piglets and this could explain the results obtained in this study (Johnston et al., 1995, Nielson et al., 1997). Sows on low CP diets would mobilize body fat particularly than sows on higher CP diets (Shields et al 1985). The milk yields obtained in this study could be considered low compared to other studies by (Einarasson and Rojkittikhun 1993, NRC 1998).

Live weight gain of the sows during pregnancy increased with decreasing CP in the diet being 30.3, 36.2 and 34.0 kg on D1, D2 and D3, respectively. Sows on D3 had lower litter size but higher live weight gain than found on D1. CP is required for the formation and development of the foetus during pregnancy. All energy provided in excess of the available CP is converted into fat and stored in the body. Low protein in the diet has been associated with high maternal fat with low protein accretion whilst high protein in the diet increased the body protein mass (Shields et al 1985). This could have occurred with this study. Weight loss in the sows during lactation was 13.6, 19.00 and 21.6 kg on LD1, LD2 and LD3, respectively. The highest weight loss in the sows was on the lowest CP diet. The results confirmed similar observations by (Hoang and Nguyen, 2001, Clowes et al., 2003). Low protein could induce as much as 30 kg weight loss in sows during lactation (Weldon et al., 1994, Mejia- Guadarrama et al., 2002) Sows on LD3 took a significantly longer period to post- weaning oestrus indicating the influence of the CP in the diet. Sows on LD3 lost the greater live weight during lactation and would require a longer period to get back into the proper physiological condition for follicular activities. Protein is mobilized from both the carcass and the reproductive tract during lactation. The reproductive tract loses the highest proportion of about 26% of its protein (Kim and Easter, 2001). Low protein influences post weaning ovulation rate with sows which mobilized much protein more protein having suppressed ovarian function (Mejia- Guadarrama et al 2002, Clowes et al 2003). As maternal reserves of body protein would be required for reproductive needs high protein levels would be required for increased ovarian follicular development (Shields et al 1985, Clowes et al 2003b) All the periods observed on this study were longer than an average of 5 days obtained on other studies (Hoang and Nguyen 2001, Mejia-Guadarrama et al., 2002, Phuc and Ogle, 2005 Gourdin et al., 2006). However those sows on a 12% CP diet took 16 days to post- weaning oestrus indicating a longer period as the observation in this study

The average live weight of the piglet at 14 day of age was non significantly lower on LD3, been 4.60, 4.57 and 3.81kg on LD1, LD2 and LD3 respectively. Average live weight 28 days of age were similar for LD2 and LD3 and at weaning (42 days) were 9.22, 9.29 and 9.01kg on LD1, LD2 and LD3 respectively

The ADG of the piglets on only the sow's milk at 14 days, of age were 0.22, 0.18 and 0.22 kg/day on LD1, LD2 and LD3 respectively, despite the significant difference in milk yield at this period. The smaller litter size of sows on LD3 would mean adequate milk for the piglets reflecting in the ADG observed. This trend continued to weaning with even a smaller number weaned on LD3 with overall ADGs of 0.18, 0.19 and 0.21 kg/day on LD1, LD2 and LD3, respectively. The ADGs of the piglets on the introduction of the creep diets were 0.22, 0.17 and 0.19 kg/day on CD1, CD2 and CD3, respectively, when the whole groups of sows on the individual lactation diet were compared. Interactions of lactation and creep diets indicated that piglets on both low CP gestation and lactation diets had similar and high ADG as those on the high CP diets (1 and 2). However, the low CP diet CD3 elicited low ADG in the piglets on Diets 1 and 2. The ADG of the piglets on the lactation diets seemed to have been influenced to the same extent by the creep diets.

CONCLUSION

The sow reproductive efficiency was reduced by the low CP diets. To conserve and efficiently utilize the scarce and expensive feed resources and possibly minimize the excretion of excess nitrogenous materials into the soil from pig manure, it may be recommended from the study that breeder diets with 13% CP, lactation diets with 16% CP and creep diets with 21% CP may be fed to the Large White pigs in Ghana.

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