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ORIGINAL RESEAECH ARTICLE

Growth performance and nutrients digestibility of cockerels fed varying levels of Garri-waste as replacement of maize

A.R. Asafa[1*], M.A. Adejobi[1], M.A. Onigemo[1], M.O. Raji[2], D.O. Obasoyo[4] and A.M. Bamgbose[1,3]

[1]Department of Animal Production, Lagos State University of Science and Technology, Ikorodu, Lagos State, Nigeria
[2]Department of Animal Health and Production Technology, Oyo State College of Agriculture and Technology, P.M.B 10, Igboora, Oyo State, Nigeria
[3]Department of Animal Nutrition, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
[4]Department of Animal and Food Science, Ambrose Alli University, Ekpoma, Edo State, Nigeria
[*]Corresponding author's E-mail: alarapeazeez91@gmail.com

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ABSTRACT

This study evaluated the effects of replacing maize with gaari-waste on the performance and nutrient digestibility of cockerels. One hundred and twenty cockerels were fed diets with 0%, 25%, 50% and 75% gaari-waste replacing maize for 70 days to determine the optimal level of gaari-waste inclusion in the cockerel diets. Experiments was conducted under completely randomized design (CRD) design using four dietary treatments, three replicates, and ten birds per replicate. Results revealed no significant difference ($p>0.05$) in feed intake, weight gain and feed conversion ratio among treatments. Birds fed diet-1, diet-3 and diet-4 at the starter phase had the highest values of weight gain 40.41g, 33.26g and 30.66g, respectively while weight gains decreased as the inclusion levels of garri-waste increased as followed 45.77g, 43.03g, 38.77g and 35.67g for T_1, T_2, T_3 and T_4 across dietary treatments, respectively. The highly significant ($p<0.05$) effect of crude protein (82.91), fiber (53.33) and dry matter digestibility (46.14) were observed with T_2 treatment, the least (68.63%) crude protein digestibility was obtained on the T_1 treatment while ash and dry matter digestibility with T_4 treatment had the least significant ($p<0.05$) effect of 30.77% and 22.08%, respectively. Conclusively, garri-waste can replace maize in cockerels' diets up to 75% without adverse effects on growth performance and apparent nutrient digestibility, offering a cost-effective alternative to maize.

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INTRODUCTION

Maize, a primary energy source in poultry feed, is increasingly expensive, threatening the sustainability of cockerel production (Adeola & Akinola, 2018; Unah *et al*., 2019). Previous studies have explored alternative feed ingredients, but the potential of gaari-waste, a by-product of cassava processing, remains underexploited (Ogunji & Okoye, 2017; Udensi *et al*., 2024). Limited information exists on the use of gaari-waste as a maize substitute in cockerel diets, creating a need to evaluate its impact on performance and nutrient digestibility. Identifying cost-effective alternatives to maize can enhance poultry production profitability and reduce waste management issues associated with gaari production (FAO, 2018). Garri-waste (a byproduct of cassava processing, often including peelings, grits, or starch residue) can serve as a partial replacement for maize in cockerel diets, with studies suggesting that replacement levels up to **50%** are feasible without severely compromising growth, provided the diet is properly formulated (Unah *et al*., 2019; Udensi *et al*., 2024). While high levels (75%–100%) generally reduce weight gain and efficiency, lower inclusion levels can be economically viable, particularly during the grower phase. There are factors that constitute an interference to the rapid expansion of rigorous poultry production in Nigeria, they are majorly

the high cost of feeds and feedstuffs and insufficient quantity of feed at the proper quality and quantity to the birds (Ojewola & Obasi, 2003; Owen *et al*., 2017). Feed constitutes about seventy to eighty percent of the total production cost in poultry occupational. Though, among various cereal grains, maize is a common feedstuff of choice for energy in monogastric diet and its inclusion in diets ranges from fifty to seventy percent (Ojewola & Obasi, 2003; Durunna *et al*., 2005). This study reported the pioneers use of gaari-waste as a maize replacement in cockerel dies, addressing a critical research finding gap. Therefore, this study evaluated the effects of replacing maize with graded levels of gaari-waste on the performance and nutrient digestibility of cockerels.

MATERIALS AND METHODS

Experimental site

The research was carried out at the Poultry unit of Animal Production Department Lagos State University of Science and Technology, Ikorodu, Lagos State, latitude 6.27^0 N and longitude 3.23^0 E. The area is elevated 11m above sea level with an average annual rainfall of 1506.6mm and temperature range of 26.8^0C (Maplandia, 2016).

Experimental design

The garri-waste was procured at a milling center in a popular market, Ikorodu while other ingredients were bought from a feed mill, Ikorodu, Lagos State, Nigeria. One hundred and twenty day-old cockerels were purchased from a reputable hatchery in Ibadan. Prior to the arrival of the birds, the brooder house was washed, disinfected and sealed with polythene sheets. Litter materials (wood shavings) were spread on the floor of the brooder house and the pen was pre-heated. After the arrival of the birds, feed and water shall be supplied *ad-libitum* for a period of ten weeks, routine medication and vaccination were strictly adhered throughout the duration of the study. A completely randomized design (CRD) was used for the experiment, the experiment had four treatments with thirty birds per treatment, and each treatment was replicated thrice with ten birds per replicate. Four experimental diets were formulated, diet-1 (T_1) had 0% inclusion of the garri-waste (control), diet-2 (T_2) had 25%, diet-3 (T_3) had 50% and diet-4 (T_4) had 75% inclusion of garri-waste to replaced maize (Table 1).

Data collection

At the end of the study, the following data were collected.

Feed intake: This is the difference between the total quantity of feed consumed and the total leftovers divided by the number of birds (NRC, 1994).

Average feed intake = Total feed supplied - total leftovers / Number of birds

Weight gain: This is the difference between final live weight of birds and the initial live weight of the birds divided by the number of birds (NRC, 1994).

Average weight gain= Final live weight - initial live weight / Number of birds

Feed conversion ratio: This is a measure of an animal's efficiency in converting feed mass into meat (NRC, 1994).

Feed conversion ratio (FCR) = Average feed intake / Average body weight gain

Digestibility: This is the proportion of a foodstuff absorbed from the digestive tract into the bloodstream. Two birds per replicate were randomly selected and transferred to metabolic cages, and polythene sheets were placed under the cages for the collection of the droppings for three days, then sundried. This was carried out on the 6^{th} week for starter digestibility and on the 10^{th} week for finisher digestibility (NRC, 1994).

Apparent Nutrients Digestibility= Nutrient feed intake-Nutrient faecal output x 100 / Nutrient feed intake

Data analysis

Data collected were subjected to one-way Analysis of Variance (ANOVA) by using SPSS (2021). Duncan Multiple Range Test (DMRT) was used to differentiate significant ($p<0.05$) means between variables.

Table 1. Experimental diets (1-10 weeks).

Feed ingredients	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)
Maize	50.00	37.50	25.00	12.50
Wheat offal	18.00	14.00	10.00	6.50
Soybean meal	8.00	8.00	8.00	8.00
Groundnut cake	20.00	23.50	27.00	30.00
Garri-waste	0.00	12.50	25.00	37.50
Bone	2.50	2.50	2.50	2.50
Limestone	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25
Palm oil	0.0	0.50	1.00	1.50

RESULTS AND DISCUSSION

Proximate composition of garri-waste and experimental diets

The proximate composition of the garri-waste and experimental diets are shown in Tables 2 and 3. The metabolizable energy (M.E.) values of the diets were 2804.00 (kcal/kg), 2808.40 (kcal/kg), 2812.20 (kcal/kg) and 2812.00 (kcal/kg) for T_1, T_2, T_3 and T_4, respectively while M.E for garri-waste is 3003.91 (kcal/kg), aligning with recommended values (Buitrago *et al.*, 2002). Crude proteins content in diets ranges from 19.99 (%) to 20.13 (%), exceeding the 16% requirement for cockerels. Garri-waste crude protein (2.20%) is consistent with previous report (1-3%) (Stupak *et al.*, 2006; Udensi *et al.*, 2024). Therefore, the experimental diets in this study met with the stipulated M.E., and crude protein level.

Growth performance of cockerels fed varying levels of garri-waste

The growth performance of cockerels fed with varying levels of garri-waste is shown in Table 3 Feed intake of the birds, according to statistical analysis, was not significantly ($p > 0.05$) influenced at the starter phase, as reported by Unah *et al.* (2019). Birds fed diet-1 had the highest feed intake value of 128.08 (g), while birds on diet-3 had the lowest feed intake (71.99g). At the finisher phase, birds also showed no significant ($p > 0.05$) effect in the feed intake. Birds fed diet-3 had the lowest feed intake value (249.41g), while birds fed diet-1 had the highest feed intake (323.60g). Table 2 also revealed that average weight gains of the birds did not differ significantly ($p > 0.005$) at both starter and finisher stages, which is in line with the finding of Enwelim (2025). Birds fed diet-1 had the highest weight gain (44.41g) at starter and 45.77 (g) finisher stages, probably due to the highest feed intake among the flock. The result of the present research indicates that cockerels in the treatment groups utilized gaari waste efficiently like maize and that gaari waste can substitute maize up to 75% inclusion levels without causing any deviation in performance parameters as supported by Udensi *et al.*, 2024). This observation is in accord with the report of Owen *et al.* (2017) who submitted that feed intake is a major determinant of weight gain and the amount of feed consumed is a critical factor in determining the rate and composition. The feed conversion ratio (FCR) is a determinant of feed consumed and weight gain. Non-significant ($p > 0.05$) differences were observed at both starter and finisher stages of the experiment. Birds fed with diet -3 had the best FCR at both the starter (2.60) and finisher (6.22) stages of the study.

Effect of varying levels of garri-waste on apparent nutrient digestibility of cockerels

The apparent nutrient digestibility coefficient (ANDC) of cockerels fed varying levels of garri-waste is shown in Table 4. Statistical analysis revealed a significant ($p < 0.05$) difference in the apparent crude protein digestibility (ACPD). The result of means separation revealed that the ACPD values for T_2, T_3 and T_4 were not significantly ($p > 0.05$) different from one other but differed significantly ($p < 0.05$) with T_1. Also, there was a significant ($p < 0.05$) difference in the crude fibre values where T_4 differed significantly ($p < 0.05$) from others, although T_2 did not differ ($p > 0.05$) from T_3 but T_1 differed significantly from T_2 and T_3. Both ether extract and ash showed no significant ($p > 0.05$) effect. Digestibility was affected by feed consumption and composition, that is, they affect animal growth and nutrient utilization.

Table 2. Proximate composition of garri-waste and experimental diets.

Variables	Garri waste	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)
ME (Kcal/kg)	3003.91	2804	2808.4	2812.2	2812
Crude protein (%)	2.20	19.99	20.06	20.13	20.05
Crude fiber (%)	4.80	4.05	4.20	4.34	4.50
Ether extract (%)	0.28	3.91	4.02	4.12	4.21
Ash content (%)	1.20	7.04	7.21	7.37	7.55
Dry matter (%)	83.90	87.47	87.27	87.07	86.77

ME= Metabolizable Energy.

Table 3. Growth performances of cockerels fed varying levels of garri-waste.

Variables	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	SEM
Average feed intake (g/bird/week) starter	128.08	75.31	71.99	84.04	12.99
Average feed intake (g/bird/week) grower	323.60	306.91	249.41	276.00	16.47
Average weight (g/bird/week) gain starter	40.41	28.34	33.26	30.66	2.61
Average weight gain (g/bird/week) grower	45.77	43.03	38.77	35.67	2.24
Feed conversion ratio (starter)	3.73	3.74	2.60	2.52	0.27
Feed conversion ratio (grower)	6.87	6.97	6.22	7.83	0.33

Table 4. Apparent nutrient digestibility coefficient.

Variables (%)	T_1 (0%)	T_2 (25%)	T_3 (50%)	T_4 (75%)	SEM
Crude protein	68.63^{b}	82.91^{a}	83.36^{a}	82.51^{a}	3.58
Crude fiber	40.00^{b}	53.33^{a}	35.02^{ab}	30.77^{c}	4.89
Ether extract	95.14	97.76	97.82	96.84	0.62
Ash content	99.86	100.00	99.86	100.00	0.04
Dry matter	23.40^{b}	46.14^{a}	22.48^{b}	22.08^{ab}	5.88

^{abc} Mean values on the same row having different superscript were significantly different ($p < 0.05$).

Conclusion

In conclusion, the results of this study showed that diet containing 50% garri-waste improved birds' performance, as evidence in feed intake, weight gain and the feed conversion ratio. Notably, the birds fed with all the inclusion of garri-waste showed no adverse effect on the performance, indicating that gaari-waste can be a viable substitute for maize in cockerel diets. These outcomes highlight the potential of gaari-waste as a sustainable and cost effective alternative feed ingredient in poultry production. Gaari-waste can be recommended for cockerel diets at any inclusion levels without negatively impacting growth performance and digestibility. Future research should focus on exploring the effects of gaari-waste on carcass characteristics, meat quality and economic viability to further establish its suitability as a feed ingredient. Alternatively, investigating the nutritional and environmental impacts of large scale gaari-waste utilization in poultry feed could provide valuable insights for the poultry industry

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DECLARATIONS

Author contribution statement: Conceptualization: A. R.; Methodology: A. M.; Software and validation: D. O. and M. A; Formal analysis and investigation: A. R; Resources: M. A.; Data curation: D. O.; M. A; Writing original draft preparation: M. A.; Writing review and editing: M. A. and M. O.; Visualization: A. R; Supervision: A. R.; Project administration: A. M. All authors have read and agreed to the published version of the manuscript.

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