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Growth performance of broiler chickens fed replacement levels of red and black finger millet (*Eleusine coracana*) varieties at starter phase

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***Target Audience:** Poultry farmers, Feed millers, Nutritionists and Researchers*

Abstract

This study examined effect of red and black finger millet (RBFM) (Eleusine coracana) on performance of broiler chicks as replacement for maize using 600 chicks for 28 days. Using 2x5 factorial arrangement in completely randomized design with RBFM inclusion at 0, 25, 50, 75 and 100% replacing maize in diets. Ten dietary treatments replicated 3 times containing 20 chicks/replicate and growth parameters determined. Results showed improvement in weights of birds fed diets containing 25% (669.50g) and 50% (677.50g) RBFM which had no statistical difference with birds fed control diets (679.80g) in main effect. Final weight and weight gain of birds fed diets containing RBFM up to 50% (684.90g and 670.00g) performed better than birds fed control diets (679.80g) in interaction. Feed intake was poorest in birds fed black finger millet at 75% (748.22g). FCR of chicks fed diets at 25% (1.70) red finger millet compared with birds fed control (1.62) diets. Cost/kg gain was increasing as RBFM were increasing, least cost was at 25% (₦222.60) red finger millet which can be compared with control (₦189.10). It can be concluded that RBFM can be alternative for maize as source of energy in chicks' diets up to 50% without affecting performance.

***Key words:** Finger millet; Eleusine coracana; Replacement; Broiler chickens and Growth performance*

Description of the problem

Poultry birds are globally and religiously accepted animals whereby their meat has no taboo neither has it been discriminated against throughout the world's history. (1) observed that Poultry industry as a major source of animal protein occupies a prominent position of supplies to the citizens in Nigeria. (2) projected that per capita consumption of livestock products will increase by about 50% from 1993 to 2020, with most of the increases attributed to developing countries as a result of population growth, urbanization and rising incomes. (3) reported that poultry has contributed to improving human nutrition and food security by being a source of high-quality protein, economic, social and cultural significance in small societies.

(4) reported that in developing countries, global trading of all meat products as well as feed and related inputs has led to a significant growth in poultry (especially broiler chickens) production and consumption. Funds invested in poultry production are recovered faster than in any other livestock enterprise (5). The Nigerian population is increasing at an alarming rate with poor feeding, which calls for caution and sensitivity by the animal scientists to avert malnutrition especially in children. The only possible way to curb the possibility of the general populace from plunging into deeper malnutrition is to increase

the protein availability in the nation through mass production of poultry birds; broiler chickens in particular. The larger Nigerian population and other developing countries are living below the poverty line; worthy of note is the present dispensation that many people cannot afford 3 square meals even the 'unbalanced diets' because there is hunger in the land. To worsen this situation is the emergence of (coronavirus) COVID-19 pandemic which has caused the shutting down of the whole world alongside the economy. Thus, it has been observed by (6) that the average animal protein intake of 8.6g of persons in most of these countries is far below the recommended 53.3g by nutritionists. Sustainable poultry production is seen as one of the fastest means of ameliorating the incessant animal protein intake shortage in many developing countries (7; 8).

In developing countries, majority of the populace suffer from protein deficiency, therefore, there is need to look for easier and simple ways of getting the animal protein required for normal body growth and functioning (9) stated that demand for animal protein has risen sharply in the recent years. It has been reported by (10) that feed cost accounts for over 65-70% of the total cost of poultry production constituting a large part of the entire expenses in poultry production. Reports by (11) indicated that maize constitutes about 50-70% of poultry ration. Maize is the most commonly used energy source and the most predominantly fed grain used in poultry feed (12). Therefore, there is need to urgently look for feed ingredients that will equally substitute as an alternative to maize with equal to or nearly equal energy source. (13) stated that the need to source, harness, process and utilize alternative feed stuff otherwise known as unconventional feed ingredients in the diets of poultry birds is more critical now than ever.

There is a cereal from the millet family which can be termed as unconventional, though unpopular but a very rich source of energy that can compete favorably with the conventional and widely used maize. It is known as finger millet *(Eleusine coracana)*, in berom tribe of Plateau state it is called *kpana* and *tamba* in hausa tribe, all found in Nigeria. However, this cereal is not cheaper than maize but when farmers are encouraged to cultivate more of it, the crop will be widely available than it is presently and that will help to crash down the price making it more available in the market, consequently rendering it cheap. As it is now, in areas where it is grown it's relatively cheap and available, therefore, poultry farmers in those areas can be encouraged to harness and utilize it as energy source for their poultry birds. Apart from containing energy, it is also rich in methionine and other limiting amino acids. (14) stated that it is rich in two of the amino acids (methionine and tryptophan), and contains a substantial amount of the other essential amino acids except lysine. Therefore, it is against this backdrop that this project was designed to determine the performance of broiler chicks when fed two varieties finger millet.

Materials and Methods

Experimental site

The study was conducted at the Poultry Section of Federal College of Animal Health and Production Technology (FCAH&PT), in Livestock Investigation Division (LID), National Veterinary Research Institute (NVRI), Vom, Nigeria. Vom is located in the Guinea Savannah zone of Nigeria, with geographical location on longitude 8^{o} 45` E and latitude $9^{o}$ 44` N on an altitude of 4200 feet (1280m) above sea level. Relative humidity ranges from 22% in January to 78% July/August. The daily average environmental temperature ranges between 17^{o}C - 28.6^{o}C

with mean monthly sunshine hours range of 177-288.30 (15).

Source of finger millet

Red and Black finger millet or *tamba* grains were purchased from Ganawuri village market in Riyom local government area, Plateau State and other neighboring markets in Kaduna State, Nigeria. The grains were purchased around November - December when it was cheaper and more available in the market.

Table 1: Gross composition of Broiler Chickens starter diets (0-4 weeks)

	Red variety					Black variety				
RBFB levels	**0 (%)**	**25 (%)**	**50 (%)**	**75 (%)**	**100 (%)**	**0 (%)**	**25 (%)**	**50 (%)**	**75 (%)**	**100 (%)**
Ingredient	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**
Maize	57.00	42.75	28.50	14.25	0.00	57.00	42.75	28.50	14.25	0.00
Finger millet	0.00	14.25	28.50	42.75	57.00	0.00	14.25	28.50	42.75	57.00
GNC	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
SBM	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Lime stone	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis										
CP (%)	23.00	23.40	23.70	24.10	24.50	23.00	23.40	23.70	24.10	24.50
ME (kcal/kg)	2926	2893	2860	2827	2794	2926	2893	2860	2827	2794
EE (%)	3.96	3.96	3.87	3.83	3.79	3.96	3.96	3.87	3.83	3.79
Crude fibre (%)	3.61	4.19	4.77	5.35	5.93	3.61	4.19	4.77	5.35	5.93
Calcium (%)	1.24	1.27	1.31	1.34	1.37	1.24	1.27	1.31	1.34	1.37
Av. P (%)	0.81	0.80	0.79	0.78	0.77	0.81	0.80	0.79	0.78	0.77
Lysine (%)	1.33	1.32	1.32	1.31	1.30	1.33	1.32	1.32	1.31	1.30
Methionine (%)	0.53	0.57	0.64	0.65	0.69	0.53	0.57	0.64	0.65	0.69
Feed cost (₦/kg)	116.97	131.22	145.47	159.72	173.97	116.97	131.93	146.89	161.85	176.82

*Vitamin-mineral premix provides per kg of diet: vit. A, 13,340iu; vit. D3, 2680iu; vit.E, 10iu; vit. K, 2.68mg; calcium pantothenate, 10.68mg; vit. B12, 0.022mg; folic acid, 0.668mg; choline choride, 400mg; chlorotetracycline, 26.68mg; manganese, 13mg; iron, 66.68mg; zinc, 53.34mg; copper, 3.2mg; iodine, 1.86mg; cobalt,0.268mg; selenium, 0.108mg;
Diets 1 and 6 – Maize based
Diets 2, 3, 4 and 5 – Red variety
Diets 7, 8 ,9 and 10 – Black variety

Experimental birds

The broiler chicks used for this experiment were of arbor acre breed purchased from Pierodex hatchery/company located in Barikin Ladi local government area, Plateau State.

Experimental diets

The experimental diets were formulated according to the recommendations of (16). The starter diets contained metabolizable energy of 2800-2900 Kcal/kg with crude protein of 23%. The experimental diets had replacement levels of red and black finger millet *(E. coracana)* varieties as the test ingredients at 0%, 25%, 50%, 75%, 100% and 0%, 25%, 50%, 75%, 100% to maize respectively. Representing treatments 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10, with treatments 1 and 6 serving as the control treatments. Before feeding RBFM to the birds it was milled to increase the surface area for ease of digestion by the digestive system of the birds.

Experimental design

Six hundred (600) day old broiler chicks of arbor acre breed was purchased from Pierodex

hatchery and used for this study. The chicks were allotted into ten dietary treatments with each treatment having three replicates and each replicate containing twenty birds in a 2x5 factorial arrangement in a completely randomized design.

Table 2: Main effect of finger millet varieties and replacement levels on growth performance of broiler chickens (0.4weeks)

	Varietal effect			Replacement levels					
Parameters	**Red**	**Black**	**SEM**	**0 (%)**	**25 (%)**	**50 (%)**	**75 (%)**	**100 (%)**	**SEM**
Initial wt (g/bird)	30.36	30.35	0.02	30.35	30.38	30.35	30.33	30.35	0.03
Final wt (g/bird)	667.40	558.50	12.88	679.80^{a}	669.50^{a}	677.50^{a}	510.20^{c}	572.20^{b}	20.37
Total wt gain (g/bird)	642.88^{a}	569.24^{b}	9.11	649.40^{a}	639.10^{a}	647.10^{a}	479.60^{c}	541.90^{b}	14.41
Av. daily weight gain (g/bird)	22.96^{a}	20.33^{b}	0.38	23.19^{a}	22.83^{a}	23.11^{a}	17.66^{b}	18.75^{b}	0.60
Total FI (g/bird)	1058.11^{b}	1137.00^{a}	16.20	1047.32^{b}	1132.14^{a}	1168.06^{a}	970.38^{c}	1170.15^{a}	26.60
Av. daily feed intake (g/bird)	37.80^{b}	40.60^{a}	0.58	37.40^{b}	40.44^{a}	41.72^{a}	34.63^{c}	41.80^{a}	0.91
FCR	1.78^{a}	2.21^{b}	0.05	1.62^{a}	1.77^{b}	1.81^{b}	2.06^{c}	2.30^{d}	0.07
Feed/cost/kg gain (₦)	260.50^{a}	308.40^{b}	9.79	189.10^{a}	233.10^{b}	264.90^{b}	331.00^{c}	404.00^{d}	10.95

abcd: Means on the same row with these superscripts differ significantly ($p<0.05$)
SEM: Standard error of means
Wt: Weight, Av. average, FI: Feed intake
FCR- Feed conversion ratio

Table 3: Interaction effect of finger millet varieties and replacement levels on growth performance of broiler chickens (0-4weeks)

RBFM variety	**Red variety**					**Black variety**					
RBFM levels	**0%**	**25%**	**50%**	**75%**	**100%**	**0%**	**25%**	**50%**	**75%**	**100%**	
Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**T8**	**T9**	**T10**	**SEM**
Initial wt (g/bird)	30.35	30.40	30.36	30.29	30.37	30.35	30.36	30.34	30.36	30.33	0.04
Final wt (g/bird)	679.80^{a}	659.10^{a}	684.90^{a}	666.40^{a}	646.80^{a}	679.80^{a}	680.00^{a}	670.00^{a}	354.10^{c}	497.70^{b}	28.81
Total wt gain (g/bird)	649.40^{a}	628.70^{a}	654.60^{a}	636.10^{a}	616.40^{a}	649.40^{a}	649.60^{a}	639.70^{a}	323.70^{c}	467.40^{b}	20.37
Av. daily wt gain (g/bird)	23.19^{a}	22.45^{a}	23.38^{a}	23.75^{a}	22.02^{a}	23.19^{a}	23.20^{a}	22.84^{a}	11.56^{c}	15.49^{b}	0.84
Total FI (g/bird)	1047.14^{b}	1064.23^{b}	1187.11^{a}	1190.75^{a}	1194.28^{a}	1047.14^{b}	1201.17^{a}	1149.33^{ab}	748.22^{c}	1147.44^{ab}	36.20
Av. daily Feed Intake (g/bird)	37.40^{b}	37.99^{b}	42.40^{a}	42.54^{a}	42.65^{a}	37.40^{b}	42.88^{a}	41.03^{ab}	26.71^{c}	40.95^{ab}	1.29
FCR	1.62^{a}	1.70^{b}	1.83^{b}	1.80^{b}	1.94^{c}	1.62^{a}	1.85^{b}	1.80^{b}	2.32^{c}	2.66^{d}	0.12
Feed cost/kg gain (₦)	189.10^{a}	222.60^{ab}	266.00^{cd}	287.00^{d}	337.60^{e}	189.10^{a}	243.70^{bc}	263.80^{cd}	374.90^{e}	470.30^{f}	15.48
Mortality (%)	5.00^{b}	3.33^{b}	0.00^{c}	10.00^{a}	5.00^{b}	8.00^{a}	8.33^{a}	8.33^{a}	10.00^{a}	5.00^{b}	1.40

abcdef: Means on the same row with these superscripts differ significantly ($P<0.05$)
SEM: Standard error of means
Wt: weight, Av. average, FI: Feed intake
FCR- Feed conversion ratio

Management of experimental birds

The birds were raised on a deep litter system where wood shaven was used as bedding materials to prevent the chicks from having direct contact with the cold floor. Feed and water were provided to the birds' *ad libitum*, all necessary vaccines were given to them according to their vaccination schedule

as published by National Veterinary Research Institute (NVRI), Vom, Nigeria. Vitalyte was giving to the birds to serve as anti-stress and after every vaccine or drug administration. When the environment was cold charcoal was used to provide heat and 200 watts' bulbs served as source of both heat and light.

Data collection

Parameters such as final weight, body weight gain, feed intake was taken by subtracting left over from feed given the data was collected on a weekly basis FCR (feed intake divided by weight gain) and cost/kg gain (feed cost per kg multiplied by FCR) were determined, mortality was recorded as it occurred.

Statistical analysis

Data generated from the study were subjected to General Linear Model Procedures of (17). Significant differences between the treatment means were separated using Duncan Multiple Range Test.

Model

The model used for the study is as follows:

$Y_{ij} = \mu + V_i + L_j + (VxL)_{ij} + eij$

Where μ = over all mean

Y_{ij} = any observation

V_i = Effect of variety (Red and Black varieties)

L_j = Effect of level of replacement (0, 25, 50, 75 an100%)

eij = Random error

Results and Discussion

The result of the main effect of finger millet varieties and their replacement levels for maize on the growth performance of broiler chickens at the starter phase is presented in Table 2. The result showed that there was significant ($P<0.05$) main effect of varietal and replacement levels on all the starter parameters measured. The result of the final weight and weight gain in the varietal effect indicates that the birds fed diets containing red finger millet had higher final weight (667.40g) and weight gain (22.96g) than the birds fed diets containing black finger millet (558.50g) and (20.33g) respectively. As the replacement level increases across the treatments the weight of the birds were decreasing. This result probably showed that the red finger millet-based diets was better than the black finger millet-based diets. However, the weight of birds fed 25% and 50% finger millet replacement levels were comparable with birds fed the control diets. This indicates that broiler chickens at the starter phase can tolerate up to 50% of finger millet in their diets. This result disagrees with the findings of (18) who stated that broiler chickens can tolerate substitution of maize with finger millet safely up to 25% in their diet. The result obtained in this is supported by the findings of (19) who reported that birds fed diets containing finger millet and pearl millet performed better than birds fed maize base diets at final weight and body weight gain.

The feed intake was significantly ($P<0.05$) lower in birds fed diets containing red finger millet (1058.11g) compared to the birds that were fed black finger millet based diets (1137.00g) and the birds fed diets with replacement levels of finger millet consumed more than the birds in the control group. As the level of inclusion increases the feed intake increases up to 50% level of inclusion, there was a sharp decrease in feed intake in birds on the replacement level at 75% of birds fed black finger millet. The reason for this trend could be that the birds were sick or diseased which consequently caused anorexia in them. This result disagrees with the report of (20) that at 75% substitution of finger millet did not affect feed consumption of broiler chickens.

The FCR showed that there was a significant ($P<0.05$) main effect for broiler chickens fed diets containing red finger millet which had a better performance than the birds that consumed black finger millet-based diets.

The result of the replacement levels indicates that birds fed diets containing 25% (1.77g) and 50% (1.81g) replacement were comparable with those on the control (1.62g). While those on 75% (2.06) and 100% (2.30) replacement were poorer with increasing levels of finger millet. Probably the poor performance of the birds in the group was the reason for this poor FCR of the birds. This result did not concur with the report of (21) who reported decrease in FCR with increase in the level of *gayamba* millet in broiler chickens' diets. (19) reported lower FCR in birds fed diets containing finger millet and pearl millet than birds fed maize based diets.

The feed cost/kg gain showed that there was significant ($P<0.05$) effect for birds fed diets containing red finger millet (₦260.50) and (₦308.40) for those on black finger millet-based diets. The replacement levels also showed that as the level of finger millet increases the feed cost also increased. Probably the cost of finger millet was responsible for this particular trend of increasing cost of the finger millet-based diets which are more than the cost of maize based diets. In similar study (22) reported that the cost of raising broiler chicks fed with ginger waste meal increased as the level of ginger waste meal increased across the dietary treatments.

The result of the interaction effect between two varieties of finger millet and replacement levels on growth performance of broiler chicks is presented in Table 3. There was significant ($P<0.05$) interaction effect in all the parameters measured across all the dietary treatments. The interaction that occurred between the two varieties could be due to the differences in the colour of the varieties. The birds fed diets containing red finger millet competed favourably with their counterpart in the control group, while birds fed diets containing black finger millet at 25% and 50% replacement levels performed favourably with birds fed maize based diets. However, the birds fed 75% and 100% replacement levels with black finger millet had lower performance. As the level of finger millet (red and black) were increasing in the diets, the weights of the birds were decreasing in an in consisted manner across the dietary treatments. Probably the birds were unable to break down the feed molecules into their individual nutrients and make it available for utilization in the body due to disease condition. And may be the high crude fibre content which is higher than that of maize also contributed to the poor performance, it was similarly reported by (23) that young broilers could not tolerate total replacement of maize with a mixture of sun-dried cassava tuber meal, brewers' dried grains and palm oil, probably due to its high fibre and possibly HCN content.

The final weight and weight gain showed that the birds that consumed finger millet-based diets performed favorably with birds on the control diets. This result is in agreement with (21) who reported that final weight and weight gain of birds fed diets containing pearl millet and finger millet had no significant differences ($P>0.05$) with birds fed control (maize based) diets. However, birds fed with black finger millet-based diets up to 75% (354.10g) and 100% (497.70g) replacement did not do well compared to the birds that consumed the other diets in the group. The reason for this poor performance may be that the birds had some disease conditions and this caused their poor performance, at the time when the birds are sick it caused them to have depraved appetite which affected their feed intake and consequently their weights.

The birds that were fed diets containing black finger millet had a particular trend in which the feed intake was increasing as the rate of finger millet replacement was increasing; however, this trend was distorted with the birds that consumed diets with 75% (26.71g) and 100% (40.95g) replacement of finger millet having the lowest feed intake. It

could be observed that the low feed intake in birds on diets with 75% and 100% replacement levels was an indication that may be the birds were diseased and that reduced their feed intake. The probable reason for the unique performance of birds at these replacement levels (75% and 100%) could be that the birds faced a health challenge which made them to put up a bad performance in all the parameters measured in the starter phase. Another reason could be because of the higher quantity of tannins found in black (0.32mg/g) finger millet which is higher than that of red (0.30mg/g) finger millet. Tannin interferes with protein digestibility, by forming a less digestible complex with dietary protein, may bind and inhibit the endogenous protein, such as digestible enzymes (24). Birds fed diets containing red finger millet had similar results in feed intake with birds fed control diets which agrees with the result reported by (19) where birds fed control diets had similar values of feed intake with birds fed finger millet and pearl millet in their diets.

The feed conversion ratio became poorer as the replacement levels of finger millet increased across the dietary treatments. The least values in FCR were observed in both controls of red and black finger millet (1.62). A particular trend was observed in feed cost/kg gain where the cost was increasing as the replacement levels of finger millet were increasing across the dietary treatments. This may not be unconnected with the cost difference between finger millet and maize which added to the cost of making the feed. In a similar experiment reported by (13) cost/kg gain was increasing as the level of *Parkia* pulp was increasing in the diets of broiler chicks across the dietary treatments. (19) reported lower FCR in birds fed diets containing finger millet and pearl millet compared to maize based diets There was more mortality in birds on the black finger millet based diets than what occurred in the red finger millet based diets, this may be as a result of disease caused by coccidiosis and may be other infections.

Conclusion and Applications

The findings concluded that:

1. Chicks fed diets containing finger millet-based diets performed favorably with chicks fed control (maize based) diets.
2. Birds fed diets containing red finger millet performed better than birds fed diets containing black finger millet.
3. Chicks fed control (maize based) diets significantly ($P<0.05$) performed better than chicks fed diets containing black finger millet at 75% and 100% replacement levels.
4. This result shows that red finger millet can completely replace maize in broiler starter diets without any adverse effects on the birds.

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