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Maxigrain® supplemented corn cob meal (CCM) utilization by Arbor acre chicks: performance and carcass characteristics at 0-4 weeks

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Abstract

In an experiment to investigate the effect of feeding corn cob meal (CCM) supplemented with Maxigrain®, one hundred and forty-four day-old Arbor acre chicks were fed 6 treatment diets for 28 days, and growth performance indices were assessed. There were 8 birds randomly allotted to each replicate and 3 replicates per treatment diet, in a 3×2 factorial completely randomized experimental design. The levels of CCM inclusion were 0, 25 and 50% and 2 levels of enzyme supplementation, 0g/kg and 0.1g/kg diet. Diet 1, 2 and 3 were without enzyme while diets 4, 5 and 6 were supplemented with the enzyme cocktail, Maxigrain®. Feed and clean water were administered ad libitum, feed intake (FI) and body weight gain (BWG) were assessed for the experimental period. Analyzed composition of diets had a dry matter range of 90.65 - 92.15%; metabolizable energy, 2849.42 to 2952.46 kcal/kg; crude protein 17.2 - 18.55%; a crude fibre range of 5.1 – 5.35% and ether extract of between 5.35 – 7.2%. Part replacement of maize with CCM significantly decreased FI from 1.01 kg/replicate/day to 0.83 kg /replicate/day and also decreased dressed percent from 74.91 – 71.77% significantly ($p<0.05$). Birds fed 25% CCM supplemented with Maxigrain performed comparably to birds fed the control diets, 25% CCM with Maxigrain is therefore recommended.

Keywords: Multi-enzyme, corncob, maize, feedstuff, Maxigrain®, broilers

Introduction

Nutrition is about the most important consideration in livestock management due to its high contribution to the total cost of production and its importance in determining the success of the enterprise; but bioavailability of nutrients fed is even more important (Ajayi and Iyayi, 2014a). A major contributing factor to cost of nutrition is the competition between animals and man for the same feedstuff, and alternatives to these feedstuffs are usually not an equal replacement in terms of nutrient content and or nutrient availability within the animal (Ajayi and Iyayi, 2014b). Monogastric animals also have the limiting factor of not having microorganisms in their gut to aid the digestibility of nutrients like the fibre fractions in feedstuffs. The use of exogenous enzymes in monogastric animal feeding are on the increase to improve nutrient digestibility, availability and utilization especially when non-conventional feedstuffs are used (Ajayi and Oyedeji, 2017). Feed enzyme also reduce environmental pollution from excess nutrients voided in faecal matter from livestock production (Ajayi, 2014). The impact of climate change cannot be overlooked as an increasing threat to decreased crop yield, crop losses and reduced production output (FAO, 2009). According to FAO (2012) the increasing cost and decreasing supply of conventional feed stuffs, especially energy sources (required in relatively large amounts compared to protein sources) are expected to limit the future expansion of the livestock and feed industry. These reports imply that the production of crops in agro-climatic zones will either lead to surpluses in areas where there have been shortages or shortages in areas where there have been surpluses. Adegede *et al.* (2016) proposing possible solutions that can help mitigate these changes recommends amendments and restructuring of government policies and strategies; but while that is soon to come, the effective use of agro-wastes like corn cob can serve as a gap filler in meeting the need for energy feed resources for livestock if the fiber components are made available within the animal. The inadequate production of maize and the intense competition between man, industries and livestock, has led to an increased cost of poultry ration in recent years (Bolu and Ibikunle, 2008). Also, the energy fraction supplied by major ingredients is one of the highest contributory factors to the rising animal feed cost in Nigeria as stated by Nwokoro (2015). This situation continues to support the search for other alternative energy sources for use in poultry feed production and their effective utilization. Corn cob in Nigeria, is either discarded as waste or used as source of energy in cooking. Its use as a feed resource has been restricted to ruminants because of its high fibre content. Meanwhile, Božović *et al.* (2004) reported an estimate of 180 to 200 kg of corn cob per ton of grains, which translates to a significant quantity of corn cob potentially available as a feed resource. The relative availability and low cost of corn cob could be a sustainable replacement option to maize as an energy source in monogastric animal feeding, if the fibre content can be made available. It has been reported that corn cob has a dry matter (DM) of 88.5 – 90.8%, crude protein (CP) of 1.7 – 3.8%, crude fibre (CF) of 28.6 – 45.7%, and ash of 1.3 – 7.7% (Nangole *et al.,* 1983; Stanogias and Pearce, 1985; Bredon *et al.,* 1987; Donkoh *et al.,* 2003; Kanengoni *et al.,* 2004; Akinfemi, 2010). Corn cob has been evaluated by different researchers with different focus, Chimonyo *et al.*, (2001) and Mashatise *et al.*, (2005) fed corn cob to different breeds of pigs, Opeolu *et al.*, (2009) worked on its utilization as an adsorbent for industrial effluent cleaning while Raheem and Adesanya, (2011) investigated its thermal conductivity; these show that the availability of corn cob is not in question. According to Ochetim (1993), in situations where there may exist readily available high energy feed ingredients like maize, a part of the energy source could be replaced by corn cob but the level of inclusion for effective utilization and performance of birds needs to be determined. An important technique for enhancing the efficiency of feed utilization in monogastric animals according to Duru and Dafwang (2010), Midau *et al.* (2011), and Shirmohammed and Mehhri (2011) is the incorporation of multi-enzymes. Ademola *et al.,* (2013) fed Maxigrain in diets containing wheat offal, rice bran and corn bran; they concluded that enzyme supplementation of fibrous feed ingredients in feed can help ameliorate the effects of heat stress on broiler chickens in addition to maintaining their performance when compared with birds on the control diet. Maxigrain® contains cellulase 10,000 IU, beta-glucanase 200 IU, xylanase 10,000 IU and phytase 2500 FTU. Corn cob have been known to contain 38.8% cellulose, 44.4% hemicellulose and 11.9% lignin, according to Pointner *et al*. (2014). Thus, a total of about 70% of the fibre fraction of corn cobs is substrate for cellulase, xylanase and glucanase, enzymes contained in Maxigrain®. This experiment was designed to determine the growth performance and carcass cuts of Arbor Acre chickens (0-4 weeks) fed varying levels of corn cob meal supplemented with Maxigrain®.

Materials and methods

This experiment was carried out at the Teaching and Research Farm of Benson Idahosa University, Benin City, Edo state. A total of one hundred and forty-four (144), day-old Arbor acre chicks were used for the experiment. They were randomly selected and sub-divided into 6 dietary treatments of three replicates each, with eight birds in each replicate in a completely randomized design. The experiment was set in a 2x3 factorial design, with two levels of enzyme (with and without) and three replacement levels of corn cob for maize (0, 25 and 50). Lighting source was provided using electricity bulbs of 100 watts (in each pen) during the night. The birds were administered anti-stress and glucose orally at the recommended dosage after randomization before the commencement of the experiment. The birds were reared in cages in an open-sided wire mesh constructed poultry house to allow for adequate ventilation. Medications, vaccinations and other routine management practices were strictly followed according to manufacturer's recommendations. The birds were offered experimental diets and cool, clean water *ad-libitum* throughout the four weeks period of the experiment. The experimental diets were formulated to contain 0%, 25%, and 50% corn cob meal (CCM) replacing maize, with and without Maxigrain® enzyme supplementation to give experimental diets T1, T2, T3 (diets without enzyme) and T4, T5, T6 (diets with enzyme) respectively. Treatment 1 (T1) was the control diet with no corn cob meal and no enzyme inclusion, while T4 is the control diet with enzyme supplementation. Maxigrain® enzyme was supplemented at the rate of 5g per 50kg of feed as recommended by manufacturer (Table 1).

Table 1: Diet composition (g/kg)

	Treatment diets					
	Diets without enzyme			Diets with enzyme		
INGREDIENTS	T1 (0% CCM)	T2 (25% CCM)	T3 (50% CCM)	T4 (0% CCM)	T5 (25% CCM)	T6 (50% CCM)
Maize	550	412.5	275	550	412.5	275
Soyabean meal (SBM)	260	286.5	280	260	286.5	280
Brewers dried grain	50	30	16.5	50	30	16.5
Fishmeal	80	80	100	80	80	100
Corn cob meal (CCM)	0	137.5	275	0	137.5	275
Palm oil	20	20	20	20	20	20
Limestone	8	8	8	8	8	8
Bone meal	26.5	20	20	26.5	20	20
NaCl	3.5	3.5	3.5	3.5	3.5	3.5
Vitamin premix*	2	2	2	2	2	2
Maxigrain®**	0	0	0	0.1	0.1	0.1
Total	1000	100	100	1000.1	1000.1	1000.1
Calculated nutrient levels:						
ME (Kcal/Kg)	3051.61	2703.82	2352.29	3051.61	2703.82	2352.29
CP (g/kg)	227.79	226.62	225.37	227.79	226.62	225.37

*Supplied per kg of diet - Vit A, 5000ui; Vit D_3, 800iu; Vit E, 12mg; Vit B_6, 1.5mg; Pantothenic acid, 5mg; Biotin, 0.02; Vit B12, 0.01mg; Folic acid, 0.3mg; Choline Chloride, 150mg; Manganese, 60mg; Iron, 10mg; Zinc, 15mg; Copper, 0.8mg; Iodine, 0.4mg; Cobalt, 0.08mg; Selenium, 0.04mg; Anti-oxidant, 40mg.

**Supplied Cellulase 10000iu, xylanase 10000iu, Phytase 2500FTU, Protease 4000iu

Parameters measured includes feed intake, weight gain and mortality. Weekly feed intake was measured throughout the period of the experiment by subtracting the feed remaining from the feed weighed in at the beginning of the week. Weight gained was measured weekly by subtracting the final weight from the initial weight at the beginning of the week. Feed efficiency was computed by calculating the amount of feed consumed per body weight gained. Mortality, was recorded as appropriate.

Preparation of corn cob meal

Corn cobs were collected from markets and local maize processing centres in Benin, Edo state. They were sun-dried for several days, crushed and grinded with a commercial hammer mill. The resultant product, hereafter referred to as corn cob meal (CCM), was re-grinded and stored in sacks until used in feed formulations. The CCM was incorporated into broiler's diet at 0%, 25% and 50% levels, replacing maize.

Evaluation of carcass quality

At the end of the 28 days feeding trial, one bird per replicate was randomly selected (based on nearness to the average group weight) for carcass evaluation. The birds were slaughtered by severing their jugular veins with a sharp surgical knife, birds were then de-feathered, washed and weighed. The internal contents were neatly removed and weighed (evisceration) followed by the cutting of the carcass into retail parts which were also weighed. Dressing weight was recorded after evisceration. The weights were expressed as percentages of dressed weight.

Chemical analysis

Proximate analysis of the feed samples was carried out using the method described by the Association of Official Analytical Chemist (AOAC, 2004) methods of analysis.

Statistical analysis

All data were subjected to the analysis of variance (ANOVA) using GLM procedures in SAS (2004) in a completely randomized design. Significant differences among treatment means were separated by Tukey's with probability set at $P<0.05$.

Results and discussion

The proximate composition of the experimental diets is as shown in Table 2. Diets 3 and 6 that had 50%CCM replacement of maize were low in ME but had higher values for fibre contents. Enzyme supplemented diets (Diet 4, 5 and 6) had similar CP levels, and their dry matter was generally better.

Table 2: Analyzed proximate composition of experimental diets

Parameter	Experimental diets					
	1	2	3	4	5	6
ME (kcal/kg)	2932.55	2934.57	2877.13	2952.46	2943.01	2849.42
Crude protein (%)	17.20	18.55	17.65	18.20	18.20	18.25
Fat (%)	7.00	6.35	5.60	7.20	6.20	5.35
Dry matter (%)	90.90	91.70	90.65	91.90	92.15	91.75
Fibre (%)	5.20	5.25	5.30	5.10	5.15	5.35
Ash (%)	12.07	12.28	11.65	13.04	12.35	13.31

ME= Metabolizable energy, Diet 1= 0%CCM, Diet 2= 25%CCM, Diet 3= 50%CCM, Diet 4= 0%CCM + enzyme , Diet 5= 25%CCM + enzyme and Diet 6= 50%CCM +enzyme.

Table 3 shows the performance indices of Arbor acre chicks fed Maxigrain® supplemented CCM diets while Table 4 shows the effect of CCM inclusion on growth performance indices. Enzyme supplementation of diets improved feed intake (FI) from 0.84 to 1.03kg/rep/day and weight gain from 0.27 – 0.33kg/rep/day (though values are not significantly different at $p>0.05$) with diet containing

25% CCM producing similar values to those of birds fed the control diets. Feed intake (FI) decreased significantly as the level of CCM increased and though weight gain was not significantly affected by CCM, 25% replacement of maize had very similar body weight gain results. Donkoh *et al.,* (2003) reported a similar trend when they fed birds with a blood and corn cob mix, in the experiment growth performance and carcass yield did not differ markedly. They fed a blood corn cob mix at 0, 30, 60, 90 and 120g/kg and bird weights were 1.50, 1.61, 1.62, 1.56 and 1.58kg respectively. Meanwhile some years earlier Ochetim (1993) also noted same effects at an inclusion of up to 11.6% corn cob in broiler diets but also noted that a 23.2% inclusion of corn cob meal reduced significantly the weight gains, feed consumption, feed utilization, carcass yield and dressing percent of birds. The lack of significance in the performance measures could be due to the cellulose, hemicellulose and lignin content of corncob being embedded in a complex matrix that is resistant to enzymatic breakdown as reported by Pointner *et al.,* (2014). There was no significant interactive effect of Maxigrain® and CCM on the growth performance indices assessed. Also, the effect of Maxigrain® enzyme cocktail did not significantly alter the measured feed intake, body weight gain and the feed conversion ratio of birds at 0-4weeks.

Table 3: Performance characteristics of Arbor acre chicks fed corn cob meal (CCM) supplemented with a multi-enzyme (0-4 weeks)

Parameter	T1	T2	T3	T4	T5	T6	SEM
Feed Intake kg/rep/day	0.99	0.84	0.84	1.03	0.99	0.81	0.22
Weight gain kg/rep /day	0.29	0.28	0.27	0.32	0.33	0.26	0.17
FCR	3.41	3.00	3.11	3.20	3.00	3.11	1.29

SEM= Standard Error of Mean, T1= treatment 1(0%CCM), T2= treatment 2(25%CCM), T3= treatment 3(50%CCM), T4= treatment 4(0%CCM + enzyme), T5= treatment 5(25%CCM + enzyme) and T6= treatment 6(50%CCM +enzyme)

The inclusion of CCM in the diets on the other hand, reduced feed intake remarkably (Table 4) but did not affect weight gain across treatments. There was a significant decrease ($p>0.05$) in feed consumption as the corn cob inclusion level increased. This is in agreement with the work of Ochetim, (1993) where he reported on a significant reduction at 23.2% inclusion level but with supplementation with Maxigrain and 25%CCM, the effect was no longer significant and growth parameters were comparable with the control. This could mean that with increased enzyme concentration, there could be further improvement in the digestibility of corn cob and its utilization in broiler chickens though a similar effect was recorded by Malik *et al.,* (2016) when they used Maxigrain® to supplement water hyacinth meal (WHM) in growing pullets.

Table 4: Effect of CCM inclusion on performance characteristics (0-4 weeks)

Parameter	0%	25%	50%	SEM
Feed Intake kg/rep/day	1.01^{a}	0.92^{ab}	0.83^{b}	0.10
Weight gain kg/rep /day	0.31	0.30	0.26	0.06
FCR	3.25	3.06	3.19	1.66

^{ab} Means in the same row with different superscripts are significantly different at $p<0.05$
SEM = Standard Error of Mean, CCM= Corn cob meal, FCR = Feed Conversion Ratio

The results of the treatment diets on carcass (dressed percent, breast, wing and drumstick) were not affected by enzyme supplementation as shown in Table 5, and CCM inclusion had significant effect on the dressed percent as seen in Table 6. These are

similar results to those of Aguihe, *et al.,* (2016) though with a different substrate (cassava peel meal), organ and carcass characteristics were improved without any adverse effects on birds.
With CCM inclusion, dressed percent decreased with increase from 0% to 50%, significantly though breast, wing and drumstick were not markedly affected by CCM nor by the enzyme Maxigrain®. Values obtained for dressed percent and drumstick were better with enzyme supplementation in diets.

Table 5: Effect of enzyme on Arbor acre chicken carcass parts at the 4th week

Enzyme level	Dressed %	Breast (%)	Wing (%)	Drumstick (%)
0 (g/kg)	72.8	19.56	10.47	12.67
0.1 (g/kg)	73.4	19.02	10.91	13.05
SEM	2.27	1.72	1.05	0.77

SEM= Standard Error of Mean

Table 6: Effect of CCM on Arbor acre cut parts at the 4th week

CCM level	Dressed %	Breast (%)	Wing (%)	Drumstick (%)
0%	74.91^{a}	20.1	10.82	12.67
25%	72.68^{ab}	19.1	10.68	12.96
50%	71.77^{b}	18.66	10.56	12.96
SEM	2.27	1.72	1.05	0.77

^{ab} Means in the same row with different superscripts are significantly different at p<0.05
SEM= Standard Error of Mean

Inclusion of CCM generally decreased dressed percent, breast, wing and drumstick. The interaction between enzyme and CCM however, shows an improvement in the live weight of birds fed 25%CCM with enzyme (Figure 1).

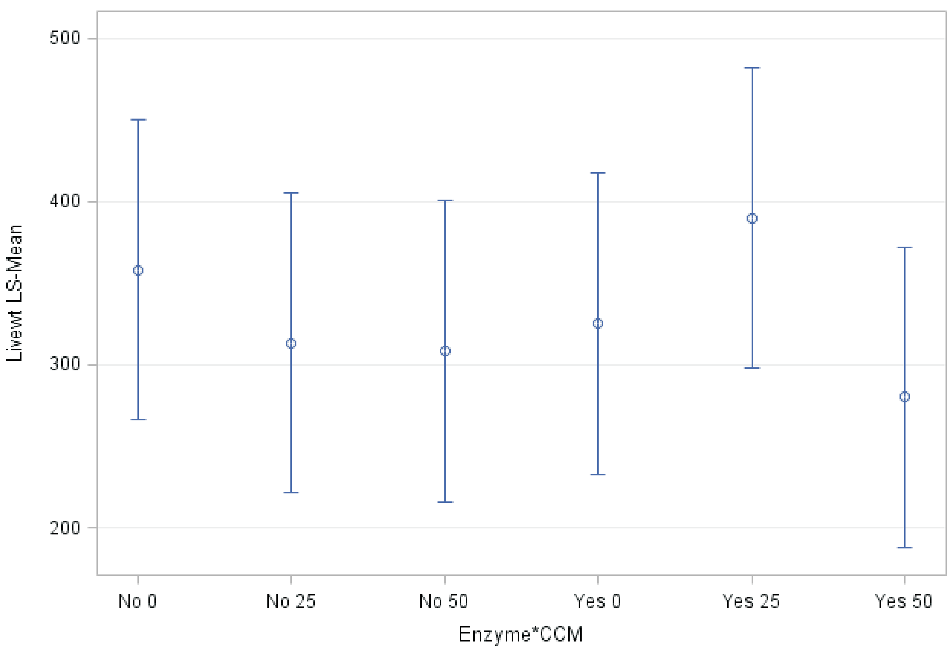

Figure 1: Interaction effect of enzyme and CCM on live weight of broiler chicks at 4 weeks

Conclusion

In conclusion, CCM can be fed to broiler chicks with no negative effects for up to 28 days when a mix of cellulase, β-glucanase and xylanase enzymes are added to the diets. Also, a 25% inclusion of corn cob meal supplemented with Maxigrain® produced similar effects, in terms of growth performance, to birds fed a control diet without CCM. Since birds fed the 50% CCM level performed poorly, the optimum replacement level of maize with CCM could be a level between 25% and 50% and this calls for more investigation to determine optimum level of CCM inclusion in broiler chicken diets.

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