



## Performance and Carcass Characteristics of Broiler Chickens Fed Diets Containing Whole Grains of *Gayamba* Pearl Millet (*Pennisetum glaucum*)

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### Abstract

A Study was carried out to investigate the growth performance and carcass characteristics of broiler chickens fed diets containing graded levels of whole gayamba pearl millet (WGGM). Five diets were formulated in which WGGM replaced milled gayamba millet (MGM) at 0, 5, 10, 15 and 20% levels, coded as diets 1, 2, 3, 4 and 5 respectively. A total of three hundred and fifty broiler chicks were randomly allotted to five diets in a completely randomized design. Each treatment consists of 70 chicks and replicated five times to contain 14 birds each. Feed and water were provided ad libitum throughout the experimental period which lasted for 49 days. Results of productive performance revealed that final weights were higher ( $P < 0.05$ ) on diets 2, 3 and 1. A similar trend was also observed for total weight gain. Significant ( $P < 0.05$ ) differences were also observed for overall daily weight gain (DWG) and feed conversion ratio (FCR). Daily weight gain was significantly ( $P < 0.05$ ) higher in birds fed diets 1 (35.83g), 2 (36.27g) and 3 (36.36g) than the values of 30.91 and 32.78g obtained on diets 5 and 4 respectively. Feed conversion ratio was also better in birds fed diets 1 (2.20), 2 (2.23) and 3 (2.18) and poorer on diets 4 and 5 with a value of 2.51 each. Carcass characteristics revealed a significant ( $P < 0.05$ ) influence of diet on carcass weight and dressing percentage in favour of diets 1, 2 and 3, while relative weights of proventriculus and gizzard were higher on diets 4 and 5. Abdominal fat weight was highest ( $P < 0.05$ ) in birds fed diet 5 and lowest on diet 4. It was therefore concluded that whole gayamba millet can replace the milled form at up to 10% level in broiler chicken diets without compromising growth performance and carcass yield.

**Keywords:** Performance, Carcass characteristics, Broiler chickens, whole grain *Gayamba* millet.

### Introduction

Feed cost accounts for about 65 – 70% of the cost of broiler chicken or egg production, and therefore any mechanism that lowers down this cost attracts the attention of poultry researchers and producers (Singh, 2013). One type of feeding programme that has been used to reduce handling and processing costs of feeds, has been the feeding of whole cereal grains (WCG) along with a balanced concentrate (Garcia and Dale, 2006; Gabriel *et al.*, 2008; Senkoylu *et al.*, 2009; Liu *et al.*, 2015; Mabelebele *et al.*, 2018). The system has also been shown to

improve dietary energy utilization (Hetland *et al.*, 2002; Liu *et al.*, 2015; Abdollahi *et al.*, 2016), gut health (Cumming, 1989; Ferket, 2000; Enberg *et al.*, 2004; Singh, 2013) and digestive function (Svihus *et al.*, 2002; Amerah *et al.* 2007; Frikha *et al.*, 2011; Bozkurt *et al.*, 2019). However, according to Liu *et al.*, (2015), numerous factors could influence the magnitude of broiler responses to whole grain feed regimes. In general terms, the characteristics of the grain (crude fibre content, grain texture and anti-nutritional factors) to be fed

whole are very key in determining the performance and visceral characteristics.

Mabelebele *et al.*, (2018) observed that feed conversion of broiler chickens at 35 days was poorer on diets containing whole sorghum. Body weight gain decreased at inclusion rate above 25% while no significant difference was observed in feed intake. Similarly, except for the combined weight of gizzard and proventriculus, the workers reported no significant effect of whole grain sorghum on visceral organs. Birds fed diets containing whole grain sorghum had higher relative weights of gizzard and proventriculus. In some earlier studies (Plavnik *et al.*, 2002; Wu *et al.*, 2004; Ravindran *et al.*, 2006; Liu *et al.*, 2015), inclusion of whole grain wheat was shown to increase gizzard weight by 38.1%. Using barley as the whole grain component of the diet, Biggs and Parsons (2009) reported that 20% inclusion of barley increased gizzard weights by 50.0%.

The effect of incorporation of whole triticale (Jones and Taylor, 2001) and wheat (Svihus *et al.*, 2010) grains on growth performance of broiler chickens revealed no influence on body weight gain. However, feed intake and feed conversion ratio were reduced by 2.97 and 2.55% respectively. Using whole pearl millet grain, Hidalgo *et al.* (2004) observed that 10% inclusion level in broiler chicken diets does not affect performance. Similarly, Akinola *et al.* (2015) substituted whole pearl millet grain for maize up to 60% level in broiler diets and reported no significant difference in weight gain. In a more recent study, Cisse *et al.*, (2017) showed that whole grain Malian pearl millet fed to broiler chickens (1-14 days of age) above 14% level resulted in lower weight gain and feed efficiency. However, at 28 – 42 days of age, no significant differences in body

weight gain and feed conversion ratio were recorded. Furthermore, the results indicated that relative weight of gizzard was higher in birds fed 28 and 43% whole millet. However, literature on the utilization of whole grain *gayamba* pearl millet in poultry diets appears to be limited. Available reports (Kawu *et al.*, 2016; Tok *et al.*, 2018; Kawu *et al.*, 2019; Kawu *et al.*, 2020) on the use of *gayamba* millet in broiler chicken diets borders only on the milled form. Consequently, this study was designed to evaluate the performance and carcass characteristics of broiler chickens fed diets containing unground *gayamba* millet.

### Materials and Methods

The experiment was carried out at the Poultry Unit, Teaching and Research Farm, Abubakar Tafawa Balewa University, Bauchi, Nigeria. The area lies within the coordinates; 10° 18' 37.2" N and 9° 50' 38.0" E. Its location is about 616 metres above sea level with an average annual rainfall of 1009 mm and daily temperatures of 13 - 17° C (December – January) and 36 – 37° C (March – April) (Geodatos, 2019). *Gayamba* pearl millet was procured from Bogoro in Bauchi state.

Five experimental diets containing 0, 5, 10, 15, and 20% whole *gayamba* pearl millet grain as replacement for the ground form were formulated for both the starter (23% CP) and finisher (20% CP) phases. The diets were coded 1, 2, 3, 4 and 5 respectively. Diet 1(control) contained ground *gayamba* pearl millet as the main energy component while Soya bean meal, groundnut cake meal and fish meal were the major protein sources. Percentage composition of ingredients and calculated analyses of experimental diets are presented in Tables 1 and 2.

A total of three hundred and fifty (350) unsexed, broiler chicks of the Cobb 500

strain were brooded and randomly allotted to the five dietary treatments with 5 replicates of 14 birds each in a completely randomized design. The birds were housed in a well-ventilated

**Table 1: Ingredients and Calculated Composition (%) of Diets Containing Whole *Gayamba* Millet Fed to Broiler Chickens at the Starter Phase**

Ingredient	DIETS				
	Levels of whole grain <i>gayamba</i> millet (%)				
	1 (0)	2 (5)	3 (10)	4 (15)	5 (20)
Milled <i>Gayamba</i> pearl millet	47.21	44.85	42.49	40.13	37.77
Whole <i>Gayamba</i> pearl millet	0.00	2.36	4.72	7.08	9.44
Soya bean meal	18.22	18.22	18.22	18.22	18.22
Groundnut Cake	15.07	15.07	15.07	15.07	15.07
Wheat Offal	10.00	10.00	10.00	10.00	10.00
Fish Meal	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
TOTAL	100	100	100	100	100
<b>Calculated Analysis (%)</b>					
Metabolizable Energy (ME/kcal)	2897.08	2897.08	2897.08	2897.08	2897.08
Crude protein	23.00	23.00	23.00	23.00	23.00
Crude fibre	3.32	3.32	3.32	3.32	3.32
Ether extract	6.45	6.45	6.45	6.45	6.45
Calcium	1.64	1.64	1.64	1.64	1.64
Phosphorus	0.71	0.71	0.71	0.71	0.71
Methionine	1.27	1.27	1.27	1.27	1.27
Lysine	0.66	0.66	0.66	0.66	0.66

deep litter pen, partitioned into 25 units of 3.5 m x 2 m each. Feed and water were served *ad libitum* and the study lasted for 49 days of 4 and 3 weeks starter and finisher phases respectively. All other routine management practices such as vaccinations and proper sanitation were observed according to standards.

Daily feed intake was determined using the difference between feed offered and weight of left-over collected the following morning. Weight gain on the other hand, was measured on weekly

basis as the difference between two consecutive weighing, while feed conversion ratio was computed using the relationship between daily feed intake and daily weight gain. Mortality was recorded as it occurred.

At the end of the study, fifty birds (2 per replicate) were randomly selected, tagged, starved for 12 hours and bled for carcass and organ analysis. Prior to slaughter, the live weight of each bird was measured. Similarly, after scalding, plucking and evisceration,

**Table 2: Ingredients and calculated Composition (%) of Diets Containing Whole *Gayamba* Millet fed to Broiler Chickens at the Finisher Phase**

Ingredient	DIETS				
	Levels of whole grain <i>gayamba</i> millet (%)				
	1 (0)	2 (5)	3 (10)	4 (15)	5 (20)
Milled <i>gayamba</i> pearl millet	51.17	48.62	46.05	43.50	40.95
Whole <i>gayamba</i> pearl millet	0.00	2.55	5.12	7.67	10.22
Soya bean meal	15.00	15.00	15.00	15.00	15.00
Groundnut Cake	10.33	10.33	10.33	10.33	10.33
Wheat Offal	15.00	15.00	15.00	15.00	15.00
Fish Meal	4.00	4.00	4.00	4.00	4.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30
Lysine	0.20	0.20	0.20	0.20	0.20
<b>TOTAL</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>
<b>Calculated Analysis (%)</b>					
Metabolizable energy (ME/kcal)	2954.08	2954.08	2954.08	2954.08	2954.08
Crude protein	20.00	20.00	20.00	20.00	20.00
Crude fibre	3.77	3.77	3.77	3.77	3.77
Ether extract	6.59	6.59	6.59	6.59	6.59
Calcium	1.67	1.67	1.67	1.67	1.67
Phosphorus	0.73	0.73	0.73	0.73	0.73
Methionine	1.24	1.24	1.24	1.24	1.24
Lysine	0.63	0.63	0.63	0.63	0.63

weights of carcasses were measured. This was accomplished by the use of a weighing balance. Dressing percentage

(DP) was calculated using the relationship:

$$DP = \frac{CW}{LW} \times 100\%. \text{ Where, CW = Carcass weight and LW = Live weight}$$

Organ weights were determined using a 1000g–capacity electronic scale and thereafter expressed as percentage of live weights.

All the data collected were analysed using the analysis of variance (ANOVA) statistical tool. SPSS version 25 was used in this process and where significant differences in means were observed, the Duncan post-hoc interface of the software was used to separate them.

### Results and Discussion

Growth performance of broiler chickens fed diets containing whole grain *gayamba* pearl millet as replacement for the ground form is presented in Table 3. Initial weight of birds (118.55 – 125.42g) used in the study did not differ. However, a significant ( $P < 0.05$ ) influence of diet on starter weight was

observed. Birds on the control diet (763.87g) had the highest ( $P<0.05$ ) mean weight which was similar to those on diets 2 (705.16 g) and 3 (746.13 g). The lowest weight was recorded in the group on diet 5 (615.32g) which was similar to those diet 4 (684.15g). Final weight, which was also significantly ( $P<0.05$ ) affected, showed that diets 2 (1790.61g) and 3 (1807.68g) were higher ( $P<0.05$ ) and similar to the control (1788.43g) while diets 4 (1636.79g) and 5 (1545.49g) which were similar, had

lower values. However, these values did not differ from the control. Total weight gain followed the same trend with final weights. Birds on diets 1(1024.55g), 2 (1085.45g) and 3 (1061.55g) which were similar, outweighed those on diets 4 (952.64g) and 5 (930.17g) which were also similar. These observations are in tandem with Hidalgo *et al.* (2004) who reported that 10% inclusion level of whole grain pearl millet did not affect performance of broiler chickens.

**Table 3: Performance of Broiler Chickens Fed Diets Containing Whole Gayamba Millet**

Parameters	Diets					SEM
	Levels of whole grain <i>gayamba</i> millet (%)					
	1 (0)	2 (5)	3 (10)	4 (15)	5 (20)	
<b>Productive performance</b>						
Initial weight (g)	123.64	121.19	125.42	118.55	124.53	6.567 <sup>NS</sup>
Week 4 weight (g)	763.87 <sup>a</sup>	705.16 <sup>ab</sup>	746.13 <sup>ab</sup>	684.15 <sup>bc</sup>	615.32 <sup>c</sup>	53.90*
Final weight (g)	1788.43 <sup>ab</sup>	1790.61 <sup>a</sup>	1807.68 <sup>a</sup>	1636.79 <sup>b</sup>	1545.49 <sup>b</sup>	94.86*
Total weight gain (g)	1024.55 <sup>ab</sup>	1085.45 <sup>a</sup>	1061.55 <sup>a</sup>	952.64 <sup>b</sup>	930.17 <sup>b</sup>	76.15*
<b>Starter phase (2 – 5 weeks)</b>						
Daily feed intake (g)	46.92 <sup>a</sup>	48.06 <sup>a</sup>	47.21 <sup>a</sup>	45.18 <sup>b</sup>	41.23 <sup>b</sup>	3.17*
Daily weight gain (g)	22.87 <sup>a</sup>	20.86 <sup>a</sup>	22.17 <sup>a</sup>	20.20 <sup>a</sup>	17.53 <sup>b</sup>	2.00*
Feed conversion ratio	2.06	2.32	2.15	2.25	2.36	0.24 <sup>NS</sup>
Mortality (No.)	1	1	0	0	0	-
<b>Finisher phase ( 6 – 8 weeks)</b>						
Daily feed intake (g)	110.26 <sup>ab</sup>	106.02 <sup>b</sup>	110.82 <sup>ab</sup>	118.77 <sup>a</sup>	114.01 <sup>ab</sup>	8.09*
Daily weight gain (g)	48.79 <sup>ab</sup>	51.69 <sup>a</sup>	50.55 <sup>a</sup>	45.36 <sup>b</sup>	44.29 <sup>b</sup>	3.62*
Feed conversion ratio	2.27 <sup>a</sup>	2.05 <sup>a</sup>	2.22 <sup>a</sup>	2.63 <sup>b</sup>	2.58 <sup>b</sup>	0.23*
Mortality (No.)	0	0	0	0	0	-
<b>Overall phase (2 – 8 weeks)</b>						
Daily feed intake (g)	78.59	77.04	79.01	81.98	77.62	4.36 <sup>NS</sup>
Daily weight gain (g)	35.83 <sup>a</sup>	36.27 <sup>a</sup>	36.36 <sup>a</sup>	32.78 <sup>b</sup>	30.91 <sup>b</sup>	2.11*
Feed conversion ratio	2.20 <sup>a</sup>	2.13 <sup>a</sup>	2.18 <sup>a</sup>	2.51 <sup>b</sup>	2.51 <sup>b</sup>	0.16*
Mortality (No.)	1	1	0	0	0	

<sup>a, b, c</sup> Means bearing different superscripts within the same row differ; \* = ( $P<0.05$ ); ns= Not significant; SEM = Standard Error of the Mean

Except for feed conversion ratio (FCR) which showed no significant ( $P>0.05$ ) dietary WGGM effects, both daily feed intake (DFI) and daily weight gain (DWG) were significantly ( $P<0.05$ )

influenced during the starter phase. Daily feed intake was higher but similar for the groups on diets 1 (46.92g), 2 (48.06g) and 3 (47.21g) than those on 4 (45.18g) and 5 (41.23g) which also did not differ



from each other. This finding contradicts the report of Jones and Taylor (2001) which showed that feed intake was reduced by 2.97% when whole grain triticale was incorporated into broiler chicken diets. Mean values for DWG were similar but higher for groups on diets 1 (22.87g), 2 (20.86g) 3 (22.17g) and 4 (20.20g) than those on diet 5 (17.53g). This disagrees with Svihus *et al.* (2010) who reported no significant ( $P>0.05$ ) effect on weight gain when

whole grain wheat was incorporated in broiler chicken diets. It is also in contrast with Akinola *et al.* (2015) whose findings revealed no significant ( $P>0.05$ ) influence of whole grain millet inclusion up to 60% level in broiler chicken rations. Feed conversion ratio ranged from 2.06 for the group on diet 1 to 2.36 for those on diet 5. A mortality figure of two (one from each of diets 1 and 2 groups) were recorded at the starter phase.

**Table 4: Carcass and Organs Characteristics of Broiler Chickens Fed Diets Containing Whole Gayamba Millet**

Parameters	Diets					SEM
	Levels of whole grain <i>gayamba</i> millet (%)					
	1 (0)	2 (5)	3 (10)	4 (15)	5 (20)	
Live weight (g)	1820.48 <sup>a</sup>	1842.58 <sup>a</sup>	1807.10 <sup>a</sup>	1637.79 <sup>b</sup>	1559.17 <sup>b</sup>	97.00*
Carcass weight (g)	1327.52 <sup>a</sup>	1348.21 <sup>a</sup>	1299.33 <sup>a</sup>	1077.64 <sup>b</sup>	1039.03 <sup>b</sup>	93.58*
Dressing (%)	72.88 <sup>a</sup>	73.12 <sup>a</sup>	71.78 <sup>a</sup>	65.73 <sup>b</sup>	66.62 <sup>b</sup>	1.97*
<b>Organ weights expressed as percentage of live weight</b>						
Lungs weight	0.49	0.52	0.50	0.48	0.55	0.13 <sup>NS</sup>
Kidney weight	0.16	0.18	0.17	0.17	0.19	0.05 <sup>NS</sup>
Liver weight	1.91	2.02	1.85	2.02	1.91	0.22 <sup>NS</sup>
Spleen weight	0.06	0.07	0.06	0.07	0.06	0.03 <sup>NS</sup>
Heart weight	0.42	0.43	0.39	0.45	0.42	0.06 <sup>NS</sup>
Proventriculus	0.68 <sup>c</sup>	0.63 <sup>c</sup>	0.75 <sup>bc</sup>	0.81 <sup>ab</sup>	0.91 <sup>a</sup>	0.13*
Gizzard weight	2.04 <sup>c</sup>	1.89 <sup>c</sup>	2.26 <sup>bc</sup>	2.44 <sup>ab</sup>	2.73 <sup>a</sup>	0.39*
Small intestine weight	5.11	5.76	5.13	5.68	5.20	1.23 <sup>NS</sup>
Large intestine weight	0.19	0.25	0.19	0.26	0.21	0.08 <sup>NS</sup>
Caecal weight	0.64	0.63	0.59	0.67	0.62	0.17 <sup>NS</sup>
Abdominal fat weight	0.96 <sup>bc</sup>	1.05 <sup>bc</sup>	1.23 <sup>b</sup>	0.75 <sup>c</sup>	1.79 <sup>a</sup>	0.45*
Pancreas weight	0.23	0.24	0.22	0.25	0.23	0.07 <sup>NS</sup>

<sup>a, b, c</sup> Means bearing different superscripts within the same row differ; \* = ( $P<0.05$ ); NS= Not significant; SEM = Standard Error of Mean

At the finisher phase however, all parameters (DFI, DWG and FCR) indicated significant ( $P<0.05$ ) influence of diets among treatments. The highest value for DFI was obtained for the group on diet 4 (118.77g) which was similar to those on diets 1 (110.26g), 3 (110.82g) and 5 (114.01g) while diet 2 (106.02g) was significantly lower. This contradicts Mastika and Cumming (1987) and Jensen (1994) who reported lower feed intake values with increased whole grain cereals in broiler diets. Daily weight gain on the other hand, was higher for groups on diets 2 (51.69g) and 3 (50.55g) which

were similar and comparable with the control (48.79g). Broiler birds on diets 4 (45.36g) and 5 (44.29g) which were also the same had lower mean values for DWG and did not differ from the control. This finding is in contrast with the reports of Gabriel *et al.* (2008) that the inclusion of whole grain wheat had no effect on weight gain. In terms of FCR, birds fed diet 5 (2.58) and 4 (2.63) which were similar, were poorer than those on diets 1 (2.27), 2 (2.05) and 3 (2.22) which were also similar. This agrees with Mabelebele *et al.* (2018) who used

sorghum whole grains. No mortality was observed at this phase.

The overall phase showed no significant ( $P>0.05$ ) effect of diet on DFI (77.04 – 81.98g). However, DWG was higher ( $P<0.05$ ) and the same for groups on diets 1 (35.83g), 2 (36.27g) and 3 (36.36g) but lower ( $P<0.5$ ) in groups on diets 4 (32.78g) and 5 (30.91g) which were also similar. The same trend was observed for FCR, with birds on diets 1 (2.20), 2 (2.13) and 3 (2.18) having better values than those on diets 4 and 5 (2.51). Overall mortality stood at two birds, one from each of the groups on diets 1 and 2.

The results for carcass and organs measurements is presented in Table 4. Live weight of birds was higher ( $P<0.05$ ) for groups on diets 1 (1820.48g), 2 (1842.58g) and 3 (1807.10g) which were similar, to those on diets 4 (1637.79g) and 5 (1559.17g) which also did not differ. Carcass weight and dressing percentage also followed the same trend with live weight. Birds on diets 1 (1327.52g), 2 (1348.21g) and 3 (1299.33g) had higher ( $P<0.05$ ) carcass weights than those on diets 4 (1077.64g) and 5 (1039.03g) which were similar. Similarly, the dressing percentage of birds fed diets 1 (72.88%), 2 (73.12%) and 3 (71.78%) were higher ( $P<0.05$ ) than those on diets 4 (65.73%) and 5 (66.62%).

Except for relative weights of proventriculus, gizzard and abdominal fats, no significant ( $P>0.05$ ) dietary influence were recorded for organ weights. The weight of proventriculus was highest ( $P<0.05$ ) for birds on diet 5 (0.91%) and lowest ( $P<0.05$ ) for those on diet 2 (0.63%) while that of gizzard was also highest ( $P<0.05$ ) on diet 5 (2.73%) but lowest ( $P<0.05$ ) for those on

the control diet (2.04%). This is in conformity with the reports of Ravindran *et al.* (2006), Liu *et al.* (2015) and Cisse *et al.* (2017) who used different whole grain cereals. However, the heavier gizzards obtained in this study, instead of translating into higher daily weight gains and better FCR as posited by Selle *et al.* (2014), showed lower gains and poorer FCR. This could probably be attributed to the higher tannin content of the grain which was reported to be 1.46% (Kawu *et al.*, 2020). Abdominal fats weight was significantly ( $P<0.05$ ) higher in birds fed diet 5 (1.76%) and lowest in those on diet 4 (0.75%). However, birds on diet 2 (0.96%) and 3 (1.05%) did not differ from those on diet 4.

## Conclusion

Based on the results of this study, it was concluded that whole grain *gayamba* pearl millet can replace milled *gayamba* millet up to 10% level in broiler chicken diets without compromising growth performance and carcass yield.

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