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Growth Performance and Carcass Characteristics of Broiler Chickens fed two varieties each of Guinea Corn and Millet as Replacements for Dietary Maize

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ABSTRACT [ENGLISH/ANGLAIS]

An experiment was carried out to evaluate the effect of complete replacement of maize with two varieties of guinea corn and two varieties of millets on the growth performance and carcass characteristics of broiler chickens. Five diets were formulated as follow; Diet 1 (maize based diet) which served as the control while diets 2,3,4 and 5 were white guinea corn, yellow guinea corn, pearl millet and finger millet based diets respectively designated as Treatment 1, 2, 3, 4 and 5. A total of two hundred and twenty five (225) Marshal Broiler chickens of one-day old were randomly allotted to the five dietary treatments in a completely randomized design (CRD). The experiment lasted 56 days. The results of the experiment showed that daily feed intake and daily weight gain of birds fed pearl and finger millet based diets (T4 and T5) were significantly ($p < 0.05$) higher than those fed other dietary treatments. The feed conversion ratio and feed cost per kg gain were also significantly ($p < 0.05$) different across the treatment groups. However, there was no significant ($p > 0.05$) difference in the mortality rate. Carcass characteristics measured were significantly ($p < 0.05$) influenced by the treatments except the dressing percentage, thigh and back weight. Also, there were no significant ($p > 0.05$) differences in the heart, kidney and gizzard weights and intestinal length. On the basis of the results of this study, it was concluded that the two varieties of millet (pearl and finger) can completely replace maize component in broilers diets without any adverse effect on growth performance and carcass characteristics of broiler chickens.

Keywords: Broiler chickens, carcass characteristics, guinea corn, maize, millets, growth performance

RÉSUMÉ [FRANÇAIS/FRENCH]

Une expérience a été réalisée pour évaluer l'effet du remplacement complet du maïs avec deux variétés de maïs Guinée et deux variétés de millet sur les caractéristiques de performances de croissance et de carcasses de poulets de chair. Cinq régimes ont été formulés comme suit ; régime 1 (à base de maïs alimentation) qui a servi de témoin tandis que les régimes 2,3,4 et 5 étaient blancs Guinée maïs, jaune Guinée maïs, le mil et les régimes à base millet respectivement désignés comme traitement 1, 2, 3, 4 et 5. Un total de deux cent vingt cinq poulets (225) maréchal de chair de vieux d'un jour ont été attribués au hasard dans les cinq régimes alimentaires dans un dispositif complètement aléatoire (CRD). L'expérience a duré 56 jours. Les résultats de l'expérience ont montré que l'ingestion journalière et le gain de poids quotidien de millet des oiseaux nourris avec les régimes alimentaires à base de perles et des doigts (T4 et T5) étaient significativement ($p < 0,05$) plus élevé que ceux nourris autres traitements alimentaires. Le rapport et les aliments coût de conversion des aliments par kg de gain étaient également significativement ($p < 0,05$) entre les groupes de traitement. Cependant, il n'y avait pas de différence significative ($p > 0,05$) du taux de mortalité. Les caractéristiques de carcasse mesurés étaient significativement ($p < 0,05$) influencé par les traitements sauf le pourcentage de dressing, cuisse et dos de poids. En outre, il n'y avait pas de différences significatives ($p > 0,05$) dans le cœur, les reins et le poids du gésier et longueur intestinale. Sur la base des résultats de cette étude, il a été conclu que les deux variétés de mil (perle et doigt) peuvent remplacer complètement composant de maïs dans les poulets de chair régimes sans aucun effet négatif sur les performances de croissance et caractéristiques de la carcasse de poulets de chair.

Mots-clés: Poulets de chair, caractéristiques de la carcasse, la Guinée maïs, maïs, millet, la performance de croissance

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INTRODUCTION

In a developing country like Nigeria, there is an inadequate supply of animal protein sources. An average Nigerian consumes only about 8.6g of animal protein per day as against 53.3g by the inhabitants of developed countries [1, 2]. Sanni and Ogundipe [3] reported that

poultry industry occupies a major position in the livestock sector of agricultural production because birds reproduce much quicker to produce meats and eggs for human consumption within the shortest possible time. FAO [4] reported that the best logical solution to Nigeria's meat scarcity is to increase broiler chicken production.

Nutrition is perhaps the most important consideration in livestock management. Inadequate supply of feeds, nutritionally unbalanced rations, adulterated ingredients or stale feeds are some of the factors responsible for low productivity of livestock in tropics [5, 6]. Apart from nutrition, Poultry industry contributes significantly to family income [7]. Therefore the major interest of the farmer is to reduce feed cost, which usually accounts for 60 to 70% of the total cost of production [6, 8, 9]. Research efforts are geared towards evaluating alternative feed ingredients for poultry. According to Atteh, Ologbenla [10], such alternatives should have comparative nutritive value but cheaper than the conventional protein and energy sources. They should also be available in large quantities.

Maize is used for other purposes such as biofuel, brewing, starch industries and for human consumption. However, inadequate production of this grain and the intense competition for maize between man, industries and livestock especially in the drier areas of the tropics has made poultry rations to be expensive [11, 12]. This situation forces the search for other alternative energy sources which are available in large quantities and are cheaper, such as guinea corn (*Sorghum bicolor* Linn.), finger millet (*Eleusinecoracana*) and pearl millet (*Pennisetumtyphoides*). Worldwide, guinea corn and millet grain crops are very important ingredients in poultry diets. They both have over 90% of the feeding value of maize [13]. Guinea corn and millets are the most widely grown cereal crops that have been successfully cultivated in the semi-arid regions of Asia and Africa since prehistoric times and their cost are relatively less in the areas of cultivation with little industrial uses in Nigeria [14]. The protein in millets is well balanced in limiting amino acids for practical poultry diets. Lysine, Methionine and Cystine contents in finger millet is about 2.86%, 1.75% and 1.51% of the crude protein [15]. Therefore their incorporation in place of maize can reduce the dependency on maize and also reduce the cost of poultry production. This study is aimed at evaluating the growth performance and carcass characteristics of broiler chickens fed two varieties each of guinea corn and millet as replacements for dietary maize.

MATERIALS AND METHODS

Experimental Site

The study was conducted at the Poultry Research Unit of the Department of Animal Science, Ahmadu Bello University, Zaria, Kaduna state, Nigeria in 2012.

Sources of Experimental Materials

The guinea corn and millet grains used in these studies were purchased from the local market in Zaria, Kaduna State. Five isonitrogenous and isocaloric diets (21.5% CP; 2900 Kcal/kgME) were formulated to meet nutrient requirement standards of broilers [16]. Diet 1 (maize based diet) served as the control while diets 2, 3, 4 and 5 were white guinea corn, yellow guinea corn, pearl millet and finger millet based diets respectively designated as Treatment 1, 2, 3, 4 and 5.

Experimental Design

A total of two hundred and twenty five (225) Marshal Broiler chickens of two-day old broiler chicks purchased from a reputable Hatchery were randomly allotted to the five dietary treatments in a Completely Randomized Design (CRD) and were reared in deep litter house which was partitioned into pens as experimental units. Each treatment had 45 broiler birds in three replicates. Water and feed were offered ad libitum throughout the study period. All the necessary routine management practices and the recommended vaccinations were strictly observed throughout the period of 56 days which the study lasted.

Data Collection

Daily feed consumption was recorded as difference of feed offered and the left-over. Weight gain was measured weekly. Feed samples were collected for analysis.

Carcass and Organs Weight Determination

At the end of 8 weeks, four birds per replicate were selected at random and starved for about 18h to empty the crops. They were then slaughtered, scalded, plucked and eviscerated. The carcass and internal organs (liver, heart, kidney, gizzard and intestines) were removed, weighed and expressed as a percentage of live weight.

Proximate Composition

Proximate composition of the test ingredients was analyzed using the method of AOAC [17].

Statistical Analysis

Experimental data were subjected to analysis of variance (ANOVA) using [18] software. Means were separated with Duncan multiple range test at 5% level of significance.

RESULTS AND DISCUSSION

Proximate Composition of the Test Ingredients

The proximate composition of the test ingredients is presented on Table 1. The nutrient composition shows that maize has higher dry matter, ether extract, NFE and ME (kcal/kg) than the two varieties of guinea corn and the two varieties of millets studied. However, percentage ash, crude protein and crude fibre were higher in finger millets than in maize and guinea corn. These results fall within the range of nutrients in cereal grains reported by Aduku [19].

The gross composition of the experimental diets as well as the performance characteristics of broiler chickens fed maize, guinea corn and millet based diets for 56days are presented in Table 2 and 3. There were significant (p<0.05) differences across the treatment means for final weight, daily weight gain, daily feed intake and feed conversion ratios. Daily feed intake and daily weight gain were significantly (p<0.05) higher for birds fed pearl and finger millet diets compared to those fed control and guinea corn based diets. Feed conversion ratios of birds fed pearl and finger millet diets (2.44 and 2.53) were significantly (p<0.05) better than birds fed diets T1 (control), white guinea corn and yellow guinea corn (2.74, 3.15 and 2.81). Feed cost per kg gain was significantly (p<0.05) higher for birds fed white guinea corn and finger millet based diets (T2 and T5) while birds fed pearl millet based diet (T4) recorded significantly (p<0.05) the lowest feed cost per kg gain. This finding agreed with the report of Luis [21] and

Andrew, Kumar [22] who reported that birds fed millet based diets gave better performance than those fed maize and sorghum groups. The significant (p<0.05) reduction in weight gain of birds fed white guinea corn diet (T2) compared to birds fed other diets is probably due to poor nutrient retention and utilization due to the high level of oxalates found in white guinea corn grain. This finding is in agreement with the reports of [23] who stated that digestibility of nutrients were less for soft sorghum (white guinea corn) than for medium (red or yellow) and hard (cream) sorghum. Birds fed yellow guinea corn based diet had similar (p>0.05) feed intake and body weight gain as those fed the control diet. This observation is not surprising since the metabolizable energy concentration of the diets were similar and for the fact that birds eat to satisfy their energy requirements. This finding is in agreement with the reports of Nagra et al [24], Rama Rao et al [25], and Tyagi et al [26]. These authors reported that replacement of maize with low tannin guinea corn did not reduce the live body weight (LBW), live body weight gain (LBWG), feed intake and feed conversion ratio compared to birds fed maize based diet. Feed conversion ratios of birds fed pearl and finger millet diets were significantly (p<0.05) better compared to birds fed other diets. This may have contributed to the observed enhanced weight gain of the birds fed these diets. This observation agrees with the reports of [27] who reported that birds fed 100% pearl millet diet had greater body weight, feed intake and feed conversion ratio than birds fed yellow maize.

Table 1: Chemical Compositions of Maize, Guinea- corn and Millet grains

Nutrients (%)	Maize (Yellow)	White G'corn	Yellow G'corn	Pearl Millet	Finger Millet
Dry Matter	94.10	90.31	91.86	91.76	89.13
Crude Protein	8.60	10.04	10.27	12.02	12.14
Ether Extract	3.82	3.06	3.19	3.78	3.54
Crude Fibre	3.20	4.69	4.78	6.01	6.30
Ash	1.81	1.86	1.89	1.62	3.24
NFE	80.60	78.80	78.92	72.20	68.06
ME(Kcal/kg)	3451.68	3379.79	3403.13	3280.94	3120.85

NFE: Nitrogen Free Extract =100-(%CP+%CF+%EE+%Ash). ME:Metabolizable Energy ME (Kcal/kg) = 37 x %CP + 81.8 x % EE + 35.5 x %NFE [20]. Determination done at the Biochemical Laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria.

The result of the carcass characteristics is shown on Table 4. There were no significant (p>0.05) differences in dressing percent, thigh weight and back weight. Live weight, dressed weight and breast weight of birds fed pearl and finger millet based diets were significantly (p<0.05) higher compared to those fed control and guinea

corn based diets. Birds fed yellow guinea corn had better (p<0.05) dressed and breast weights than those fed white guinea corn diet. This result agrees with the reports of Davis et al [27], and Medugu et al [28] who reported that millets can be well-utilized to produce broiler chickens with superior carcass quality compared to maize and

Table 2: Gross Composition of the Experimental Diets

Ingredients (%)	T1, Maize	T2, White G'corn	T3, Yellow G'corn	T4, Pearl Millet	T5, Finger Millet
Maize	53.74	0.00	0.00	0.00	0.00
White Guinea corn	0.00	54.20	0.00	0.00	0.00
Yellow Guinea corn	0.00	0.00	54.20	0.00	0.00
Pearl millet	0.00	0.00	0.00	54.90	0.00
Finger millet	0.00	0.00	0.00	0.00	54.90
Maize offal	5.00	5.00	5.00	5.00	5.00
Groundnut cake	22.50	21.00	21.00	18.40	18.40
Soya cake	10.00	10.00	10.00	10.00	10.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Limestone	0.65	0.65	0.65	0.65	0.65
Bone meal	3.00	3.00	3.00	3.00	3.00
Palm oil	1.05	2.10	2.10	4.00	4.00
Common salt	0.25	0.25	0.25	0.25	0.25
Vit/M. Premix	0.30	0.30	0.30	0.30	0.30
L-Lysine	0.25	0.25	0.25	0.25	0.25
DL- methionine	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated Parameters (%)					
M.Energy(Kcal/kg)	2932	2933	2933	2933	2933
Crude protein	21.50	21.50	21.50	21.50	21.50
Ether extract	5.48	5.92	5.92	9.06	9.06
Crude fibre	3.91	3.96	3.96	5.49	5.49
Calcium	1.25	1.25	1.25	1.25	1.25
Avail. P.	0.65	0.65	0.67	0.69	0.71
Lysine	1.15	1.14	1.14	1.17	1.17
Methionine	0.46	0.46	0.47	0.47	0.46
Meth. + cystine	0.87	0.84	0.84	0.92	0.92
Feed cost/kg (N/kg)	90.30	93.80	93.80	103.70	124.80

*Biomix premix provided the following per kg of diet: Vit. A, 10,000 i.u.; Vit.D₃, 2000 i.u.; Vit. E 23mg; Vit. K, 2mg; Vit. B₁ (Thiamine) 1.8mg; Vit B₂ (Riboflavin) 5.5mg; Vit. B₆ (Pyridoxine), 3.0mg; Vit.B₁₂ 0.015mg; Pantothenic acid 7.5mg; Folic acid 0.75mg; Niacin 27.5mg; Biotin 0.6mg; Choline chloride 300mg; Cobalt 0.2mg; Copper 3mg; Iodine 1mg; Iron 20mg; Manganese 40mg; Selenium 0.2mg; Zinc 30mg; Antioxidant 1.25mg; ME= Metabolisable Energy.

Table 3: Performance Characteristics of Broilers fed Maize, Guineacorn and Millet based diets

Parameters	T1, Maize	T2, White G'corn	T3, Yellow G'corn	T4, Pearl Millet	T5, Finger Millet	SEM
Initial weight, g/b	42.69	42.66	42.69	42.62	42.60	0.14
Final weight, g/b	2051.7 ^b	1810.8 ^c	2037.0 ^b	2451.0 ^a	2343.7 ^a	90.87
Total weight gain, g/b	2009.01 ^b	1768.14 ^c	1994.31 ^b	2408.38 ^a	2301.1 ^a	89.02
Daily weight gain, g	35.88 ^b	31.57 ^c	35.61 ^b	43.01 ^a	41.09 ^a	3.24
Total feed intake, g/b	5506.6 ^b	5574.4 ^b	5596.8 ^b	5885.2 ^a	5811.1 ^a	47.23
Daily feed intake, g	98.33 ^b	99.54 ^b	99.94 ^b	105.09 ^a	103.77 ^a	1.69
Feed conversion ratio	2.74 ^b	3.15 ^c	2.81 ^b	2.44 ^a	2.53 ^a	0.13
Cost of feed/kg weight,N	257.22 ^{ab}	338.65 ^c	277.43 ^b	250.21 ^a	314.54 ^c	14.88
Mortality rate, %	2.22	2.40	2.20	2.10	2.21	2.81

SEM: standard error of mean. ^{abcd}Means on the same row with different superscripts are significantly ($p < 0.05$) different.

Table 4: Carcass Characteristics of Broilers fed Maize, Guinea corn and Millet based diets

Parameters	T1, Maize	T2, White G'corn	T3, Yellow G'corn	T4, Pearl Millet	T5, Finger Millet	SEM
Live weight (g)	2049.5 ^b	1808.7 ^c	2035.5 ^b	2449.0 ^a	2340.2 ^a	72.47
Dressed weight (g)	1785.0 ^b	1587.0 ^c	1814.7 ^b	2093.3 ^a	2031.7 ^a	91.36
Dressing percent (%)	68.19	63.89	68.10	66.86	67.62	2.43
Carcass weight (g)	1398.33 ^b	1156.67 ^c	1383.33 ^b	1637.33 ^a	1581.67 ^a	67.28
Breast weight (%)	18.29 ^b	18.04 ^c	21.19 ^a	20.00 ^a	20.49 ^a	0.91
Thigh weight (%)	24.27	23.36	23.42	25.59	24.44	1.98
Back weight (%)	16.57	16.49	16.62	18.04	17.89	0.86

SEM: standard error of mean. ^{abcd}Means on the same row with different superscripts are significantly ($p < 0.05$) different

Table 5: Organs Weight of Broilers fed Maize, Guinea corn and Millet based diets

Parameters	T1, Maize	T2, White G'corn	T3, Yellow G'corn	T4, Pearl Millet	T5, Finger Millet	SEM
Heart weight (%)	0.52	0.47	0.46	0.51	0.46	0.03
Kidney weight (%)	0.42	0.34	0.39	0.41	0.41	0.06
Liver weight (%)	1.91 ^b	2.21 ^a	2.16 ^{ab}	1.97 ^{ab}	1.91 ^b	0.14
Gizzard weight (%)	2.30	2.48	2.43	2.47	2.49	0.15
Intestine weight(g)	3.60 ^b	3.56 ^b	3.66 ^b	4.00 ^{ab}	4.40 ^a	0.28
Intestine length (cm)	10.84	10.86	10.96	10.99	11.10	0.63

SEM: standard error of mean. ^{abcd}Means on the same row with different superscripts are significantly ($p < 0.05$) different

guinea corn based diet. There were no significant ($p > 0.05$) differences in dressing percent across dietary treatments. The percentages of primal cut (thigh and back) except breast muscle were not significantly affected by the treatments.

The result of the organs weight is shown on Table 5. There were no significant ($p > 0.05$) differences in organs weights such as heart, kidney, gizzard and intestine length across dietary treatments indicating that there were no abnormalities or pathological lesions in these organs. The liver weights were significantly ($p < 0.05$) higher for birds fed guinea corn based diets. Oloyo [29] also reported higher liver weights when broilers were fed un-supplemented guinea corn/palm kernel meal based ration. The linear increase in the weights of the intestine across the treatments may be due to their involvement in the digestion process.

CONCLUSION

On the basis of the results of this study, it was concluded that the two varieties of millet (pearl and finger) can completely replace maize component in broilers diets without any adverse effect on growth performance and carcass characteristics of broiler chickens. With this, dependency on dietary Maize is drastically reduced.

REFERENCES

- [1] Ogundipe SO. Management of Broilers. NAERLS Extension Guide. No.40, Poultry Series No.4. Ahmadu Bello University, Zaria. 1996.
- [2] Ojo SO. Productivity and Technical Efficiency of Poultry Egg Production in Nigeria. International Journal of Poultry Science, 2003;2:459-64.
- [3] Sanni SA, Ogundipe SO. Economics of some modules of poultry production in Kaduna State, Nigeria. Nigerian Journal of Animal Production. 2005;32(1):102-7.
- [4] FAO. Sorghum and Millet in Human Nutrition. Food and Nutrition Series. No. 27. Food and Agriculture Organisation, Rome/WHO p. 333.1995. Retrieved on July 12, 2005 from <http://www.fao.org/DOCREP/TO818e/TOP18Eoo.html>
- [5] Ogundipe SO. Non Conventional Poultry Feedstuffs. Farm Research to Poultry Practice, Poultry Farmers Workshop. N.A.E.R.L.S. Ahmadu Bello University, Zaria, Nigeria, 1987. Pp. 69.
- [6] Ogundipe SO, Abeke FO, Sekoni AA, Dafwang II, Adeyinka AI. Effect of duration of cooking on the utilization of lab labpulpureus by pullet chicks. In: Proceedings of the 28th Annual conference of the

- Nigerian Society for Animal Production held at Ibadan, Nigeria. 2003. p. 233-5.
- [7] Ogundipe SO, Sanni SA. Economics of poultry production in Nigeria. A training workshop manual. National Animal Production Research Institute, A.B.U. Shika, Zaria. 2002. p. 27-45.
- [8] Nworgu FC, Adebawale EA, Oredein OA, Oni A. Prospects and Economics of Broiler Production Using Two Plant Protein Sources. *Tropical Journal of Animal Science* 1999;2:159-66.
- [9] Igwebuike JU, Kwari ID, Ubosi CO, Alade NK. Replacement Value of Spent Sorghum Grains for Maize in Broiler Finisher Diets. *Journal of Sustainable Agricultural Environment*, 2001;3:224-33.
- [10] Atteh JO, Ologbenla FD. Replacement of Fish Meal with Maggots in Broiler Diets. Effects on Performance and Nutrient Retention. *Nigerian Journal of Animal Production* 1993;20:44-9.
- [11] Asha RR, Rukmagadha S, Ravindran R, Mohan B, Murugandhan B, Vedhanayagam K. Replacing maize with other grains in broiler diet. *Indian Journal of Poultry Science* 1986;21:343-4.
- [12] FAO. Food and Agricultural organization of the United Nations. Village chicken production systems in Rural African House, Food security (edns). Agricultural Department, FAO Corporate Document Repository, 2006:9-11.
- [13] Rooney LW. Processing methods to improve nutritional value of sorghum for livestock. Pages 206–210 in *Sorghum Nutritional Quality*. Proceedings of International Conference, W. Lafayette, IN. Purdue University, West Lafayette, IN. 1990.
- [14] Nyannor EK, Adedokun SA, Hamaker BR, Ejeta G, Adeola O. Nutritional evaluation of high-digestible sorghum for pigs and broiler chicks. *Journal of Animal Science*, 2007;85:196-203.
- [15] Rachie KO, Peters LV. The Eleusine – A review of the world literature. International Crops Research Institute for semi-arid Tropics, Hyderabad, India. 1997.
- [16] NRC. National Research council. Nutrient requirements of poultry 9th Rev. Edn. National Academy press, Washington, D. C. 1994.
- [17] AOAC. Official Method of Analysis. 15th Edn., Association of Official Analytical Chemists, Washington, DC., USA., 1990. Pp. 66-88.
- [18] SAS. Statistical Analysis System Institute. Users Guide Version 9 for Windows. Cary North Carolina, USA. 2008.
- [19] Aduku AO. Tropical Feedstuff- Analysis Table. Department of Animal Science, Faculty of Agriculture. Ahmadu Bello University, Samaru, Zaria, Nigeria. 1993. p.1-2.
- [20] Pauzenga U. Feeding parent stock *Zootech. International*. 1985. p.22-5.
- [21] Luis ES. Nutrient composition and feeding value of millets, sorghum grains and corn in poultry diets. Ph.D Dissertation, University of Nebraska, Lincoln (Abstract). 1982. Retrieved 05/06/07 from <http://digitalcommons.unl.edu/dissertations/AAI81105771>.
- [22] Andrew DJ, Kumar KA. Pearl Millet for Food, Feed and Forage. *Advanced Agronomy* 1992;48:89-139.
- [23] Cao H, Hancock JD, Hines RH, Behnke KC, Park JS, Senne BW, Jiang JM, Froetschner JR, Sorrell P. Effects of sorghum endosperm hardness and processing on growth performance and nutrient digestibility in pigs and broiler chickens". *Swine Day*. KSU, 1998. Pp. 251-255.
- [24] Nagra SS, Chawla JS, Phaul PS. Effect of feeding sorghum on growth performance of broilers. *Indian Journal of Poultry Science*, 1990: 25:138- 144.
- [25] Rama Rao SV, Shyamsunder AK, Reddy MR, Raju MV, Praharaj NK. Utilization of different millets replacing maize in coloured broiler chicken diet". *Indian Journal of Animal Nutrition*, 2002;19: 353-358.
- [26] Tyagi PK, Elangovan AV, Mandal AB, Pramod K, Tyagi SK, Johri AK. Effects of feeding low tannin sorghum grain to broiler chickens. *Indian Journal of Animal Nutrition*. 2003;20:322-326.
- [27] Davis AJ, Dale NM,erreira FJ. Pearl millet as an alternative feed in broiler chickens diets. *Journal of Applied Poultry Research*, 2003;12:137 – 144.
- [28] Medugu CI, Kwari ID, Igwebuike JU, Nkamer I, Mohammed ID, Hamker B. Performance and Economics of production of broiler chickens fed sorghum or millet as replacement for maize in the semi-arid one of Nigeria. *Agriculture and biology Journal of North America* 2010;1(3):321-5.
- [29] Oloyo RA. Responses of broilers fed guinea corn /palm-kernel meal based ration to supplemental biotin. *J. Sci. Food and Agri*. 1991;55:539-50.

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CONFLICT OF INTEREST

No conflict of interest was declared by authors.

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