The reproductive performance of breeding sows fed diets containing cocoa-cake-with-shell and dried cocoa husk

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Abstract

The reproductive performance of breeding sows fed diets containing the cocoa by-products, namely cocoa-cake-with-shell (CCWS) and dried cocoa husk (DCH), over a long period was investigated. Large White primiparous sows were distributed over four dietary treatments made up of diets 1 (Control), 2 (5% CCWS), 3 (10% DCH) and 4 (20% DCH). The sows were fed the breeder diets during pregnancy, then the corresponding location diets on farrowing. For all sows, there was no depression in the litter sizes between the first and the second parities. Average litter size for second and third parities were 11.8, 12.5, 12.0 and 11.0 for Diets 1, 2, 3 and 4, respectively. Average birth weight of the piglets were 1.42 kg, 1.16 kg, 1.27 kg and 1.21 kg for Diets 1, 2, 3 and 4. The corresponding average weaning weights were 6.33, 6.41, 5.57 and 4.94 kg. The results showed that it is possible to include cocoa by-products in the diet of breeding sows at the rate of 5 per cent for CCWS and 10 or 20 per cent for DCH. These levels showed no detrimental effects on the reproductive performance of the sows.

(Original Scientific Paper accepted 10 Jul 01.)

Introduction

The major constraint on pig production in Ghana has been the provision of adequate nutrition. Attention has been focused on agro-industrial by-products (AIBPs) as potential solution to the problem with feeding pigs. Prices of some of the few AIBPs already in use are escalating by the day due to intense demand. Others already evaluated and not in widespread use have to be properly packaged for adoption.

Ghana is a major producer of cocoa in the world with a current output of about 400,000 tonnes of cocoa bean per annum. The bean is contained in the husk or pod constituting the whole fruit. When the bean is removed the pod, which constitutes about 75 per cent of the fruit, is left to rot on the farm. If this could be collected and dried it could yield about 554,400 tonnes of dried cocoa husk (DCH), a by-product, which could be used for livestock feeding. Extraction of cocoa butter from the bean by the extrusion process yields another by-product, which is the cocoa-cake-with-shell (CCWS). Like other cocoa producing and processing areas, Ghana produces CCWS on a large scale. However, all of this is exported as no use has been found for it locally.

The potential of DCH as a feedstuff for pigs has been shown in studies which indicated that levels up to 30 per cent could be included in the diet of growing-finishing pigs with good performance (Adeyanju & Ilorin, 1979; Laud-Anderson & Okai, 1980; Okai *et al.*, 1984; Barnes *et al.*, 1984; Barnes & Oddoye, 1985). Discarded cocoa beans had been fed to grower-finisher pigs. It was found that it could replace 25 per cent of the maize in the diet and it also required the critical balancing of the amino acids (Omole & Adegbola, 1974). Feeding cocoa-cake meal to weaner pigs at a level of 8 per cent inclusion in the diet was found to be detrimental to their performance. However, an inclusion level of 10 per cent in the diet could be tolerated by finisher pigs (Braude & Foot, 1942). There is virtually no reported study on the use of CCWS as a feedstuff for pigs.

Both DCH and CCWS contain theobromine which is a methylated derivative of xanthine. It is poisonous to livestock when consumed above certain levels which puts limitation on the use of these by-products in pig diets (Owusu-Domfeh, 1972). There are no reported studies on these cocoa by-products with breeding pigs. The possibility of the adverse effects of theobromine

on pregnant sows was indicated in a preliminary study on sheanut cake, which, like both DCH and CCWS, contains theobromine. It had been fed to grower-finisher pigs with no adverse effects by Rhule (1999) but led to abortions when fed to breeding sows on the Animal Research Institute Farm. This work was undertaken as a preliminary study to determine the possible effects on the reproductive performance of breeding sows fed on diets containing two cocoa by-products, namely DCH and CCWS over a long period. Due to logistical and financial constraints an extremely limited number of pigs could only be assigned to the study. The lack of information from the literature on the use of these by-products in feeding breeding sows dictated the inclusion levels used in the study.

Materials and methods

Eight large white primiparous sows were randomly distributed over four diets so that there were two sows to a diet. Each sow was regarded a replicate. There were four diets comprising a control diet without cocoa by-products and three other diets with cocoa-cake-with-shell (CCWS) at one level and dried cocoa husk (DCH) at two levels of inclusion. The composition of the diets is shown in Table 1.

TABLE 1a

Composition of Diets Containing Cocoa-Cake-with-Shell (CCWS) and Dried Cocoa Husk (DCH) fed to Sows (%)

	Breeder diets			
	1 (Control)	*2 (5% CCWS)*	*3 (10% DCH)*	*4 (20% DCH)*
Ingredient composition				
CCWS	-	5.0	-	-
DCH	-	-	10.0	20.00
Maize	39.65	36.15	29.65	20.07
Ricebran	30.00	30.00	30.00	30.00
Industrial palm kernel cake	20.00	20.00	20.00	20.00
Fishmeal	4.05	3.45	4.05	3.85
Soybean meal	4.60	3.70	4.60	4.38
Oyster shell	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Premix	0.20	0.20	0.20	0.20
	100.00	100.00	100.0	100.00
Determined composition				
Moisture	10.98	10.72	11.20	11.08
Crude fibre	11.89	11.89	15.01	15.22
Ash	9.45	9.04	8.77	9.31
Ether extract	5.73	7.12	6.54	6.16
Crude protein	11.53	11.53	11.23	10.53
Theobromine	0.11	0.09	0.09	0.10
Gross energy (MJ/kg)	12.57	13.21	11.99	11.84

TABLE 1b

Composition of Diets Containing Cocoa-Cake-with-Shell (CCWS) and Dried Cocoa Husk (DCH) fed to Sows (%)

	Lactation diets			
	1 (Control)	*2 (5% CCWS)*	*3 (10% DCH)*	*4 (20% DCH)*
Ingredient composition				
CCWS	-	5.0	-	-
DCH	-	-	10.0	20.00
Maize	39.65	36.15	29.65	20.07
Ricebran	28.00	28.25	28.20	28.09
Industrial palm kernel cake	20.00	20.00	20.00	20.00
Fishmeal	6.05	5.20	5.85	5.76
Soybean meal	4.60	3.70	4.60	4.38
Oyster shell	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Premix	0.20	0.20	0.20	0.20
	100.00	100.00	100.0	100.00
Determined composition				
Moisture	9.83	10.73	10.53	10.49
Crude fibre	11.75	12.69	14.81	16.01
Ash	8.01	9.18	7.31	10.77
Ether extract	4.03	5.12	4.57	4.54
Crude protein	13.33	12.45	11.10	11.86
Theobromine	0.25	0.28	0.45	0.55
Gross energy (MJ/kg)	12.52	12.73	11.91	11.62

Management and feeding

Gilts had initially been fed the control diet during the first parity. On being weaned the sows were served at oestrus. They were checked from nineteen days for possible return to oestrus. The sows were then randomly allocated to the treatments when confirmed to be pregnant. Each sow was fed once daily 2.0 kg of the respective diet. The sows were fed the breeder diets during gestation. At parturition they were fed the corresponding lactation diets. Each sow was fed over three consecutive gestation periods. Parameters considered were litter size, still births, average birth weight, number weaned and weaning weight.

Analyses

The diets were chemically analyzed according to the procedures of AOAC (1973). Theobromine in the diets was analyzed according to the procedure of Pearson (1970). Data were analyzed by analysis of variance (Snedecor & Cochran, 1972). Means were compared by Duncan's multiple range test (Steel & Torrie, 1960).

Results

The average litter sizes at first parity were 9.5, 11.5, 9.0 and 10.0 for the sows prior to being fed

TABLE 2

Reproduction Performance of Sows fed Diets Containing Cocoa-Cake-with-Shell (CCWS) and Dried Cocoa Husk (DCH)

	Diets				
	1 (Control)	*2 (5% CCWS)*	*3 (10% DCH)*	*4 (20% DCH)*	*SEM*
i. *Litter size*					
1st Parity	9.5	11.5	9.0	10.0	0.65
2nd Parity	12.5	12.0	11.5	11.0	0.65
3nd Parity	11.0	13.0	12.5	11.0	0.65
	11.0	12.2	11.0	10.8	
ii. *Average birth weight (kg)*					
1st Parity	1.26	1.26	1.32	1.31	0.08
2nd Parity	1.44	1.15	1.37	1.33	0.08
3nd Parity	1.40	1.17	1.16	1.08	0.08
	1.37	1.19	1.28	1.24	
iii. *Average number weaned*					
1st Parity	8.0	8.5	9.0	10.1	0.40
2nd Parity	10.5	10.0	10.5	10.5	0.40
3nd Parity	10.0	8.0	9.5	9.5	0.40
	9.5	8.8	9.7	10.2	
iv. *Average weaning weight (kg)*					
1st Parity	8.13	8.14	6.17	6.70*	0.27
2nd Parity	6.70	5.45	5.58	4.67*	0.27
3nd Parity	5.95	7.36	5.75	5.20*	0.27
	6.93	6.98	5.83	5.52	

diets 1, 2, 3 and 4, respectively (Table 2). The average litter sizes at the second parity were 12.5, 12.0, 11.5 and 11.0 for sows on diets 1, 2, 3 and 4, respectively. These were not found to be significantly different ($P > 0.05$) from each other (Table 2). At the third parity, the average litter sizes were 11.0, 13.0, 12.5 and 11.0 for the sows on diets 1, 2, 3 and 4, respectively (Table 2). These were not found to be significantly different ($P > 0.05$) from each other. Average litter size of the sows on each treatment improved with successive parity. The average birth weights at second parity were 1.44, 1.15, 1.37 and 1.05 kg for piglets from sows on diets 1, 2, 3 and 4, respectively (Table 2).

These were not found to be significantly different from each other ($P > 0.05$). The corresponding values at the third parity were 1.40, 1.17, 1.16 and 1.08 kg.

The average number of piglets weaned at the second parity were 1.44, 1.15, 1.37 and 1.05 kg for piglets from sows on diets 1, 2, 3 and 4, respectively (Table 2). These were not found to be significantly different from each other ($P > 0.05$). The corresponding values at the third parity were 1.40, 1.17, 1.16 and 1.08 kg.

The average number of piglets weaned at the second parity were 10.5, 10.0 10.5 and 10.5 for sows on diets 1, 2, 3 and 4, respectively. These were not found to be significantly different ($P > 0.05$). The corresponding values at the third parity were 10.0, 8.0, 9.5 and 9.5. These were not found to be significantly different ($P > 0.05$). The average weaning weights of the piglets at the second parity were 6.7, 5.45, 5.58 and 4.67 kg for sows on diets, 1, 2, 3 and 4, respectively. These were found to be significantly different ($P < 0.05$). The corresponding weights at the third parity were 5.95, 7.36, 5.75 and 5.20 kg. These were found to be significantly different ($P < 0.05$).

Discussion

The crude fibre content of the diets was markedly increased by increasing inclusion levels of the cocoa by-products. The theobromine levels in the lactation diets also increased with increasing levels of the cocoa by-products. The theobromine levels in the breeder diets were rather low compared to the lactation diets considering their composition. It was, however, not possible to repeat the analysis. The presence of theobromine in the control diets could not be explained apart from the possibility of its existence in the other feedstuffs used. The crude protein levels in both the breeder and lactation diets were considered adequate (NRC, 1979). Theobromine could form complexes with the proteolytic enzymes in the pancreas and the intestinal mucosa leading to decreased digestibility of nitrogen of the diet. This could also decrease the digestibility of energy (Longstaff & McNab, 1991). Not much work has been reported on the use of CCWS for pig feeding.

The shell has a higher concentration of theobromine which is toxic to pigs than the cocoa husk (Abiola & Tewe, 1991). Cocoa cake meal containing theobromine when fed to piglets resulted in abdominal disorders (Braude & Foot, 1942). Mice fed diets containing 26 per cent cocoa bean meal and 31 per cent cocoa shell died after a week due to the adverse effects of theobromine (Owusu-Domfeh *et al.*, 1970; Owusu-Domfeh, 1972). Theobromine could also cause intestinal lesions in the digestive tract (Yeong *et al.*, 1989).

Dried cocoa husk has been fed to pigs at levels of 20 per cent replacing maize in the diets with good average weight gains and feed conversion efficiency comparable to the pigs on control diets (Omole & Adegbola, 1975; Adeyanju & Ilori, 1979; Laud-anderson & Okai, 1980; Barnes & Oddoye, 1985; Barnes *et al.*, 1984; Okai *et al.*, 1984). Pigs fed 30 per cent DCH had improved carcass quality with increases in carcass length, percentage ham, loin and loin eye area (Adeyanju & Ilori, 1979).

Pigs fed diets containing 0.21 per cent theobromine were comparable to those on the control diet for average daily gains and feed conversion efficiency. These were significantly different from those pigs fed diets with 0.4 theobromine (Rhule, Unpublished). When sows were fed the diet containing 0.21 per cent theobromine, all aborted (Rhule, Unpublished). This suggested that whereas the 0.21 per cent theobromine was tolerated by the grower-finisher pigs, it was deleterious to the sow. The theobromine levels in all the breeder diets used in this study were lower than the 0.21 per cent which led to abortions in the reported study. The treatments did not indicate deleterious effects in all the sows. The theobromine levels in the breeder diets could be considered tolerable by the sow and the foetuses since there were no abortions or still births.

The average birth weight of the piglets at the third parity were slightly lower for diets 3 and 4 compared to those at the second parity. The levels

of theobromine in the diets did not seem to have had any deleterious effects on the development of the foetuses.

The lactation diets had higher levels of theobromine than the breeder diets. The number of piglets weaned was similar for all treatments but there was an indication of decreasing numbers between the second and third parities on the diets with CCWS and DCH. The weaning weights of the piglets indicated that the growth of the piglets from sows on diet 4 was at a slower rate than those on the other diets. Theobromine would decrease the digestibilities of both protein and energy by forming complexes with digestive enzymes (Longstaff & McNab, 1991). This would lead to lower growth rates as observed with the piglets on lactation diet 4 with its theobromine level of 0.55 per cent.

The study has indicated that the levels of both CCWS and DCH fed had no deleterious effects on the reproductive performance of sows. However, the 20 per cent DCH level would inhibit the average weaning weight of the piglet.

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