Influence of Corn Cobs Inclusion in Pig Diets on Growth Performance and Carcass Characteristics

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Abstract

A 16-week trial was conducted to determine the influence of feeding corncobs to grower pigs on performance, carcass quality and fat content. A total of 40 Large White pigs with a mean liveweight of 27 ± 5 were randomly assigned to five treatments; 0% corncobs, 15% corncobs without enzyme, 15% corncobs with enzyme, 25% corncobs without enzyme and 25% corncobs with enzyme and labelled treatments A, B, C, D and E, respectively. Data collected indicated no significant ($p > 0.05$) difference in the average intake and total intake among treatments but there was significant ($p < 0.05$) difference in average weight gain and feed conversion ratio between treatment A and D. Feed cost/kg gain were similar ($p > 0.05$) among the treatments. The back fat and P2 measurement of pigs fed the tested diets (B, C, D, and E) were significantly ($p < 0.05$) lower than that of pigs fed the control diet (A). It was concluded that corncobs have some potential use as a dietary ingredient and it can be included up to 25% in pig diets without adverse effect on performance and carcass evaluation of pigs.

Key words: Corn cobs, Enzyme, Fibre and Grower pigs.

1. Introduction

Inadequate nutrition is one of the key limitations to pig production in Ghana as feed resources are limited in both quantity and quality [1]. Feed constitutes a major factor, in magnitude of 60 to 80 % of the total cost of the production of pig [2]. To improve this challenge and sustain production in the tropics, other feed resources have to be explored as the cereals used for feeding also constitute staples for the human population. The feeding of agro industrial by-products (AIBPs) and residues of crops has been considered, as these are not consumed by man and can be converted by pigs into desirable meat [2].

Corn cobs are readily available agricultural waste. However, they are of a low nutritive value with a composition of 4.4% CP, 34.9% CF, 91.5 DM, and 4.2% EE [3] with appreciable levels of phosphorus, magnesium, and copper (Onwuka et al 1997). Corncob contains 32 mg/kg DM Zn, 16 mg/kg DM Fe, and the Ca content is about 1.4 mg/kg DM. Its high crude fibre fraction is composed of 15% lignin, 45% cellulose, and 35% hemicellulose [4]. The fibre is mostly 80%NDF [5].

Although corncob is highly fibrous it could have a crucial agricultural application as fibre has been found to effectively lower the levels of cholesterol in the blood [5]. Increase in dietary fibre (DF) intake by pigs can lead to specific changes in the structure of the belly. When dietary fibre was increased through the addition of distiller's dried grains with solubles at 10, 20 and 30% of the diet, the thickness of the belly primal was considerably reduced from 3.15 to 3.00cm, 2.84 and 2.71cm, respectively, signifying decreased fatness [6]. Partanen et al (2002) observed that although percent carcass lean, thickness of the backfat and growth performance were similar between pigs fed medium-fibre (NDF grower: 188g/kg DM; finisher: 196g/kg DM) and high-fibre (NDF grower: 240g/kg DM; finisher: 285g/kg DM) diets. Pigs fed the high-fibre diets had considerably lower side-fat depth (15.6 vs. 14.3 mm) [7]. Corn cobs have been included at different levels in the diets of pigs in determinations to decrease high cost of feed [8] [9]. However, most pork produced in Ghana tends to be very fatty as most famers do not feed balanced diets to their pigs, because of the high cost of feed ingredients. High levels of cholesterol and fat from animal products have been associated with coronary heart diseases and stroke and fear of this has had negative impact on acceptance of pork.

The objective of the study was therefore to improve pork quality by reducing the cholesterol and fat contents through dietary manipulation using corn cobs as a feed ingredient.

2. Materials and methods

2.1 Experimental location and diets

The trial was conducted at the Piggery Section of the Council for Scientific and Industrial Research-Animal Research Institute (CSIR-ARI), Katamanso, in the Adenta Municipality, Accra Ghana. Five (5) iso-nitrogenous (17% CP) diets were formulated to contain 0% corncob, 15% corncob without enzyme, 15% corncob with enzyme, 25% corncob without enzyme and 25% corncob with enzyme. These were labelled A, B, C, D and E, respectively. Batches of the diets were compounded to last for at most 10 days. The maize and the cob were milled using a hammer mill with a 2mm diameter sieve. The rest of the feed ingredients were not ground. Each formulated diet was then put in sacks and labeled properly.

2.2 Enzyme used

The enzyme used is Indigenous Micro Organisms (IMO), which is bacteria based. The Indigenous Micro Organisms were grown from the soils on the farm using local carbohydrate foods (cassava) to produce a concentrate. The concentrate was then diluted with water for use. The corn cob was soaked in the IMO solution over-night. The microorganisms break down the cellulose locked up in fibre and avail nutrients to the animals.

Table 1: Percentage composition of experimental diets

Ingredient (KG)		Dietary Treatment			
	A-0% corn cobs	B-15% corn cobs	C-15% corn cobs + Enzyme	D-25% corn cobs	E-25% corn cobs + Enzyme
Corn cobs	0	15	15	25	25
Wheat bran	9	8	8	10	10
Soybean meal	10.5	14	14	16.25	16.25
Maize bran	12.75	9.25	9.25	7	7
Maize	26	19	19	14	14
Palm kernel cake	29	24	24	20	20
Rice bran	8	6	6	3	3
Fish meal	3	3	3	3	3
Oyster shell	1	1	1	1	1
Salt	0.5	0.5	0.5	0.5	0.5
Premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100

Feed cost/kg (GHS)	1.25	1.06	1.07	1.03	1.04
Calculated composition %					
Crude protein	16.91	16.77	16.77	16.80	16.80
Ether extract	6.19	5.10	5.10	4.38	4.38
Crude fibre	9.45	12.99	12.99	15.25	15.25
ME (MJ/KG)	13.67	14.12	14.12	14.24	14.24
Lysine	0.98	1.15	1.15	1.24	1.24
Methionine	0.34	0.36	0.36	0.36	0.36

Vitamin and TMP (Trace Mineral Premix): Inclusion rate is 25 kg/tonne to supply the following per tonne of feed: Vit.A, 2,000,000 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.

Table 2: Cost of ingredients used to compound the diet.

Feed ingredient	PRICE/kg (GHS)
Corn cobs	0.27
Wheat bran	0.60
Soybean meal	2.60
Maize bran	1.00
Maize	1.40
Palm kernel cake	0.38
Rice bran	0.50
Fish meal	3.2
Oyster shell	0.24
Salt	2.00
Vitamin-trace mineral premix	6.00
Enzyme	

2.3 Experimental animals, design and treatment

Forty (40) Large White grower pigs (20 males and 20 females) ranging from 20kg to 35kg, with an average live weight of 27kg ± 5, were selected at the Piggery Unit of the Council for Scientific and Industrial Research-Animal Research Institute (CSIR-ARI), Accra for the feeding trial. The weights of the 40 pigs were equalized among the five dietary treatments. Each treatment consisted of four females and four males with four replicates per treatment and two animals per replicate in a completely randomized design. The two animals in each replicate were of the same sex. Pigs were fed a daily amount of feed equal to 5% of the individual live weight. Water was provided ad libitum. The pigs were weighed separately every week and the daily feed portion were adjusted. The pigs were fed till they reached an average live weight of 70 ± 5 kg.

2.4 Management of experimental animals

A thorough cleaning of the pens including the feed and water troughs with a disinfectant prior to the start of the trial was done. The water troughs and floors were also cleaned every morning during the experiment. Each pen contained a concrete feed and watering trough. Feed was provided every morning while fresh clean tap water was provided every morning and evening as a daily routine. Pigs were also washed with water every morning and kept clean and cool. On the day of the start of the feeding trial the experimental pigs were weighed individually with a Gascoigne weighing scale3 to obtain the initial weights. Ear tagging was done for easy identification of pigs.

2.5 Parameters measured

2.5.1 Feed intake

The determination of weekly feed intake (WFI) was done every Monday throughout the experimental period. The WFI was obtained by summing the quantities of feed allocated to each pig during the week. Feed was weighed using a table top weighing scale4. The summation of WFI for the period a particular pig stayed on the experiment was described as the total feed intake (TFI) for that pig. Average Daily Feed Intake (ADFI) was established by dividing TFI by the number of days the pig remained on the experiment.

2.5.2 Live weights and live weight gains

The initial weight of each replicate was taken at the beginning of the experiment. Afterwards, pigs were weighed every week specifically on Mondays before feeding to determine body weight changes for the week using the Gascoigne weighing scale3. The Average Daily Gain (ADG) was then determined by dividing the weekly gain by seven (days). The live weight gained for the week was the differences between the previous week’s recorded weight and the current weight. The difference between the final weight (70± 5kg) and the initial weight of each pig was the total weight gain (TWG).

2.5.3 Feed conversion ratio, feed cost, and feed cost per kg gain

Feed conversion ratio, defined as the quantity of feed (kg) consumed to gain a unit of live weight (kg), was calculated as the ratio of total feed consumed to total weight gain for each pig. The cost of feed was the sum total of the cost of each ingredient used in compounding 100 kg of a diet; from this the cost per kg was calculated. The economy of gain for each pig was calculated as the feed cost/kg live weight gain, i.e. the cost of feed required to produce a kg of weight and was computed as the product of feed cost (per kg) and the feed conversion ratio.

2.5.4 Carcass evaluation

2.5.4.1 Slaughtering of pigs

Each experimental pig was slaughtered when it attained the target weight of 70±5kg on the weighing day. The slaughtering was done at the Meat Processing Unit of the Council for Scientific and Industrial Research-Animal Research Institute (CSIR-ARI). An electric stunner was used to stun the pigs, they were then slaughtered and allowed to bleed. Pigs were scalded with hot water (80^{o}C) immediately after bleeding and the remaining hairs were singed with a gas burner. The carcasses were then hanged, washed and eviscerated.

2.5.4.2 Warm carcass parameters

Warm dressed weight was determined as the whole carcass weight after the removal of the viscera. The viscera (internal organs) were collected into a bucket and after washing off the clots of blood and fluids, the weight was determined and recorded using a table top scale.

The liver, kidneys, heart, spleen, thymus gland and respiratory tract were separated and weighed individually as described by Bridi and Silva [10].

The weights of the full GIT and then the empty GIT was taken after which the empty stomach was weighed.

2.5.4.3 Chilled carcass parameters

The following parameters were taken after 24 hours chilling of each carcass in a cold room (40C):

(i) Chilled dressed carcass weight was the weight of the whole carcass (without the viscera). Each chilled carcass was then divided into two equal halves along the vertebral column and the left half was then used to determine the following parameters:

(a) Carcass length-this was determined from the left half of a hanging carcass and it was the distance between the anterior edge of the first rib and the anterior edge of the aitch bone [11].

(b) Weights of thigh, shoulder, hand, rip back, rip streak, rump back, rump streak and fillet. The absolute weights were measured on a table top scale as described by Bridi and Silva [10].

(ii) Back fat thickness

The average of the thickness of the back-fat was measured from three points, the first rib, the last rib and rump and the P2 value was assessed by measuring the depth of back-fat at the P2 position which was taken 6.5cm from the dorsal midline and at the head of the last rib [11].

2.6 Statistical analysis

All data collected were subjected to analysis of variance (ANOVA) using Genstat Statistical software (Discovery Edition 3). The 5% probability level was used for determining significance among treatments.

3. Results and discussion

3.1 Chemical composition of corn cobs

The chemical composition of the corn cob is shown in Table 3. The crude protein, ether extract and dry matter values of 2.42%, 3.96% and 85.81%, respectively were slightly lower than those recorded by Rajmane and Deshmukh [3] who recorded 4.4% crude protein, 4.2% ether extract and 91.5% dry matter whiles the crude fibre value 39.89% was higher than that of Rajmane and Deshmukh [3] who recorded 34.9%. The changes in the values could be attributed to differences in production methods, climate, stage of maturity, soils, variety of maize and harvesting time, cultivar and perhaps drying methods employed [12].

Table 3: Chemical composition of corn cobs

Parameters	Values (%)
Crude Protein	2.42
Crude Fibre	39.89
Ether Extract	3.96
Dry Matter	85.81
Ash	2.16

3.2 Performance characteristics

3.2.1 Health and mortality of pigs

All the animals on the experiment did not show any visible external signs of ill health during the period of the experiment and willingly consumed their allowances of the experimental diets. No mortalities were recorded in the study. Okyere also recorded no mortalities when he fed broiler chickens with diet containing up to 40% wheat bran which is high in fibre but with different levels and type of OPTIZYME™ [13]. Again, in a similar work done by Boateng and others, they recorded no mortalities when grower pigs were fed diets containing up to 60% of rice bran supplemented with Xzyme™ (25g per 100kg of feed) [14]. Also, no mortality was recorded when different breeds of pigs were fed diets containing high quality fibre [15].

A summary of the growth performance of pigs fed graded levels of corn cob with or without enzyme is presented in Table 4. Initial live weight (ILW), average daily feed intake (ADFI) and total feed intake (TFI) did not manifest dietary influences.

Table 4: Growth performance of the pigs fed corn cob based diet

	Dietary treatment							
Parameters	A-0% CC	B-15% CC	C-15% CC + Enzyme	D-25% CC	E-25% CC + Enzyme	LSD	SEM	P – Values
Number of pigs (kg)	8	8	8	8	8			
Initial Live Weight (kg)	28.62	29.25	29.25	28.38	29.62	1.75	0.61	0.59
Final Live Weight (kg)	72.31^{a}	70.44^{b}	70.50^{b}	69.12^{b}	70.06^{b}	1.71	0.59	0.01
Average Daily Gain (kg)	0.56^{a}	0.50^{ab}	0.50^{ab}	0.45^{b}	0.49^{ab}	0.07	0.02	0.05
Total Weight Gain (kg)	43.69^{a}	41.19^{b}	41.25^{b}	40.75^{b}	40.44^{b}	2.05	0.71	0.03
Average Daily Intake (kg)	2.53	2.47	2.51	2.48	2.50	0.10	0.04	0.72
Total Feed Intake (kg)	179.37	182.01	192.95	205.86	187.73	27.41	9.46	0.32
Feed Conversion Ratio	4.12^{a}	4.44^{ab}	4.70^{ab}	5.10^{b}	4.67^{ab}	0.74	0.26	0.03
Feed cost/kg Gain, GHS	5.15	4.70	5.03	5.25	4.86	0.78	0.38	0.30
Days to slaughter	79.6^{a}	82.2^{ab}	85.8^{ab}	91.9^{b}	83.1^{ab}	10.83	3.74	0.02

LSD - Least Significant Difference **SEM** – Standard Errors of Mean **a, ab** - means in the same row with different superscripts differ significantly ($p < 0.05$) **CC** – Corn Cobs

3.2.2 Live weight changes

The initial live weight was similar ($p < 0.05$) across dietary treatments (Table 4). However, final live weight and total weight gain of pigs fed the control diet were significantly higher ($p < 0.05$) than that of the pigs fed the tested diets but there was no significant difference among the tested diets. Pigs were slaughtered when they attained a live weight of 70+5kg. The average daily weight gain (ADWG) values were 0.56, 0.50, 0.50, 0.45 and 0.49 for the corresponding dietary treatments A, B, C, D and E respectively. Although the daily feed intake of the animals did not record any significant ($p > 0.05$) differences, there were significant ($p < 0.05$) differences in the average daily weight gains. Treatment A which is the control diet was significantly ($p < 0.05$) higher than treatment D i.e. 25% corn cob without enzyme. Each of them was however similar to the rest of the treatments. These results suggest that, the pigs were able to effectively and efficiently digest the corn cob used in the tested diets probably due to the addition of enzyme. The pigs on tested diets except treatment D (25% corn cobs without enzyme) were similar to the control diet. With an addition of enzymes, fibre digestion is increased and an increase in animal performance is expected. Kerr and Shurson reported that, the inclusion level of enzymes for a range of diet increased the digestion and absorption of nutrient and therefore the rate of growth [16]. Report by Choct showed that cell walls of legumes, cereal grains, and oil seed meals contained complex carbohydrates usually known as non-starch polysaccharides (NSP) which are not easily digested due to inadequate amount of degradable endogenous enzymes produced by pigs usually at the pre weaning stage and therefore supplementation with an enzyme is imperative [17]. The days to slaughter of pigs on the five dietary treatments were 79.6, 82.2, 85.2, 91.9 and 83.1 for treatments A, B, C, D and E respectively. The control diet was significantly ($p <0.05$) lower than treatment D (25% corn cobs without enzyme) but each of them was similar to the rest of the treatments. This could be due to the high ADWG of pigs on dietary treatment A.

3.2.3 Total feed intake

The total feed intake (TFI) of the pigs on the five diets did not show any significant ($p > 0.05$) differences (Table 4). The similar TFI among treatments suggest that the corn cob based diet was acceptable to the pigs. This shows that, unless prevented by bulk, or possibly palatability, a pig is likely to eat until its energy requirement is fulfilled, since energy is the first limiting nutrient in a pig diet [18]. These results agree with the findings of some researchers who reported that provided energy density is sufficient, the pig can tolerate a wide range of crude fibre in the diet [19] [8]. Also, the intake of feed can be influenced by level of palatability [20].

3.2.4 Average daily feed intake

The different dietary treatments did not impact significantly ($p > 0.05$) on the daily feed intake suggesting that pigs will readily consume diets containing up to 25% Corn Cobs. However, pigs fed with the enzyme added diets had numerically higher feed intake than their counterparts fed diets without enzyme. Supplementation of feed with enzyme improves feed intake hence growth rate [21]. Pigs on the five treatments were fed 5% of their body weight and consumed similar amounts of feed on daily basis. There were no leftovers for all the dietary treatments. Table 1 indicates that the energy content of the experimental diets was similar. Pigs, like other monogastric animals, generally eat to satisfy an inner metabolic need for energy and will therefore eat similar amount of diets containing similar levels of energy.

3.2.5 Feed conversion ratio (FCR), feed cost and economy of gain

With the mean FCR values recorded, there was a significant difference ($p < 0.05$) between treatment A (0% corn cob) and D (25% corn cob without enzyme). Each of them was however similar ($p >0.05$) to the rest of the treatments. Pigs on diet A utilized the diet efficiently followed by treatment B, then E and C and treatment D which was the least efficient. This result could be due to decreased ADG with increasing feed intake as the corn cob increased in the diets because FCR is a measure of how well an animal converts feed intake into live weight gain [22]. A similar trial by Boateng et al, observed an improvement in FCR at every level of rice bran with addition of the xzyme [14].

The feed cost per kg for the dietary treatments decreased with increasing levels of corn cobs. Treatment A had the highest feed cost per kg and this can be attributed to the kg price of maize which from Table 4, is GHS 1.40 and its 26% inclusion in the diet as compared to GHS 1.06 for 15% inclusion of corn cob and GHS 1.03 for 25% inclusion of corn cob. Although the feed cost/kg of the control diet was higher than that of tested diets, the feed cost/kg gain were similar ($p > 0.05$) among the dietary treatments. This could be due to the better FCR of pigs on the control diet. However, the feed cost/kg gain was numerically higher for treatment D (25% corn cobs without enzyme) and the control diet but was lowest for diet B (15 % corn cobs without enzyme), a difference of 55 and 45 pesewas per kg for treatments D and A respectively. Therefore, 45pesewas x 41.19 kg weight gain will save GHS 18.54 per animal for treatment B when compared to the control. This implies that including 15% corn cobs without enzyme in diet of grower pigs was more profitable compared to the control diet. Therefore, producing more pigs at a reduced cost as observed in this study, is likely to result in decreased cost of production. Corn cobs are relatively cheaper and might be responsible for the decrease cost/kg gain.

3.3 Carcass characteristics

Table 5: Carcass characteristics of the pigs fed the five different experimental diets.

Parameters	Dietary treatment							
	A-0% CC	B-15% CC	C-15% CC + Enzyme	D-25% CC	E-25% CC + Enzyme	LSD	SEM	P Value
Physical measurements								
Live weight (kg)	72.31^{a}	70.44^{ab}	70.50^{ab}	69.57^{b}	70.06^{b}	1.84	0.64	0.05
Warm weight (kg)	48.12	47.19	47.31	46.29	46.69	2.41	0.83	0.60
Chilled weight (kg)	46.81	45.62	45.81	44.86	45.31	2.33	0.81	0.53
Carcass length (cm)	72.31	69.81	70.00	69.21	70.94	3.44	1.19	0.41
Measurement of Fat								
Backfat average (cm)	2.00^{a}	1.63^{ab}	1.58^{ab}	1.27^{b}	1.25^{b}	0.47	0.16	0.02
P2 measurement (cm)	1.35^{a}	0.95^{ab}	0.83^{b}	0.66^{b}	0.53^{b}	0.46	0.16	0.01
Exposed surface								
Lion eye area (cm^{2})	24.87	26.09	26.17	25.45	24.98	3.75	1.30	0.93
Weight of major joints								
Shoulder (kg)	3.27	3.11	3.27	3.11	3.29	0.36	0.12	0.70
Hand (kg)	3.02	3.36	2.98	3.46	3.09	0.46	0.16	0.16
Head (kg)	5.42	5.36	5.44	5.26	5.42	0.34	0.12	0.83
Rip Streak (kg)	1.82	1.64	1.54	1.69	1.55	0.30	0.10	0.34
Rip back (kg)	3.37	3.13	3.17	3.01	3.07	0.37	0.13	0.37
Rump back (kg)	2.99	2.91	2.76	2.68	2.59	0.47	0.16	0.43
Rump streak (kg)	1.34^{a}	1.27^{ab}	1.21^{ab}	1.01^{b}	0.97^{b}	0.30	0.11	0.04
Thigh (kg)	4.74	5.13	5.01	4.84	5.06	0.42	0.15	0.32
Trotters (kg)	0.86	0.93	0.87	0.92	0.91	0.11	0.04	0.66
Weight of organs								
Viscera (kg)	13.38	14.63	13.83	13.94	14.01	1.59	0.55	0.62

Full GIT (kg)	7.64^{a}	9.28^{b}	8.14^{ab}	8.49^{ab}	8.74^{ab}	1.18	0.41	0.05
Empty GIT (kg)	2.76	2.83	2.64	2.66	2.94	0.32	0.11	0.29
Empty stomach (kg)	0.58	0.64	0.65	0.64	0.66	0.08	0.03	0.27
Liver (kg)	1.14^{ab}	1.23^{a}	1.08^{bc}	0.99^{c}	1.09^{bc}	0.12	0.04	0.01
Respiratory tract (kg)	0.72^{b}	0.75^{b}	0.68^{b}	0.59^{a}	0.69^{b}	0.08	0.03	0.00
Fillet (kg)	0.26	0.27	0.27	0.27	0.29	0.05	0.02	0.85
Thymus gland (g)	17.25	16.78	17.29	17.29	16.73	3.28	1.13	0.99
Kidney (g)	206.60^{a}	193.87^{ab}	189.52^{ab}	189.69^{ab}	177.59^{b}	25.82	8.91	0.03
Heart (g)	203.91	210.15	199.90	195.65	216.24	20.99	7.25	0.30
Spleen (g)	103.31	90.97	93.39	103.58	102.26	17.99	6.21	0.45
Mesenteric lymph (g)	491.87^{a}	391.50^{b}	434.63^{ab}	399.38^{b}	369.51^{b}	64.51	22.27	0.01

LSD – Least Significant Difference **SEM**– Standard Error of Mean **a, ab**- means in the same row with different superscripts differ significantly ($p < 0.05$) **CC** – Corn Cobs

3.3.1 Absolute carcass parameters

Physical measurement

Fig. 1 Carcass length

Table 5 shows that the carcass parameters measured; warm weight, chilled weight as well as carcass length were statistically ($p > 0.05$) similar. Treatment A had the highest warm and chilled weight and carcass length but was not significantly ($p > 0.05$) different from those on the corn cob with or without enzyme. Probably this was as a result of the termination criteria used, i.e., all pigs were slaughtered when they attained the stipulated live weights of 70 ± 5 kg. It also suggests that the test diets had the same nutritional effects as that of the control diet. Numerically, pigs on the control diet were longer than their counterparts on the tested diets. This result contradicts the findings of Adusah, who found out that carcass of pigs on high fibre with probiotic diets were longer than those on the control diet [23]. It also agrees with an earlier which reported that increasing the level of corn cob from 0 to 200g/kg did not influence chilled weight and carcass length. They did not observe any significant ($p > 0.05$) differences among the treatment means [24].

There was no significant ($p > 0.05$) difference in live weight at slaughter for pigs that were on corn cobs with or without enzyme; i.e. treatment B, C, D and E. The values of live weight at slaughter recorded for pigs on the control diet and 15% corn cob with or without enzyme i.e. A, B and C were also similar ($p > 0.05$) but were significantly higher ($p < 0.05$) than that of the pigs that were on 25% corn cob with or without enzyme i.e. treatment D and E. These results are contrary to those of Chimonyo and co, who recorded similar ($p > 0.05$) values in live weight at slaughter when pigs were fed up to 20 % corn cobs [24].

3.3.2 Weights of major joints

The mean values obtained for the other carcass measurements; i.e. weight of thigh, shoulder, fillet, hand, head, trotters, rip back, rip streak and rump back were also similar ($p > 0.05$) among the five dietary treatment except rump streak. The similarities observed on the major joints are probably due to the similarities observed for warm weight, chilled weight and carcass length. No significant ($p > 0.05$) differences were also observed in the relative and absolute weights of these parameters when diets containing varying levels (20, 30 and 40%) of higher fibre diets plus an exogenous enzyme were fed to grower -finisher pigs [25]. Saka also suggested that these body components (thigh, head, hand, trotters, rip back, rip streak, rump back, rump streak and shoulder) will only differ under extreme situations of malnutrition [26]. This suggest that the pigs on this experiment were well fed and also, farmers would have alternatives in considering feedstuff for compounding diets at a reduced cost without compromising on final output and quality of carcass produced. Though the mean values obtained for the major joints were similar among the dietary treatments, pork from pigs on the tested diets will be more accepted by consumers because pig on the tested diets had leaner carcasses compared to pigs on the control diet. High levels of cholesterol and fat from animal products have been associated with coronary heart diseases and stroke and fear of this has had negative impact on acceptance of pork. Pork from pigs on the corn cobs diet may be sold at premium price which will greatly benefit the farmers.

3.3.3 Back fat and P2 measurement

Fig. 2 P2 measurement

Fig. 3 Back fat (control diet)

Fig. 4 Back fat (15% corn cobs without enzyme)

Fig. 5 Back fat (15% corn cobs with enzyme)

Fig. 6 Back fat (25% corn cobs without enzyme)

Fig. 7 Back fat (25% corn cobs with enzyme)

Back fat and P2 are the main determinants of the fat content of pork. The mean values obtained as shown in table 8 were significantly ($p < 0.05$) different. However, there was no significant ($p > 0.05$) difference among pigs that were on the tested diets i.e. treatment B, C, D and E for both back fat and P2 measurement. Pigs on the control diet recorded the highest values 2.00 and 1.35 for back fat and P2 respectively. Pigs fed the corn cob diets with or without enzyme had lower values than the pigs fed the control diet. The values of back fat and P2 measurement decreased as the level of corn cob increased. The values obtained show that pigs fed corncob with or without enzyme had leaner carcasses than the pigs that were on the control diet. Generally, consumers prefer lean meat and tend to discriminate against high fat meat due to health risk involved. These findings are in agreement with the work of Fombad and Maffeja, who reported that the production of lean pork carcasses can be attained by replacing feeds that are high in energy with bulky low energy feeds that are high in crude fibre or by the inclusion of inert materials such as polyethylene, corncob cellulose and sand in diet of pigs [27]. When dietary fibre is increased in the diets of pigs, the belly primal thickness significantly decreases indicating reduced fatness [6]. Also, lower side-fat depth (15.6 vs. 14.3 mm) is achieved when grower and finisher pigs are fed diets that are high in fibre [7].

3.3.4 Exposed surface

Fig. 8 Loin eye area A

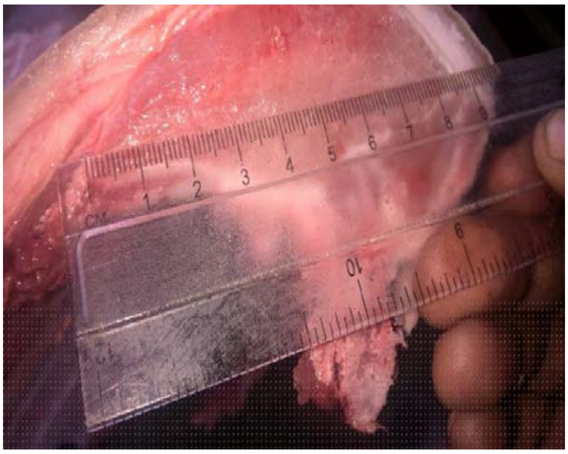

Fig. 9 Loin eye area B

The mean values obtained for loin eye area were not influenced significantly ($p > 0.05$) by the dietary treatments. However, pigs on the control diet recorded the least value for loin eye area.

3.3.5 Weight of internal organs

The values for the internal organs, i.e. heart, spleen, empty stomach, thymus gland, empty GIT, full GIT, liver, respiratory tract, kidney and mesenteric lymph are also shown in Table 5. Heart, spleen, empty stomach, thymus gland and empty GIT were not influenced significantly ($p > 0.05$) by the dietary treatments. A similar pattern was observed when varying levels of African Locust Bean Fruit Pulp which is high in fibre was fed to growing pigs [28] and also when high fibre with enzyme was fed to albino rats [14]. The weight of viscera as shown in Table 5 were not significantly ($p > 0.05$) different. The mean values for dietary treatment A, B, C, D and E were 13.38, 14.63, 13.83, 13.94 and 14.01kg respectively. Though there was no significant ($p > 0.05$) difference among treatments, pigs on the corn cob diets with or without enzyme recorded higher values than the pigs on the cob-free diet. High fibre diets increase the size of visceral organs in pigs depending on the fibre's physico-chemical characteristics and fibre level [29]. The difference between the current study and an earlier work done [29] could be due to the type of fibre and level used. The mean values recorded for mesenteric lymph, full GIT, liver, kidney and respiratory tract as shown in Table 5 were significantly ($p < 0.05$) different. The mesenteric lymph of treatment A (control) was significantly ($P < 0.05$) higher than treatments B (15% corn cob without enzyme), D (25% corn cob without enzyme) and E (25% corn cob with enzyme) but was similar ($p > 0.05$) to treatment C (15% corn cob with enzyme). Prolonged intake of corn cob supplemented diets by growing pigs can led to an increase in weight of the gastrointestinal tract [30]. Respiratory tract of pigs on the control diet was significantly ($p < 0.05$) higher compared to pigs on treatment D but was similar to the rest of the treatments. In terms of full GIT, treatment A was significantly lower ($p < 0.05$) compared to treatment B but each of them was similar to the rest of the treatments. Again, the kidney of pigs on the control diet was significantly ($p < 0.05$) higher than their counterparts on treatment E (25% corn cobs with enzyme) but was similar to treatments B (15% corn cobs without enzyme), C (15% corn cobs with enzyme) and D (25% corn cobs without enzyme).

4. Conclusion

The result of this study therefore indicates that, corn cob which is economically cheaper and regarded as waste in some areas of Ghana can be used successfully as a feed ingredient in conventional pig feed without any adverse effect on the growth performance, health status and carcass characteristics of grower pigs. Pork from pigs fed diets with added corn cobs had lower fat and lower blood cholesterol levels compared to pork from pigs fed diets without corn cobs. From economic point of view, dietary treatments B and E were relatively cheaper to feed.

5. Recommendation

Corn cobs is recommended as an alternative feed ingredient in pig diets for pig farmers in Ghana and wherever corn cobs are available worldwide and can be included up to 25% in pig diets without any adverse effect on pigs. Also, further studies must be carried out to determine the digestibility of the corn cob using pigs.

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