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PERFORMANCE AND COST BENEFIT OF BROILER CHICKENS FED DIETARY LEVELS OF QUALITY PROTEIN MAIZE AS REPLACEMENT FOR NORMAL MAIZE

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ABSTRACT
An experiment was carried out to evaluate the performance and cost benefits of broiler chickens fed dietary levels of Quality Protein Maize (QPM) as replacement for normal maize. Five diets were formulated in which QPM replaced normal maize at 0, 25, 50, 75 and 100% levels. The diets were designated as D1, D2, D3. D4 and D5, respectively. Two hundred and forty (240) day-old Abor Acre broiler chickens were allotted to 5 diets in replicates of 4 containing 12 birds each in a completely randomized design. Feed and water were provided *ad libitum* and the study lasted for 42 days. Results showed a significant ($P<0.05$) effect of QPM on daily weight gain, feed conversion ratio, final weight and total weight gain at the finisher phase. Birds on D3 (59.68g), D4 (61.74g) and D5 (64.35g) which were the same and comparable with D1 (54.96g), had significantly ($P<0.05$) higher daily weight gain than those on D2 (51.44g). Total weight gain of birds on D5 (1800.28g), D4 (1735.55g), D3 (1728.28g), which were the same, was higher ($P<0.05$) than on D1 (1601.66g) and D2 (1585.44g), which were also the same. Feed cost per kg was higher (₦365.76 – 396.60) in QPM-based diets than the control (₦355.44). However, feed cost per kg gain was lower (₦797.75 – 828.04) in diets containing 50% and above QPM as replacement for normal maize compared to the control (₦844.17). The highest cost saving of ₦46.42 (5.5%) was obtained on D3. It was therefore concluded that QPM can completely replace normal maize in broiler chicken diets with marked reduction in feed cost. However, 50% replacement level appeared to be the most economical.

Keywords: Performance, Quality protein maize, Cost benefit, Normal maize, Replacement.

INTRODUCTION
The contribution of broiler chickens as an outstanding source of dietary animal protein has been globally acknowledged. Broiler chickens are raised specifically, for meat production. They are most efficient converters of feed into animal protein in comparison to other domestic animals (Tirwari *et al*., 2013). In Nigeria, the poultry industry, generally, contributes about 25% of the Agricultural Gross Domestic Product (Edeh *et al.*, 2020). Although bedevilled by grave challenges, the industry has great potentials for development. One of these challenges has been that of feed cost which accounts for about 75% of the total cost of production (Asaniyan and Ogundele, 2020). Conventional feed ingredients, especially maize and soya bean, which are hitherto the principal/conventional energy and protein sources in poultry diets have become competitive and expensive. Thus, the need to explore the use of other alternative ingredients that will cut down cost of production. Earlier studies have shown that millet, irrespective of the variety, has the potentials to replace maize in poultry diets (Bulus *et al.*, 2014; Kawu *et al*. 2020 and Bot *et al.*, 2021).

Similarly, sorghum, at various levels and or processing methods has been used to reduce feed cost in broiler chickens (Tandiang *et al.*, 2014; Mohammed and Talha, 2016; and

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Daramola *et al.*, 2021). Studies have also shown that some maize varieties/cultivars, particularly, Quality Protein Maize (QPM), contains more lysine and tryptophan than normal maize (NM) (Panda *et al.*, 2013). Arumugasami *et al.* (2023) posited that QPM contains 11% CP and has a 50% higher level of lysine than regular maize. Previous studies have also demonstrated that feeding QPM-based diets resulted in improved or comparable production performance compared with feeding normal maize (NM)-based diets under varying conditions (Onimisi *et al.*, 2008; Panda *et al*., 2010; 2011 and 2012). However, literature on recent studies conducted under tropical conditions are limited. This study was therefore designed to determine the performance and cost benefits of broiler chickens fed dietary replacement of Quality Protein Maize as replacement for normal or regular maize.

MATERIALS AND METHODS

The study was conducted at the Poultry Teaching and Research Unit, Abubakar Tafawa Balewa University, Bauchi, Bauchi State. The area lies between latitude 10^0, 17^0N, longitude 9^0 49^0E and at altitude of 902 meters above the sea level.

Experimental Diets

Five (5) experimental diets were formulated in which QPM replaced normal maize at 0, 25, 50, 75 and 100% levels, designated as D1, D2, D3. D4 and D5 respectively (Tables 1 and 2). Full fat soya bean was the main plant protein source. Other feed ingredients include, fish meal, wheat offal, limestone, bone meal, vitamin/mineral premixes, lysine, methionine and salt. The starter and finisher diets contain 23 and 20% levels of crude protein respectively.

Table 1: Ingredients and Composition (%) of Experimental Diets Containing QPM as Replacement for Normal Maize Fed to Starter Broiler Chickens (3 – 5 weeks)

	Diets				
Ingredients	**D1**	**D2**	**D3**	**D4**	**D5**
Normal Maize	45.73	34.29	22.87	11.43	0.00
Quality Protein Maize	0.00	11.44	22.86	34.30	45.73
Full Fat Soya Bean	33.57	33.57	33.57	33.57	33.57
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Fish Meal	5.00	5.00	5.00	5.00	5.00
Borne Meal	2.50	2.50	2.50	2.50	2.50
Limestone	2.50	2.50	2.50	2.50	2.50
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00	100.00

ME = Metabolizable Energy

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Table 1: Ingredients and Composition (%) of Experimental Diets Containing QPM as Replacement for Normal Maize Fed to Starter Broiler Chickens (3 – 5 weeks) **Cont'd.**

	Diets				
Ingredients	**D1**	**D2**	**D3**	**D4**	**D5**
Calculated analysis (%)					
ME (kcal/kg)	2989.20	2989.20	2989.20	2989.20	2989.20
Crude protein	23.00	23.03	23.07	23.11	23.15
Crude fibre	2.91	2.91	2.91	2.91	2.91
Ether extract	8.45	8.45	8.45	8.45	8.45
Lysine	1.34	1.36	1.38	1.40	1.42
Methionine	0.51	0.51	0.51	0.51	0.51
Calcium	2.20	2.20	2.20	2.20	2.20
Phosphorus	0.80	0.80	0.80	0.80	0.80

ME = Metabolizable Energy

Table 2: Ingredients and Composition (%) of Experimental Diets Containing QPM as Replacement for Normal Maize Fed to Finisher Broiler Chickens (6 – 8 weeks)

	Diets				
Ingredients	**D1**	**D2**	**D3**	**D4**	**D5**
Normal Maize	52.10	39.07	26.05	13.03	0.00
Quality Protein Maize	0.00	13.03	26.05	39.07	52.10
Full Fat Soya Bean	27.00	27.00	27.00	27.00	27.00
Wheat Offal	12.00	12.00	12.00	12.00	12.00
Fish Meal	3.00	3.00	3.00	3.00	3.00
Borne Meal	3.00	3.00	3.00	3.00	3.00
Limestone	2.00	2.00	2.00	2.00	2.00
Premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Total	100.00	100.00	100.00	100.00	100.00

ME = Metabolizable energy

Table 2: Ingredients and Composition (%) of Experimental Diets Containing QPM as Replacement for Normal Maize Fed to Finisher Broiler Chickens (6 – 8 weeks) **Cont'd.**

	Diets				
Ingredients	**D1**	**D2**	**D3**	**D4**	**D5**
Calculated analysis (%)					
ME (kcal/kg)	3007.60	3007.60	3007.60	3007.60	3007.60
Crude protein	20.00	20.03	20.07	20.11	20.15
Crude fibre	3.58	3.58	3.58	3.58	3.58
Ether extract	7.50	7.50	7.50	7.50	7.50
Lysine	1.22	1.25	1.27	1.29	1.31
Methionine	0.52	0.52	0.52	0.52	0.52
Calcium	2.07	2.07	2.07	2.07	2.07
Phosphorus	0.71	0.71	0.71	0.71	0.71

ME = Metabolizable energy

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Management of Experimental Animals

Two hundred and forty (240) day-old Abor Acre broiler chickens purchased from a reputable hatchery were brooded for two weeks and allotted to 5 diets in replicates of 4 containing 12 birds each in a completely randomized design. Feed and water were provided *ad libitum* and the study lasted for 42 days. Routine vaccination and sanitary measures were all carried out as recommended.

Data collection

Performance characteristics which include; daily feed intake, daily weight gain and feed conversion ratio were measured. Daily feed intake was determined by the difference between weight of feed offered and that of left-over collected after 24 hours. Body weight gain, by difference between two consecutive weighing (one-week interval) while feed conversion ratio was computed using the relationship between feed intake and weight gain. Data collected for cost benefit analysis were; feed cost per kg, total feed cost, feed cost per kg gain and cost saving.

Data Analysis

All data, except for cost benefit analysis, was subjected to One Way Analysis of Variance (ANOVA) using IBM SPSS statistics 25 for windows (SPSS, 2017). Means were separated through the Duncan Multiple Range Test of the same software, at $P<0.05$ level of significance.

RESULTS AND DISCUSSION

The result of growth performance of broiler chickens fed dietary QPM as replacement for normal maize is presented in Table 3. At both the starter and overall phases, no significant influence of QPM was observed among diets. Initial weight of birds was between 160.83 and 174.17g. Daily feed intake (DFI) which did not differ significantly among of birds at the starter phase, ranged between 53.34g (D3) and 57.81g (D2), daily weight gain (DWG) from 20.91g (D4) to 24.06g (D2) and feed conversion ratio (FCR) from 2.37 to 2.64 in D3 and D1 respectively. At the finisher phase, however, birds fed D3 (59.68g), D4 (61.74g) and D5 (64.35g) which were the same and comparable with D1 (54.96g), had significantly ($P<0.05$) higher daily weight gain than those on D2 (51.44g). Similarly, FCR was better and the same in birds fed D5 (1.86), D4 (1.99) and D3 (2.03) than those on D1 (2.26) and D2 (2.31). These findings are in contrast with Tyagi *et al.* (2008) and Panda *et al.,* (2011) who reported non-significant effect of QPM as replacement for normal maize on the performance indices of broiler chickens. Birds on D5 (1974.45g) had the highest ($P<0.05$) final weight, followed by D4 (1898.05g) which did not differ from D3 (1890.78g) and D1 (1762.49g). Diet 4 (1748.77g) gave the lowest final weight and was comparable with D1 and D3.

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Table 3: Performance of Broiler Chickens Fed Dietary Quality Protein Maize as Replacement for Normal Maize (3 – 8 weeks)

	Diets					
Parameter	**D1**	**D2**	**D3**	**D4**	**D5**	**SEM**
Starter phase						
Initial weight (g)	160.83	163.33	162.5	162.5	174.17	4.47^{NS}
Wk. 3 weight (g)	608.33	668.53	637.5	601.51	623.1	22.36^{NS}
DFI (g)	56.4	57.81	53.34	54.45	56.16	0.96^{NS}
DWG (g)	21.31	24.06	22.62	20.91	21.38	1.07^{NS}
FCR	2.64	2.4	2.37	2.6	2.63	0.09^{NS}
Mortality (no.)	0	1	1	1	0	-
Finisher Phase						
Final weight (g)	1762.49^{bc}	1748.77^{c}	1890.78^{bc}	1898.05^{b}	1974.45^{a}	47.18*
DFI (g)	124.35	118.65	121.33	123.06	119.86	2.01^{NS}
DWG (g)	54.96^{ab}	51.44^{b}	59.68^{a}	61.74^{a}	64.35^{a}	1.87*
FCR	2.26^{b}	2.31^{b}	2.03^{a}	1.99^{a}	1.86^{a}	0.06*
Mortality (no.)	4	3	1	3	2	-
Overall phase						
TWG (g)	1601.66^{b}	1585.44^{b}	1728.28^{a}	1735.55^{a}	1800.28^{a}	25.16*
TFI (g)	3795.96	3705.66	3668.28	3727.92	3696.42	42.57^{NS}
DFI(g)	90.38	88.23	87.34	88.76	88.01	1.08^{NS}
DWG (g)	38.14	37.75	41.15	41.33	42.87	1.72^{NS}
FCR	2.37	2.34	2.12	2.15	2.05	0.14^{NS}
Mortality (no.)	4	4	2	4	2	-

DFI = Daily feed intake, DWG = Daily weight gain, FCR = Feed conversion ratio, TWG = Total weight gain, SEM = Standard Error of Means, NS = Not significant.

In Table 3, higher weights recorded in birds on QPM-based could be informed by the relatively higher content of some essential amino acids such as lysine and tryptophan in QPM (Arumugasami *et al.*, 2023). Total weight gain of birds on D5 (1800.28g), D4 (1735.55g), D3 (1728.28g), which were the same, was higher ($P<0.05$) than that of birds fed D1 (1601.66g) and D2 (1585.44g), which were also the same.

Results for cost benefit analysis of using QPM to replace dietary normal maize in broiler chicken diets is presented in Table 4. Total feed intake of birds on D1 (3.8kg) was higher than D4 (3.73kg), then D2 (3.71kg), D5 (3.70kg) and D3 (3.67kg) in that order. Feed cost per kg was higher (₦365.76 – 396.60) in QPM-based diets than the control (₦355.44). This was informed by the higher price of QPM over normal maize. Total feed cost per bird was also higher in diets containing QPM (₦1356.67 – 1467.42). However, feed cost per kg gain was lower (₦797.75 – 828.04) in diets containing 50% and above QPM as replacement for normal maize compared to the control (₦844.17). This was due to higher total weight gain obtained in birds fed these diets. The highest cost saving of ₦46.42 (5.5%) was made on D3. This confirms an earlier report by Nyanamba *et al.* (2003) which indicated that QPM can replace normal maize in broiler chicken diets with 5% reduction in feed cost. The result of current study implies that although QPM can completely replace normal maize in broiler chicken diets, the best and economical level is at 50%.

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Table 4: Cost Benefit of Replacing Normal Maize with Quality Protein Maize in Broiler Chicken Diets

	Diets				
Parameters	**D1**	**D2**	**D3**	**D4**	**D5**
Total Feed Intake	3.80	3.71	3.67	3.73	3.70
Feed cost (₦/kg)	355.44	365.76	376.05	386.27	396.6
Total feed cost (₦)	1350.67	1356.97	1380.1	1440.79	1467.42
Total weight gain (kg)	1.60	1.59	1.73	1.74	1.80
Feed cost/kg gain (₦)	844.17	853.44	797.75	828.04	815.23
Cost saving (₦)	-	-9.27	46.42	16.13	28.94
Percent cost saving	-	-1.09	5.50	1.91	3.43

CONCLUSION AND RECOMMENDATIONS

Based on the results of this study, it was concluded that Quality Protein Maize can completely replace normal maize in the diets of broiler chickens without any negative effect on performance characteristics. Furthermore, the use of QPM as energy source in broiler chicken diets at 50% and above can reduce feed cost. For economic reason, the best replacement level is 50% and therefore recommended for poultry farmers and feed millers.

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