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# COMPARATIVE CARCASS AND ORGAN CHARACTERISTICS OF BROILERS FED BREWERS DRIED GRAIN AND RED SORGHUM SPENT GRAIN (*burukutu* RESIDUE)

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## ABSTRACT

A study, using 105, day-old broiler chicks (*Abor acre*) was conducted to assess the effect of Brewers Dried Grain (BDG) and Red Sorghum Spent Grain (RSSG - *burukutu* residue) on the carcass and organ features of broilers for 8 weeks. The birds were weight-balanced, randomly selected and divided into 3 treatment groups in which the control group had neither BDG nor RSSG while the other two diets contained either 15% BDG or 15% RSSG in 5 replications with 7 birds in each replicate using a completely randomized design. For the carcass characteristics (percentage of live weight), the RSSG influenced ($P<0.05$) the live weight (g) and the drumstick weight. Both test diets influenced ($P<0.05$) the crop weight of the birds. The breast and back weights of BDG fed diets were significantly higher ($P<0.05$) than the RSSG, although the RSSG did not differ ($P>0.05$) from the control. For the organ characteristics, there were no differences ($P>0.05$) among all the treatments. It was concluded that, at 15% inclusion level, both BDG and RSSG are good substitute for maize in conventional broiler ration. However, the choice will depend on the cost value of the ingredients.

**Keywords:** Brewers dried grain, red sorghum spent grain, broilers, carcass, organ

## INTRODUCTION

The production of broilers has been a major enterprise that has boosted the living standard of an average citizen in Nigeria due to the rate at which they attain market weight compared to other livestock (Ajayi *et al*., 2017; Awodola and Yahaya 2017). In attaining market weight, certain features are essential and this include, the birds' carcass and organs. The development of these features center around the diet that is fed to the birds in maintaining their energy and protein requirements. However, the production cost that will enable broilers to yield their gains will directly affect an average consumer as the price may become unaffordable.

Maize is a staple food in Nigeria. It is also a good source of energy and often accounts for about 50% (on the average) of the total feed formulation (Ironkwe and Bamgbose 2011). However, due to its high consumption by both humans and animals, its price has often adversely affected livestock production (Ajayi *et al*., 2017). These exorbitant prices of feed ingredients explain why large-scale poultry farms in Nigeria still face increasing challenges of how to survive, make reasonable profits and thrive in the business (Adeyemo and Ifon, 2009).

The use of readily available and less expensive agro industrial by-products has been suggested as alternative to conventional feeds (Olorede *et al*., 2009; Onunkwo *et al*., 2018). However, in using these by-products as feed ingredients, nutritionists often emphasize on the growth and development of the internal organs as these may be major constraints to an effective broiler production (Amaduruonye *et al*., 2018).

One of the fastest growing industrial sectors in Nigeria is the brewing industry. The nation generates thousands of tons of brewers' grain as by-product from the brewing of beer. In the past, the disposal of these by-products (regarded as waste) was part of the production costs for the breweries. Today, the story has changed, owing to the knowledge that these byproducts are actually beneficial to animals, therefore generating income for the brewers (Onyimba *et al*., 2009). Brewers dried grain (BDG) is the term used for these brewery by-products and it differs in composition due to its different plant sources but the most important grit material was the barley. However, the barley has gradually been replaced by sorghum (red or white) due to the ban of barley malt importation in the country (Holmes *et al*., 2013). As a result, sorghum spent grain (SSG) is gradually replacing BDG. It is worthy of note that, the use of enzymes has always been encouraged in the use of brewery by-products as animal feeds (Alabi *et al*., 2014; Selle and Ravindran 2007; Ankra *et al*., 2014; Olajide *et al*., 2013), however, in this research, the use of enzyme was avoided to directly compare the effects of BDG and Red Sorghum Spent Grain (RSSG) on the birds at 15% inclusion level to determine their tolerance in the gastro-intestinal tract of the birds as well as their digestive efficiency.

The objective of this research is therefore, to assess the utilization of Brewers Dried Grain and Red Sorghum Spent Grain both at 15% level of inclusion on carcass and organ development.

## MATERIALS AND METHODS

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm, University of Ibadan, Ibadan. BDG was obtained from the Nigerian Breweries, Plc, Ibadan while the RSSG was procured from a local alcohol producing mill at the Army Barracks Ojoo, Ibadan, Nigeria. The two ingredients were then sundried in bright sunlight for 7 days. A total of 105, day-old broiler chicks (*Abor acre* strain) were used for the experiment till 8 weeks. They were divided into 3 treatment groups in a completely randomized design with 5 replicates having 7 birds per replicates such that the mean groups of birds were similar. All the birds were raised on control starter diet for 2 weeks, thereafter, 3 experimental diets were formulated for starter and finisher phases such that the control had neither BDG nor SSG but the other two diets contained either 15% BDG or 15% RSSG.

Vaccines were administered at prescribed intervals. Cost analysis was computed as all the cost incurred throughout the experiment which included cost of day-old chicks, cost of feeding, cost of transportation, cost of medication and general cost of management including sanitation cost.

At the end of the experiment, 45 chickens (3 chickens from each treatment replicate based on average weight of the group) were selected for slaughter. They were deprived of feed for 12 hours but had access to drinking water. The chickens were weighed in the morning and slaughtered by cutting the jugular vein. Slaughtered birds were scalded in hot water for 1 minute, after which feathers were manually removed. The birds were eviscerated for carcass yield and organ weight determination as indicated by Kleczek *et al*., (2007). The carcass and organs were weighed and calculated as percentage of the live weight.

### Chemical and Proximate Composition

The proximate analysis and the fibre fraction of the feed were conducted according to the method of AOAC (2005).

### Statistical Analysis

The results were subjected to statistical analysis using the analysis of variance

procedure of statistical analysis software (SAS, 2004).

## RESULTS AND DISCUSSION

The proximate compositions of the 3 treatment diets are presented in Table 1. The dry matter of the feed and test ingredients ranged from 86.00 to 89.33. The sun-drying of test samples was done for 7 days, bearing in mind, the possibility of nutrient loss such as the nonstructural carbohydrates, amino acids and certain minerals during drying (Odjo *et al*., 2015). Also, the sun-drying was done to provide a picture of what a typical village poultry farmer would get if implemented due to the absence of an electric oven in a village farm, not forgetting the quick deterioration of brewery by-product in the presence of moisture. The chemical composition was similar to literatures (Swain *et al*., (2012); Ashour *et al*., (2019); Ankra *et al*., (2014) and Demeke (2007). Crawshaw (2004) stated that, the nutritional composition of brewers grains as by-products varies due to the grain used, the industrial process involved and on the method of preservation. In this research, the compositions of the test samples were at a close range. However, the crude fibre value of BDG (18.00) was higher compared to the SSG (14.00). This follows the same trend with the values of cellulose (16.71 and 13.79 respectively). The NDF values of the test samples however showed that the SSG was higher than the BDG by 5.33%. The review on different researches on broilers consuming brewers' grain (Abd El-Hack *et al*., 2019) indicated high feed intake but low feed efficiency in birds that consumed more than 20% inclusion level. For example, in the work of Adama *et al*., (2007) who compared varying levels of sorghum dried brewers' grain (SDBG), it was noted that, increase in SDBG in the diet although reduced the cost of feed/kg, it however reduced the gross margin as well, thereby recommending 20% inclusion of SDBG as the inclusion level with the highest gross margin which is not far from the 15% inclusion level in this research.

Table 2 shows the feed formulation of both starter diet and finisher diet which were formed in isocaloric values. The control contained neither BDG nor RSSG. Therefore, the maize content in the control was higher and since the research is to reduce the cost of feed, the cost of control diet was higher.

**Table 1: Chemical Composition of Feed Samples Fed to Broilers**

| Content (%DM) | Test Feed | | Starter Diet | | | Finisher Diet | | |
|---|---|---|---|---|---|---|---|---|
| | BDG | RSSG | CTRL | 15%BDG | 15% RSSG | CTRL | 15%BDG | 15% RSSG |
| DM | 86.67 | 86.00 | 86.50 | 87.02 | 86.59 | 88.00 | 88.67 | 89.33 |
| CP | 25.04 | 25.59 | 22.75 | 23.41 | 22.97 | 19.95 | 21.54 | 22.31 |
| CF | 18.00 | 14.00 | 6.00 | 7.02 | 6.00 | 10.00 | 14.00 | 14.00 |
| Ash | 7.00 | 8.00 | 7.00 | 6.00 | 7.00 | 7.00 | 6.00 | 7.00 |
| EE | 9.02 | 8.00 | 7.00 | 7.40 | 8.02 | 12.00 | 11.04 | 11.34 |
| NFE | 40.94 | 44.41 | 57.25 | 56.17 | 56.01 | 51.05 | 47.42 | 45.35 |
| NDF | 37.55 | 42.88 | 14.36 | 12.49 | 12.86 | 15.01 | 14.20 | 13.12 |
| ADF | 21.00 | 21.00 | 10.00 | 12.00 | 11.00 | 8.04 | 12.00 | 10.00 |
| ADL | 14.29 | 17.21 | 4.00 | 8.33 | 5.00 | 6.37 | 5.50 | 6.00 |
| HEM | 16.55 | 11.88 | 4.36 | 0.49 | 1.86 | 6.97 | 2.20 | 3.12 |
| CELL | 16.71 | 13.79 | 6.00 | 3.67 | 6.00 | 1.67 | 6.50 | 4.00 |

*CTRL=Control; BDG=Brewers' dried Grain; RSSG=Red Sorghum Spent Grain; (S)= Starter; (F)=Finisher; DM=Dry Matter; CP=Crude Protein; CF= Crude Fibre; EE= Ether Extract; NFE= Nitrogen Free Extract; NDF= Neutral Detergent Fibre; ADF= Acid Detergent Fibre; ADL= Acid Detergent Lignin; HEM= Hemicellulose; CELL= Cellulose*

**Table 2: Gross Composition of Diets Fed to Broilers**

| Feed Ingredients % | Starter Diet | | | Finisher Diet | | |
|---|---|---|---|---|---|---|
| | CTRL | 15% BDG | 15% RSSG | CTRL | 15% BDG | 15% RSSG |
| Maize | 48.00 | 43.33 | 43.33 | 60.26 | 53.65 | 53.65 |
| Wheat Offal | 8.81 | - | - | 6.00 | - | - |
| BDG | - | 15.00 | - | - | 15.00 | - |
| SSG | - | - | 15.00 | - | - | 15.00 |
| GNC | 5.00 | 4.00 | 4.00 | 1.50 | 1.50 | 1.50 |
| SBM | 30.50 | 30.00 | 30.00 | 28.00 | 27.00 | 27.00 |
| Fish Meal | 2.50 | 2.50 | 2.50 | 1.00 | 1.00 | 1.00 |
| Palm Oil | 2.00 | 2.00 | 2.00 | - | - | - |
| Limestone | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| DCP | 1.50 | 1.50 | 1.50 | 1.50 | 0.13 | 0.13 |
| Methionine | 0.14 | 0.12 | 0.12 | 0.19 | 0.17 | 0.17 |
| Salt | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| Premix | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** |
| **Calculated Analysis** | | | | | | |
| Crude Protein | 23.11 | 23.22 | 23.22 | 20.08 | 20.06 | 20.06 |
| ME (Kcal/kg) | 2906.85 | 2841.82 | 2841.82 | 2901.48 | 2802.50 | 2802.50 |
| Lysine | 1.25 | 1.26 | 1.26 | 1.20 | 1.20 | 1.20 |
| Methionine | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| Calorie/ Protein Ratio | 125.78 | 122.00 | 122.39 | 144.50 | 139.68 | 139.68 |
| Cost per Kg of Feed | | | | 84.79 | 75.50 | 72.80 |

*Premix: Vit. A 8000iu, Vit. D3 2000iu, Vit. E 5iu, Vit. K 2mg, Riboflavin 4.20mg, Vit. B12 0.01mg, pantothenic acid 5mg, Nicotinic acid 20mg, Folic acid 1mg, Choline 300g, Mn 56mg, Fe 20mg, Cu 10mg, Zn 50mg and Co 1.25mg*

*CTRL=control; BDG= Brewers' Dried grain; RSSG= Red Sorghum Spent Grain*

**Carcass Characteristics**

Withholding feed for 12 hours before slaughtering ensures the reduction of gut contents and bacteria, which in turn reduces the risk of the carcass contamination during dressing without adversely affecting the meat yield and quality (Ajayi *et al*., 2017; Amaduruonye *et al*., 2018).

In Table 3, the resultant live weight showed that RSSG birds were significantly ($P<0.05$) lighter compared to the BDG and the control. Nwachukwu *et al*., (2009) noted that the body depth and breast width in broiler-type chicken are best indicators of body weight which in itself is a composite structure of determining carcass traits or variances. The carcass characteristics showed that there were no differences ($P>0.05$) among the test diets and the control in terms of percentage bled, plucked, eviscerated, dressed, head, neck, thigh, wing, shank, gizzard (with or without lining) and abdominal fat. This indicated that the different diets presented fairly similar ($P>0.05$) development of carcass traits with the

control. However, for the breast and back weights, birds on RSSG were significantly (P<0.05) lighter than those on BDG, although, both were not significantly (P>0.05) different from the control. For the drumstick, the RSSG exhibited significantly (P<0.05) lighter weight compared to the control, BDG was however not significantly different from the control and RSSG. For the crop weight, both BDG and RSSG were significantly (P<0.05) lower than the control. Therefore, the BDG was not significantly different (P>0.05) from the control for all the carcass parts analyzed except 'the crop' in which BDG was significantly (P<0.05) lighter in weight.

**Table 3: Carcass Characteristics of Broilers Fed 15% BDG and 15% SSG**

| Carcass (% of live weight) | CTRL | 15%BDG | 15%RSSG | SEM |
|---|---|---|---|---|
| Live weight (g) | 2390[a] | 2360[a] | 2120[b] | 16.25 |
| Bled | 93.42 | 96.14 | 87.74 | 1.22 |
| Plucked | 88.60 | 90.92 | 84.86 | 1.39 |
| Eviscerated | 81.14 | 81.87 | 75.29 | 0.89 |
| Dressed | 75.00 | 75.48 | 70.09 | 1.23 |
| Head | 2.20 | 2.55 | 2.29 | 0.09 |
| Neck | 4.23 | 4.11 | 4.05 | 0.11 |
| Thigh | 5.67 | 5.43 | 4.96 | 0.17 |
| Drumstick | 5.40[a] | 5.22[ab] | 4.79[b] | 0.08 |
| Wing | 4.20 | 4.21 | 3.96 | 0.06 |
| Shank | 1.80 | 1.81 | 1.86 | 0.05 |
| Breast | 20.54[ab] | 22.83[a] | 18.56[b] | 0.43 |
| Back | 14.87[ab] | 15.43[a] | 14.07[b] | 0.42 |
| Gizzard with lining | 2.26 | 2.35 | 2.24 | 0.04 |
| Gizzard without lining | 2.04 | 2.15 | 2.00 | 0.03 |
| Lining | 0.15 | 0.19 | 0.18 | 0.01 |
| Crop | 0.55[a] | 0.38[b] | 0.46[b] | 0.02 |
| Abdominal Fat | 2.04 | 1.61 | 1.32 | 0.05 |

*a,b,c * Means along the same row with different superscript(s) are significantly different (p<0.05).*
*CTRL= Control; BDG=Brewers' Dried Grain; SSG= Sorghum Spent Grain. SEM= Standard Error of Mean*

**Live weight**

The average live weight ranged from 2120 to 2390g with the RSSG having lower (P<0.05) final weights compared to the BDG and the control. The BDG and the control were however, not significantly (P>0.05) different from each other.

The eviscerated carcass ranged from 75.29 to 81.87% of live weight but was not significant (P>0.05) in which RSSG, control and BDG had 75.29%, 81.14% and 81.87% respectively. These results were however, higher compared to the reports of Swain *et al*., (2012).

The dressing percentage followed the same trend with the percentage eviscerated in which RSSG, control and BDG had 70.09%, 75.00% and 75.48% respectively but were not significant (P>0.05). The dressing percentage

are however, lesser than the report of Aduku and Olukosi (2000) who reported 78% for Nigerian dressed chickens. It was also lesser than the record of Ankra *et al*., (2014). The reason for the difference with Ankra *et al*., (2014) could be due to the treatment of sorghum spent grain (*pito* mash) with plantain peel ash extract.

The breast weights ranged from 18.56 to 22.83% of live weight and was significant (P<0.05). The birds on RSSG (18.56%) were less developed (P<0.05) compared to BDG (22.83%), although the results of both test diets were not different (P>0.05) from the control (20.54%). Adeleke *et al*., (2009) reported that there is a significant association between live weight and breast girth, that is, the two are strongly related and that the relative contribution of breast girth to the body weight of chickens is curvilinear.

The back weight followed the same trend with the breast weight. There was a significant difference (P<0.05) and the range was 14.07 to 15.43%. BDG (15.43%) was higher (P<0.05) than the RSSG (14.07%) although both were not significantly (P>0.05) different from the control.

The abdominal fat weight ranged from 1.32 to 2.04% of live weight but was not significant (P>0.05) in which RSSG, BDG and control had 1.32%, 1.61% and 2.04% respectively. The values of the abdominal fat followed the same trend with Swain *et al*., (2012) and Ashour *et al*., (2019) with control diet having higher value compared to the test diets although, in this research, not significantly (P>0.05) different from the test diets. According to Aderolu *et al*., (2007), excess energy supplied to animal could be stored in form of fat but the addition of fibre to the diet may cause dilution in the feed energy content making birds leaner due to reduced fat deposition.

Crop weights ranged from 0.38 to 0.55% of live weight and was significant (P<0.05). Birds in the control group (0.55%) had higher (P<0.05) crop weight while birds on BDG (0.38%) and RSSG (0.46%) were not significantly (P>0.05) different. According to Aderolu *et al*., (2007), the weight of crop may increase at graded level of dietary fibre due to more work to blend the fibre digested. However, in this experiment, the differences observed among the treatments indicated that the crops of the control diet were the heaviest, while that of the BDG was the lightest. This might also be due to the expansion of the crop of the BDG fed diet beyond the elastic limit in addition to the stress and strain that the crop would have experienced while the birds were trying to cope with the body requirement and the bulkiness of the feed (Adeyemi *et al*., 2012).

**Organ Characteristics**

Table 4 showed the organ characteristics of the birds on the different diets. There were no significant (P>0.05) differences among the treatments for the parameters measured.

**Table 4: Organ Characteristics of Broilers (as % of live weight) Fed 15% BDG and 15% RSSG**

| Organ (% of live weight) | CTRL | 15% BDG | 15% RSSG | SEM |
|---|---|---|---|---|
| Heart | 0.38 | 0.39 | 0.40 | 0.02 |
| Spleen | 0.05 | 0.08 | 0.08 | 0.02 |
| Duodenum | 1.69 | 1.53 | 1.52 | 0.05 |
| Caeca | 0.95 | 0.94 | 1.05 | 0.02 |
| Double Caeca | 1.88 | 1.87 | 2.10 | 0.04 |
| Colorectrum | 0.62 | 0.59 | 0.59 | 0.01 |
| Kidney | 0.46 | 0.48 | 0.52 | 0.03 |
| Lungs | 0.58 | 0.60 | 0.57 | 0.03 |
| Liver | 1.94 | 2.32 | 2.35 | 0.08 |

*a,b,c * Means along the same row with different superscript(s) are significantly different ($p<0.05$).*
*CTRL= Control; BDG=Brewers' Dried Grain; RSSG=Red Sorghum Spent Grain. SEM= Standard Error of Mean*

## CONCLUSION

It was concluded that, at 15% inclusion level, both BDG and SSG are good substitute for maize in conventional feed ration. However, the choice will be determined by the cost value of the ingredients which is dependent on availability.

## REFERENCES

Abd El-Hack, M. E., Alagawany, M., Patra, A., Abdel-Latef, M., Ashour, E. A., Arif, M., Farag, M. R. and Dhama, K. (2019). Use of brewers dried grains as an unconventional feed ingredient in the diets of broiler chickens: a review. *Advances in Animal and Veterinary. Science*, 7(3): 218-224.

Adama, I. Z., Ogunbajo, S. A. and Mambo, M. (2007). Feed intake, growth performance and nutrient digestibility of broiler chicks fed diet containing varying levels of sorghum dried brewer's grain. *International Journal of Poultry Science*, 6 (8): 592-598.

Adeleke, M. A., Ogunsanya, J. D., Akano, K., Ozoje, M. O., Ikeobi, C. O. N. and Olufunmilayo, A. A. (2009). Breast girth measurement as an estimate of live weight in Nigerian local chickens. *Nigerian Society for Animal Production*, 34: 399-401.

Aderolu, A. Z., Iyayi, E. A. and Onilude, A. A. (2007). Performance, organ relative weight, serum and hematology parameters in broilers finisher fed biodegraded brewers dried grain. *Pakistan Journal of Nutrition* 6(3): 204-208.

Adeyemi, O. A., Adekoya, J. A. and Sobayo, R. A. (2012). Performance of broiler chickens fed diets containing cassava leaf: blood meal mix as replacement for soybean meal. *Revista Científica UDO Agrícola*, 12 (1): 212-219.

Adeyemo, A. A. and Ifon, A. T. (2009). Extent of use of ICT by poultry farms in Oyo State. *Nigerian Society for Animal Production*, 34:244.

Aduku, A.O. and Olukosi, J.O. (2000). Animal Products Processing and Handling in the Tropics. 2nd ed. GU Publications. Abuja, Nigeria, 147.

Ajayi, O., Olumide, M. D., Tayo, G. O., Chioma, G. O., Akinsoyinu, A. O. and

Ndubuisi, L. O. (2017). Carcass and hematology parameters of broiler chickens reared on sun cured sesame supplemented sesame diet. *Proceedings of the Conference of Nigeria Society for Animal Production*, 42:135.

Alabi, O. O., Atteh, J. O., Adejumo, I. O. and Ogundele, O. O. (2014). Effects of dietary levels of brewers' dried grain supplemented with commercial enzymes on performance, nutrient retention and gastro- intestinal tract characteristics of Arbor Acre broilers. *International Journal of Agriculture Innovations and Research*, 2 (5): 2319-1473.

Amaduruonye, W., Ikwunze, K., Oguike, M. A. and Onunkwo, D. N. (2018). Influence of ginger (*Zingiber officinale*) on histology, blood profile and internal organ characteristics of broilers. *Nigerian Journal of Animal Science*, 20(1):61-71.

Ankra, A. B., Sam, E. A. and Nyantakyi, S. (2014). Improving the utilization of sorghum spent grain (Pito mash) in broiler diets by treating with plantain peels ash extract. *Journal of Biology, Agriculture and Health Care*, 4:26.

AOAC (2005). Official Methods of Analysis. *Association of Official Analytical Chemists*, Washington D.C., USA, Page 48.

Ashour, E. A., Abd El-Hack, M. E., El-Hindawy, M. M., Attia, A. I., Osman, A. O., Swelum, A.A., Alowaimer, A. N., Saadeldin, I. M. and Laudadio, V. (2019). Impacts of dietary inclusion of dried brewers' grains on growth, carcass traits, meat quality, nutrient digestibility and blood biochemical indices of broilers. *South African Journal of Animal Science*, 49:3.

Awodola, P. O. O. and Yahaya, M. O. (2017). Growth performance and carcass characteristics of broiler chickens fed with graded levels of Roselle calyx (Hibiscus sabdariffa L.). *Annual Conference of Nigerian Society for Animal Production*, 42:246.

Crawshaw, R., (2004). Co-product feeds: animal feeds from the food and drinks industries. Nothingham University Press. http://www.amazon.com/Co-Product-Feeds-Animal-Drinks-Industries/dp/1897676352

Demeke S. (2007). Comparative nutritive value of Atella and industrial brewers' grains in Chicken starter ration in Ethiopia. *Livestock Research for Rural Development*, 19:8. http://www.Irrd.org/Id19/1/deme19008.htm

Holmes, C. P., Cahill, G., Smart, K. A. and Cook, D. J. (2013). The composition and ultrastructure of sorghum spent grain. *Journal of the Institute of Brewing*, 119: 41–47.

Ironkwe, M. O. and Bamgbose, A. M. (2011). Effect of replacing maize with brewers dried grain in broiler finisher diet. *International Journal of Poultry Science*, 10(9): 710-712.

Kleczek, K., Wilkiewicz-Wawro, E., Wawro, J., Makowski, W. (2007). Effect of body weights of day-old Muscovy ducklings on the growth and carcass traits. *Arch. Tier. Dummerstorf*, 50(2): 204-213.

Nwachuckwu, E. N., Amaechi, A. F. and Oke, U. K. (2009). Growth and carcass characteristics of crossbred frizzle and normal feather broiler in a humid tropical environment. *Nigeria Society for Animal Production*, 34:378-381.

Odjo, S. D. P., Malumba, P. K., Yves, B. and François B. (2015). Impact of drying and heat treatment on the feeding value of corn. A review. *Biotechnology, Agronomy, Society and Environment*, 19(3): 301-3

Olajide, R., Akinsoyinu, A.O., Iyayi, E.A. and Afolabi, K.D. (2013). The effect of brewers

dried grains supplemented by enzyme on performance of isa-brown laying hens. *Poljoprivreda*,19:2013 (1) 65-69.

Olorede, B.R., Jimoh, A.A. and Mokogwu, O.B. (2009). The effect of the processing methods of *Faidherbia Albida* 'Gao' on the hematology and serum chemistry of broiler chickens. *Nigerian Society for Animal Production*, 34:92.

Onunkwo, D. N., Ugwuene, M. C., Eze, J. C. R. and Okpechi, F. C. (2018). Replacement value of palm kernel meal for maize on growth, egg quality, and economic parameters of local duck hens. *Nigerian Journal of Animal Science*, 20 (1): 145-151.

Onyimba, I. A., Ogbonna, C. I. C., Akueshi, C. O.and Chukwu, C.O.C. (2009). Changes in the nutrient composition of brewery spent grain subjected to solid state natural fermentation. *Nigerian Journal of Biotechnology*, 20:55 – 60. http://www.ajol.info/index.php/njb/index

SAS (2004). Statistical Users Guide. SAS. Int., Cary, NC. USA.

Selle, J. and Ravindran, V. (2007). Microbial phytase enzyme in poultry nutrition. A Review. *Animal Feed Science and Technology*, 135: 1-41.

Swain, B. K., Naik, P. K., Chakurkar, E. B. and Singh, N. P. (2012). Effect of feeding brewers' dried grain on the performance and carcass characteristics of Vanaraja chicks. *Journal of Applied Animal Research*, 40(2):163-166.