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FEEDING VALUE OF VARYING LEVELS OF CORN AND COB MEAL ON WEANED PIGS

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Abstract

A total number of thirty-two (32) TN breed weaned pigs, aged 7 weeks having the average weight of 10.5 ± 0.5 kg were used to assess the feeding value of varying levels of corn and cob meal (CCM) on weaned pigs. The proximate composition and milling proportion of CCM were analyzed and its effect on growth response, nutrient digestibility, and blood parameters of weaned pigs fed varying levels. The acclimatization period of the pigs lasted for seven days and they were randomly allotted to four (4) dietary treatments with eight (8) pigs as replicates. The experiment was carried out for seven weeks. The experimental design was completely Randomized Design. The feed had 0%, 10%, 20% and 30% CCM in the diets tagged D1, D2, D3 and D4 respectively. 97.63% of whole maize were millable using hammer mill of 2 mm screen size. The proportion maize to cob was 89.25% to 10.75%. CCM significant influenced ($p < 0.05$) the feed intake and weight gain of the pigs. The crude fibre, ether extract, nitrogen free extract and ash digestibilities were significantly affected ($p < 0.05$). The packed cell volume, haemoglobin, red blood cell, neutrophils and lymphocytes count were significantly influenced ($p < 0.05$). The aspartate transaminase, alanine transaminase, albumin, glucose, urea, cholesterol and high density lipoprotein level were also significantly affected ($p < 0.05$). In conclusion, CCM in pig nutrition is considered favourable up to 10% inclusion level for optimum growth performance.

Keywords: whole maize, unshelled maize, dietary fibre, pig, maize cob

INTRODUCTION

The increasing world population has had a significant impact on the demand for animal products. There has been reduction in global meat production and alteration in the supply chain (Ijaz *et al.,* 2021) resulting in limited availability of meat as a result of the covid-19 pandemic. Even before the incidence of the global crisis, the deficiency of protein is common in developing countries (Muller, 2005). In developing countries, protein-energy malnutrition has been responsible for up to 56% of child deaths (Pelletier *et al.,* 1993; Muller, 2005), and this has posed chronic and acute effects on children. There is a greater demand for animal-source protein to fill the gap (Judith *et al.*, 2020). Because of this reason, it is essential to look for a less expensive and alternative supply of meat from animals with a short life cycle, such as rabbits, chickens, and pigs to provide animal protein (Ironkwe and Amefule, 2008).

The performance and physiology of pigs is heavily reliant on nutrition (Ojediran *et al.,* 2017) apart from genetics and other environmental factors. The total cost of feeding in pig production amount to

60–76% of the total cost. The cost of feed ingredients is increasing, which limits the production efficiency of pig enterprise as a cheap and readily available source of animal protein (Adeyemi and Akinfala, 2018). Feed supplies are dwindling. An ideal farmer is mostly concerned with profit maximization by opting in for feedstuffs with the low cost compared to other conventional feed ingredients that are supplying the same nutrient.

The increase in the cost of feeding has resulted in a continuing quest for low-cost alternative feedstuffs as appropriate replacements for traditional feed components (Longe, 2006). Maize (*Zea mays*), the principal source of energy in diets of pig (Skoufogianni *et al.,* 2020), accounting for 30–50% of calories (Shiferaw *et al.,* 2011). When maize is shelled, the cob, a common agricultural byproducts in smallholder communities, is usually disposed of and left on the field (Kanengoni *et al*., 2002; Jansen, 2012). Corn and cob meal (CCM) consists of the corn with the cob by grinding them together. Corn and cob meal (CCM) might be a useful local element that can be incorporated at a moderate cost (Millet *et al.*, 2005; Ojediran *et al.,* 2023). As a result, the question of whether this substance may be employed in feed composition without compromising performance and product quality emerges.

Pigs are known for their short generation intervals, excellent production potential, efficient conversion rate, and carcass yield. They are also one of the fast-growing and efficient livestock animals that can turn food waste into profitable goods (Adeniyi *et al.,* 2013). Where there is no religious taboo, many developing nations' economies lay a significant emphasis on the production of pigs. (Ojediran *et al.,* 2019), and the demand for pigs and their by-products is on the increasing side. Therefore, there is a need for an increase in the level of pig farming.

This experiment is aimed at assessing the nutritive value of CCM, maize fraction, the growth parameters, nutrient digestibility, and blood parameters of weaned pigs offered varying levels of CCM.

MATERIALS AND METHODS

Experimental Site

The experiment carried out at Ladoke Akintola University of Technology Teaching and Research Farm's piggery unit, which is located at latitude 18°15’N of the equator and longitude 4°5’E of the Greenwich meridian (Ojediran *et al*., 2020).

Procurement of Test Ingredient and Experimental Diet

Well-preserved unshelled maize was procured from Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, a reputable and trusted agricultural firm. The unshelled maize was sun-dried. The ratio of grains to cob was determined using a sensitive weighing scale. The whole maize was milled with hammer mill with 2 mm screen size. The fibrous un-millable portion was taken out of the hammer mill to establish the

I: *Gross composition of feeding diet*

Ingredients	D1 (%)	D2 (%)	D3 (%)	D4 (%)
Maize	10.00	0.00	0.00	0.00
Corn and cob meal (CCM)	0.00	10.00	20.00	30.00
Soybean meal	10.00	10.00	10.00	12.00
Full fat cashew	7.00	7.00	7.00	4.00
Palm kernel cake	55.00	55.00	55.00	51.00
Wheat offal	15.00	15.00	5.00	0.00
Bone meal	1.50	1.50	1.50	1.50
Limestone	1.00	1.00	1.00	1.00
Vitamin premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100	100	100	100
Calculated nutrients				
Metabolizable energy (kcal/kg)	2722.92	2750.81	2775.44	2746.75
Crude protein	19.85	19.67	18.82	18.20
Ether extract	7.34	7.83	7.27	6.05
Crude fibre	8.64	11.02	12.95	14.80
Lysine	0.98	1.02	0.97	0.89
Methionine	0.42	0.44	0.40	0.36

quantity. The meal was then mixed with other feed ingredients. Thereafter, four diets were formulated having crude protein value between 18–19% and metabolizable energy 2 700–2 800 ME/Kcal/kg as shown in Tab. I. CCM was incorporated in the proportion of 10%, 20%, and 30% in Diet 2 (D2), Diet 3 (D3), and Diet 4 (D4) respectively, while Diet 1 (D1) had 10% maize as the control diet.

Experiment Pigs and Management

Thirty-two (32) TN breed weaned pigs of 7 weeks old with and average weight of 10.5 ± 0.5 kg were acclimatized for seven (7) days and offered a weaner ration having 22% CP prior to the experiement. The pigs were then randomly allotted to four (4) dietary groups with eight (8) of them serving as replicate. Each of the pigs was housed separately in a concrete pen and were offered feed and water *ad libitum*. The experiment was conducted for 49 days.

Experimental Design and Statistical Analysis

The design of the experiment was Completely Randomized Design (CRD). Statistical package for the social science (SPSS version 16) was used for the analysis. All the data obtained from the experiment were subjected to statistical analysis using one-way analysis. The treatment means were presented with group standard errors and the statistics were compared using the Duncans Multiple Range (DMR) test procedure of test with a probability of 5% (P level = 0.05).

Data Collection

Proximate Analysis, Fibre Fraction, and Energy Composition

The nutrient composition of the representative samples of each experimental diets, unshelled maize, maize grain, and cob were analyzed using the recommended procedure of AOAC (1990). The fibre fraction of the unshelled maize, maize grain, and the cob was analyzed using the Van Soest detergent fibre analysis. The metabolizable energy was determined using the Pauzenga equation.

M.E. (kcal/kg) = 37 × % CP + 81 × % EE + 35.5 × % NFE).

Growth Parameters

Data on the initial and final weight of the pigs, total and average daily weight gain, feed offered, average daily feed intake were collected while the feed conversion ratio was computed.

Nutrient Digestibility

The pigs were moved into the metabolic section, a week prior to the collection of faecal samples. They were afterward acclimatized for three (3) days and the faecal samples of each pigs were collected for three (3) days consecutively. The fresh faecal samples were collected from each treatment and oven dried to reduce the water constituent. During the faecal collection phase, total faecal samples were collected and dried in a forced-air oven prior to grinding and compositing for each pig before analysis. The proximate composition was afterwards analyzed according to the procedures of the Association of Official Analytical Chemists (AOAC 1990).

Blood Parameters

Three (3) pigs per replicate were slaughtered on the 49th day of the experiement. 5 ml of blood was collected into EDTA bottles for haematological analysis: Red blood cell, White blood cell, Packed cell volume, Haemoglobin, Mean corpuscular volume, and Mean corpuscular haemoglobin using Haematological Auto-analyzer. 5 ml of blood was collected into plain bottles for Serum biochemistry (Aspartate aminotransferase, Alanine transaminase, Alkaline phosphatase, Total protein, Albumin, Globulin, Cholesterol, Triglyceride, and Creatinine). They were analyzed using the procedure enumerated by Ojediran *et al.* (2022).

RESULTS

The milling proportion of the unshelled maize is shown on Tab. II. On average, 97.63% of the unshelled maize was milled into CCM while 2.37 % of the maize was retained in the hammer mill. The unshelled maize was milled using a hammer mill of 2 mm screen size to check for the proportion of the milled maize and retained components within the hammer mill. 97.63 ± 2.16% was milled while 2.37 ± 1.17% was retained.

Tab. III shows the proportions of maize grain to the cob. Several samples of healthy unshelled maize were randomly picked to check for the proportion of maize grain to cob in unshelled maize. The average proportion of maize grain was 89.25% while the proportion of the cob was 10.75%.

The proximate composition, fibre fraction, and metabolizable energy of corn and cob meal (CCM) are shown in Tab. IV. Corn and cob meal (Fig. 1) had 6.85% Crude protein, 26.80 % Crude fibre, 2.40% Ether extract, 1.95 % Ash, 62.00 %, Nitrogen Free Extract, 16.01% Neutral Detergent Fibre, 6.00% Acid Detergent Fibre, 5.00% Acid Detergent Lignin, and 2 648.85 Kcal/kg metabolizable energy.

II: *Milling proportion of whole maize using 2 mm screen size*

Whole maize (%)	CCM (%)	Un-milled maize (%)
100	97.63	2.37

III: *Proportions of maize grain to cob in whole maize*

Whole maize (%)	Maize grain (%)	Maize cob (%)
100	89.25	10.75

1: *Ground maize cob*

2: *Ground CCM*

3: *Retained inner cob*

Tab. VI reveals the data collected on the growth response of weaned pigs fed different levels of CCM. The initial weight, final weight, and feed conversion ratio was not influenced ($p > 0.05$). However, the total weight gain, Average daily weight gain, total feed intake, and average daily feed intake values were significantly influenced ($p < 0.05$). The total weight gain ranges from 14.05 kg (D3) to 20.94 kg (D1). Pigs fed D3 and D4 were lower in values ($p < 0.05$) and were significantly different from those offered diet D1 while those fed diet D2 were comparable. This trend was observed in the average daily weight gain. Pigs fed D1 recorded the least feed conversion ration (2.62) followed by D4 (2.98) while D2 and D3 recorded the same feed conversion ratio (3.09) though not significant ($p > 0.05$).

Tab. VII shows the nutrient digestibility of weaned pigs fed varying levels of CCM. There was no significant difference ($p > 0.05$) in the Crude protein (CP) digestibility of the pigs fed varying levels of CCM. However, there was a significant difference ($p < 0.05$) in the Crude fibre (CF), Ether extract (EE), Nitrogen free extract (NFE), and Ash digestibility of the pigs fed varying levels of CCM. The pigs fed D3 had the highest CF digestibility (84.62%) while pigs fed D4 had the least digestibility value for CF (78.49%). The pigs fed D1 had the least EE digestibility (76.41%) while D3, D2 and D4 had 94.47%, 93.25% and 90.75% respectively. The pigs fed D3 had the least digestibility value for NFE (72.24%) while pigs fed D1 had the highest digestibility value for NFE (87.99%) while the pigs fed D2 and D4 were comparable (78.84% and 81.58% respectively). Pigs fed D2 had the highest digestibility value for Ash (80.50%) while pigs fed D4 had the least value (41.63%).

IV: *Proximate analysis of Corn and cob meal*

Parameters (%)	Corn and cob meal (CCM)
Dry matter	88.64
Crude protein	6.85
Crude fibre	26.80
Ether extract	2.40
Ash	1.95
Nitrogen free extract	62.00
Neutral detergent fibre	16.01
Acid detergent fibre	6.00
Acid detergent lignin	5.00
Hemicellulose	10.01
Metabolizable energy (Kcal/kg)	2648.85

V: *Proximate composition of maize fractions*

Parameters (%)	Unshelled maize (CCM)	Maize grain	Maize cob only	Retained inner cob
Dry matter	88.64	91.99	93.08	95.99
Crude protein	6.85	8.38	4.00	1.38
Crude fibre	26.80	3.02	30.00	32.00
Ether extract	2.40	8.03	2.01	2.00
Ash	1.95	2.01	2.02	2.02
Nitrogen free extract	62.00	78.56	61.97	62.6
Neautral detergent fibre	16.01	16.03	80.00	84.00
Acid detergent fibre	6.00	4.00	48.00	50.00
Acid detergent lignin	5.00	2.00	44.00	48.00
Hemicellulose	10.01	12.03	36.03	34.01
Metabolizable energy (Kcal/kg)	2 648.85	3 749.37	2 510.75	2 435.36

VI: *Growth performance parameters of weaned pigs fed varying levels of CCM*

Parameters	D1	D2	D3	D4	SEM	P-val
Initial weight (kg)	10.41	10.58	10.74	10.78	0.41	0.99
Final weight (kg)	31.35	28.54	24.79	25.85	1.20	0.22
Total weight gain (kg)	20.94[a]	17.96[ab]	14.05[b]	15.08[b]	1.05	0.05
Average daily weight gain (kg)	0.43[a]	0.37[ab]	0.29[b]	0.31[b]	0.02	0.05
Total feed intake (kg)	54.29[a]	50.94[b]	41.38[d]	44.48[c]	1.32	0.00
FCR	2.62	3.09	3.09	2.98	0.17	0.76

a–d mean within the row lacking common superscript differ ($p < 0.05$); SEM – standard error of means; kg – kilogram

VII: *Nutrient digestibility of weaned pigs fed varying levels of CCM*

Parameters (%)	D1	D2	D3	D4	SEM	P-val
Crude protein	81.35	84.43	83.52	81.24	0.84	0.51
Crude fibre	80.20[bc]	82.25[b]	84.62[a]	78.49[c]	0.76	0.00
Ether extract	76.41[b]	93.25[a]	94.47[a]	90.75[a]	2.24	0.00
Nitrogen free extract	87.99[a]	78.84[ab]	72.24[b]	81.58[ab]	2.09	0.03
Ash	69.40[a]	80.50[a]	77.74[a]	41.63[b]	5.17	0.00

a–c mean within the row lacking common superscript differ ($p < 0.05$); SEM – standard error of means

VIII: *Haematological parameters of weaned pigs fed varying levels of CCM*

Parameters	D1	D2	D3	D4	SEM	P-val
Packed cell volume (g/l)	37.15[c]	40.25[b]	43.30[a]	42.40[ab]	0.70	0.00
Haemoglobin (g/dl)	11.10[b]	11.30[b]	12.00[ab]	12.85[a]	0.25	0.03
Red blood cell ($x10^6$/µl)	6.32[b]	6.30[b]	6.71[ab]	7.05[a]	0.12	0.05
White blood cell ($x10^3$/µl)	14.45	14.45	19.35	17.90	0.88	0.10
Mean corpuscular volume (fl)	58.85	64.40	64.60	60.20	1.10	0.14
Mean corpuscular haemoglobin (pg)	17.60	17.95	17.90	18.20	0.19	0.79
Neutrophil (%)	34.50[a]	32.00[a]	30.00[a]	23.50[b]	1.35	0.01
Lymphocyte (%)	56.00[c]	58.50[bc]	60.50[b]	66.00[a]	1.07	0.00
Monocyte (%)	9.50	9.50	9.50	10.50	0.40	0.80

a–c mean within the row lacking common superscript differ ($p < 0.05$); SEM – standard error of means

Tab. VIII presents the haematological parameters of the pigs. The results revealed that PCV, HB, RBC, N, and L were significantly affected ($p < 0.05$). However, other haematological parameters such as WBC, MCV, MCH, and Monocytes count were not influenced ($p > 0.05$). The pigs fed CCM had higher PCV ($p < 0.05$) than those fed the control diet. The PCV of the pigs fed D3 was the highest (43.3 g/l) and was similar to D4 (42.40 g/l). The pigs fed D2 (40.25 g/l) was lower while animals fed D1 had the lowest values (37.15 g/l). The pigs fed D4 had the highest Hb value (12.85 g/dl) ($p < 0.05$), those fed diet D1 and D2 had the least while those fed D3 compared favourably. Animals fed D4 had the highest RBC, while those fed D2 had the least RBC count ($p < 0.05$). As the inclusion level of CCM increased, the N values decreased across the dietary levels while L count increased.

Tab. IX shows the serum biochemistry of the pigs. The results showed that alkaline phosphate (ALP), total protein (TP), creatinine, triglyceride and low-density lipoprotein (LDL) were not significantly different ($p > 0.05$). However, the table also revealed that aspartate transaminase (AST), alanine transaminase (ALT), albumin (ALB), glucose, urea, cholesterol and high-density lipoprotein (HDL) were significantly influenced ($p < 0.05$). Pigs fed D1 had the highest ($p < 0.05$) AST and glucose while the pigs fed CCM had higher cholesterol and HDL than the control diet.

DISCUSSION

Tab. X shows the proximate composition of maize grain as compared with other studies. The moisture content reported by Sule *et al.* (2014) was between11.60% and 20.00%, the ash between 1.10%

IX: *Serum biochemistry of weaned pigs fed varying levels of CCM*

Parameters	D1	D2	D3	D4	SEM	P-val
Aspertate transaminase (µ /l)	82.00[a]	51.00[b]	34.00[c]	49.50[b]	4.89	0.00
Alanine transaminase (µ /l)	17.00[a]	19.00[a]	9.00[b]	8.50[b]	1.33	0.00
Alkaline phosphate (µ /l)	57.50	75.50	62.50	79.00	5.14	0.43
Total protein (g/dl)	54.50	53.50	52.00	54.00	1.07	0.89
Albumin (g/dl)	30.00[b]	39.00[a]	28.00[b]	29.50[b]	1.51	0.02
Glucose (mg/dl)	7.45[a]	5.50[bc]	4.80[c]	6.00[b]	0.28	0.00
Urea (mmol/l)	1.65[ab]	2.70[a]	1.70[ab]	1.30[b]	0.21	0.05
Creatinine (mg/dl)	164.50	134.50	150.50	133.50	6.60	0.31
Cholesterol (mg/dl)	3.45[b]	4.10[a]	4.00[a]	3.70[ab]	0.09	0.02
Triglyceride(mg/dl)	0.75	0.75	0.60	0.70	0.05	0.75
High density lipoprotein (mg/dl)	1.45[b]	1.70[ab]	1.75[a]	1.60[ab]	0.05	0.05
Low density lipoprotein (mg/dl)	1.70	2.10	2.00	1.75	0.09	0.29

a-c mean within the row lacking common superscript differ ($p < 0.05$); SEM – standard error of means

X: *Proximate composition of maize grain compared using other studies*

Parameters (%)	Sule *et al.* (2014)	Ape *et al.* (2016)	Shaista (2016)	Onyango *et al.* (2004)
Moisture	11.60–20.00	7.16	8.98–10.45	8.68 ± 0.13
Ash	1.10–2.95	2.19	0.81–1.35	2.08 ± 0.01
Crude protein	4.50–9.87	8.75	11.05–12.79	8.71 ± 0.08
Ether extract	2.17–4.43	2.40	-	2.88 ± 0.01
Carbohydrate	44.80–69.60	77.46	-	86.33 ± 0.09
Crude fibre	2.10–26.77	2.40	0.79–2.48	-

XI: *Proximate composition of maize cob compared using other studies*

Parameters (%)	Abubakar *et al.* (2016)	Kpalo *et al.* (2020)	Demirbaş (2004)
Moisture	6.00 ± 0.07	9.27	-
Ash	2.49 ± 0.01	2.42	1.10
Crude fibre	33.33 ± 0.21	13.92	11.50
Ether extract	4.72 ± 0.07	-	-
Crude protein	4.19 ± 0.10	1.56	3.13
Carbohydrate	48.56 ± 0.14	-	-

and 2.95%, 4.50–9.87% crude protein, 2.17–4.43% ether extract, and 2.10–26.77% crude fibre. The proximate composition reported by Ape *et al.* (2016) and Onyango *et al.* (2004) falls into the same range that was reported by Sule *et al.* (2014) except for the difference in the carbohydrate compositions. Onyango *et al.* (2004) reported 86.33 ± 0.09% for carbohydrates while Sule *et al.* (2014) reported 44.80–69.60% for carbohydrates. The crude protein of the maize grain analyzed for this study was similar to the reported value by Ape *et al.* (2016) (8.75%) and Onyango *et al.* (2004) (8.71 ± 0.08 %) as shown in Tab. V. The analyzed crude protein fell in the same range as the reported crude protein value by Sule *et al.* (2014) (4.50–9.87%) but comparably lower than the reported crude protein value reported by Shaista (2016) (11.05–12.79%). The observed variation may be attributed to factor like processing, climatic factors, storage and variety.

The proximate composition of maize cob in this study was compared using other studies and is shown in Tab. XI. The ash composition as reported by Abubakar *et al.* (2016) and Kpalo *et al.* (2020) were similar, 2.49 ± 0.01% and 2.42% respectively. The crude fibre composition of maize cob as compared using the 3 reports varies. 33.33 ± 0.21% was reported by Abubakar *et al.* (2016), 13.92% was reported by Kpalo *et al.* (2020) and 11.50% was reported by

Demirbaş (2004). This difference could be as a result of the differences in the maize varieties and stage of maturity. The analyzed crude protein and crude fibre (4.00 % C.P. and 30.00 % C.F.) for the maize cob used for this study was similar to the value that was reported by Abubakar *et al.* (2016) (4.19 ± 0.10 % C.P. and 33.33 ± 0.21 % C.F.) as shown on Tab. VII.

The milling product of whole maize observed in this study could be influenced by the harvesting age and the variety. Maize grain is made up of endosperm (82–83%), germ (10–11%), pericarp (5–6%), and tip cap (0.8–1.0%) (Singh *et al.*, 2014). The variation in the cellulose, hemicellulose and lignin composition of the maize cob which increases with maturity, could be the reason for the variation in the milling proportion of whole maize. While hemicellulose and cellulose microfibrils are entangled by hydrogen bonds, making the latter more difficult to reach (Somerville *et al.*, 2004)., the cellulose content of maize is a strong and fibrous part of the cell wall that is very stable and insoluble in water (Dyer, 2008; Abolore *et al.*, 2023). Because cellulose content increases with the plant's maturity and provides tensile strength to the cell wall of the plant, as the maize plant matures with low moisture content, the cob becomes tougher and less mill-able.

The estimated proportion of cob to maize grain of this study disagreed with the report of Blandino *et al.* (2016). Blandino *et al.* (2016) reported 18.70% cob and 81.30% grain. The estimated percentage of cob to grain in this study was 10.75% to 89.25%. There is no stipulated range for the percentage of grain to cob in whole maize because the percentage yield of grain to crop depends on factors such as the method of shelling, the variety of the maize, agronomic practice and the soil type used. Agronomic practices such as the application of fertilizers and herbicides, weeding, and control of insects and pest will increase the percentage of grain yield. However, the slight difference between the report of Blandino *et al.* (2016) and this study could be due to the variety of maize used, agronomic practices, and moisture content.

The ether extract (EE) content of the CCM was slightly similar to the reported value by Millet *et al.* (2005), that is, 2.4% compared with 2.7%. The crude fibre (CF) and crude protein (CP) values were comparably higher than the reported value by Millet *et al.* (2005). This could be due to the method of processing (method of drying and the relative moisture content of the unshelled maize), the screen size of the hammer mill used during the processing, and the age of harvest of the maize. Hammer mills with a lower screen size may produce CCM with lower CF value as a result of a reduced amount of corn cob that will pass through the screen and be processed into CCM while hammer mills with increased screen size may produce CCM with higher CF value. The screen size used for this study was 2 mm. There is a positive relationship between the crude fibre composition of CCM and the cellulose composition of the maize (Dyer, 2008), that is, the crude fibre increases with an increase in the cellulose composition. The level of maturation, the variety, climate, soils, and production methods all have an impact on the composition of maize (Szyszkowska *et al.*, 2007). As a result, mature maize contains higher levels of NDF, ADF, and DM while less mature maize contains higher levels of CP and starch (Millet *et al.*, 2005; Hanif and Akhtar, 2020).

The significance of the CCM on the weight gain, total and average feed intake was due to the increase in the crude fibre (CF) of the diets (D1 – 8.64%, D2 – 11.02%, D3 – 12.95%, D4 – 14.80%) as the percentage of CF in CCM increased. The increase in the CF in CCM is due to the high CF composition in maize cob, therefore, the presence of maize cob in CCM when supplemented in pig diets is considered fibrous (Kanengoni *et al.*, 2015). Because of this presence of cobs, CCM has comparatively high fibre than grain. The fibre content of corn cob as reported by Abubakar *et al.* (2016) was 33.33 ± 0.21%. The report of Abubakar *et al.* (2016) is highly fibrous for pigs (irrespective of the growing stage) to efficiently convert. According to Sola-Oriol *et al.* (2009), an important factor affecting feed intake and palatability in pigs is the amount of fibre in their diet. With increase in the dietary fibre level of pigs, voluntary intake of feed reduces as a result of gut fill, therefore, reducing the availability and digestibility of nutrients and energy (Souza da Silva *et al.*, 2012). Generally, high crude fibre levels can decrease voluntary feed intake in animals due to various factors such as increased gut fill, reduced digestibility, and decreased palatability.

The reduced feed intake that was reported in this study as the CF of a diet increased is a result of the increase in the retention rate of feed within the gastro-intestinal tract of the pig (Sola-Oriol *et al.*, 2009). The high fibre content will increase the bulkiness of the diet, resulting in increased gut fill and reduced space for nutrient-dense feed components, thus, leading to a decrease in the overall intake of the diet by the pigs (Lindberg, 2014). The reduction in feed intake of the pigs as the inclusion level of CCM increases agrees with the above-cited conclusion of Lindberg (2014), Sola-Oriol *et al.* (2009) and da Silva *et al.* (2012). Therefore, the differences in the growth responses of the pigs can be attributed to the high fibre in the diets.

The reduced performance in terms of growth of the pigs fed CCM-included feed showed the effect of corn cob in the CCM and thus, the reduced performance agreed with the growth performance reported by Ndindana *et al.* (2002) and Ojediran *et al.* (2023) where cob meal was administered to different pig breeds. Pigs' decreased growth performance is mostly caused by the impairment in nutrient digestibility and energy deposition brought on by dietary fibre (Hao *et al.*, 2021). Agyekum and Nyachoti (2017) also agreed on the adverse influence of high dietary fibre on the growth performance of pigs. High crude fibre content in animal feed generally tends to decrease feed intake, weight gain and feed conversion ratio (Kanengoni *et al*., 2015). However, the specific effects may vary depending on the species, fibre source, and overall diet composition.

The percentage of nutrients absorbed by the animal is referred to as nutrient digestibility and it is related to the origin and content of dietary fibre (De Vriesa *et al.*, 2012). It is often defined as the difference between the amount of nutrients taken and the amount of nutrients left in the faeces. The digestion of nutrients, particularly energy and certain minerals, can be significantly impacted by high crude fibre content in animal feed (Zhang *et al.,* 2013). Insoluble fibre components can limit the ability of digestive enzymes to access nutrients, hampering the breakdown and absorption of those nutrients in the gastrointestinal tract (Lattimer and Haub, 2010; Tejeda and Kim, 2021). CCM is high in crude fibre (CF) and lower in crude protein (CP) when compared to the grain. Pigs' fibre digestion can be affected by a number of variables, such as the frequency of feeding, the animal's age and weight, and the physical and chemical makeup of the diet, level and passage rate of the feed (Morel *et al.,* 2006). The crude fibre digestibility of the pigs increased as the inclusion level increased and this could be as a result of the decrease in the feed intake of the pigs which will directly result into reduction in the passage rate of the feed offered. Due to the fact that nutrient digestibility is time dependent, feed intake is linked to the acceleration of the rate at which ingesta travel via the GI tract and, as a result, affects nutrient digestibility (Clauss *et al.,* 2007; Wang *et al*., 2024). This same factor could be the same reason for the increase in the ether extract (EE) digestibility of the pigs as the inclusion level of CCM increased. Studies have shown that high fiber diets can have both positive and negative effects on NFE digestibility. The digestibility of NFE may be lowered by high-fiber diets (Abd El-Wahab *et al.,* 2022), particularly those with a high percentage of poorly fermentable fibre and this is due to the possibility that some types of fibre, such as lignin, may not be broken down by the animal's enzymes and bacteria, which would reduce the amount of other nutrients that may be absorbed (Singh and Kim, 2021).

The health and disease status of farm animals can be accurately predicted by their haematological profiles (Eze *et al*., 2010), therefore, they are accurate measures of an animal's physiological health, and changes in them are crucial for assessing how animals react to various physiological circumstances. According to Koomkrong *et al.* (2017), the normal haematological parameters of pigs often fall within the following range of values: WBC: 11 to 22 $\times 10^3/\mu l$, Neutrophils: 28% to 47%, Lymphocytes: 39% to 62%, Monocytes: 2% to 10%, and Haemoglobin: 10 to 16 g/dL. Eze *et al.* (2010) reported that the normal PCV range for pigs is between 25.0 to 46.0%. The Hb, WBC, PCV, RBC, L, and N falls within the reported values of Koomkrong *et al.* (2017). Haemotological parameters shows that CCM had no adverse effect on the physiological state of the animals. The increase in the RBC, Hb, and PCV shows that the pigs were not anaemic. The Neutrophil values of the pigs reduced while the Lymphocytes increased as the inclusion level increased. Neutrophil is the component of the blood that eliminate bacteria and infection by eating them and producing enzymes that kill them (Rosales, 2018) while Lymphocytes are a type of white blood cell (leukocyte) that plays a crucial role in the body's immune system by helping the body recognize and defend against specific pathogens (Newberry, 2004; Vaillant *et al*., 2024). It can be concluded that CCM improve the immune response of the pigs.

The ALT and AST levels quantify synthetic liver enzyme activities (Ogbu *et al*., 2014). The very low readings of these liver enzymes relative to reported normal values indicate compromised liver function (Buzzard *et al*., 2013). Furthermore, dietary deficiencies such as a vitamin B6 deficit, can cause a sharp fall in ALT and AST levels (Karajibani *et al*., 2021). Albumin, glucose and urea were significantly influenced. Albumin is mostly produced by the liver and is indicative of bodily health (Kalra *et al*., 2023). Albumin plays a major role in the maintenance of plasma osmotic pressure and nutrient metabolism (Hamilton and Rombeau, 2005). The albumin values of the pigs were between 28.00 and 39.00 g/dl while the normal range is 24.9–46.0 g/dl (Miller and Jedrzejczak 2001; Zhang *et al*., 2022). Studies have shown that feeding soluble fiber-rich diets to pig will lower cholesterol and LDL levels, however, the influence of dietary fibre on blood cholesterol levels in swine may differ depending on factors including the type and quantity of fibre, the diet's overall composition, and the metabolism of the specific animal.

CONCLUSION AND RECOMMENDATION

It can be concluded that the use of CCM in pig nutrition is considered favourable up to a 10% inclusion level based on the growth performance. The result of this study also indicated that CCM, an economically cheaper feedstuff in conventional pig enterprise is having no adverse effect on the haematological profile and serum biochemistry of the pigs. Up to 10% inclusion level of CCM in weaned diet is recommended. Incorporating exogenous fiber-degrading enzymes could be explored to improve the digestibility of crude fiber and nitrogen-free extract (NFE), especially when using higher levels of CCM. Future studies could explore the impact of different milling techniques and particle sizes on the nutritional value and digestibility of CCM to optimize its utilization.

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