ADAN J. Agric. 2026, 7 (1): 71-77
© *Association of Deans of Agriculture in Nigerian Universities (ADAN)*
ISSN 2736-0385
DOI: **10.36108/adanja/6202.70.0180**

Growth performance of broiler chickens fed diets containing rumen-filtrate fermented maize cobs as partial replacement for maize

Mijindadi, H. M., Oluwafemi, R.A., Hamzat, R.A. and Shoyombo, A.
Department of Animal Science, Faculty of Agriculture, University of Abuja. Abuja. Nigeria

Corresponding Author: *huleratmijindadi@yahoo.com*

Abstract

High cost of maize in commercial poultry production remains one of the challenges towards meeting animal protein requirements by Nigerians. This study evaluated the effects of graded levels of Rumen-Filtrate Fermented Maize Cobs (RFFMC) as partial replacement for maize in broiler chicken's diet. The experiment lasted for eight weeks in a Completely Randomized Design (CRD), and was carried out at the poultry unit of the University of Abuja Teaching and Research farm, Faculty of Agriculture, permanent site, along Giri-Airport Road, Abuja. There were four (4) dietary treatments and three (3) replicates per treatment with ten (10) birds per replicate. Standard routine management procedures were strictly followed. The test ingredients replaced maize at 0%, 10%, 20% and 30% levels for T1, T2, T3 and T4 respectively. Growth performance data (feed intake, daily weight gain, FCR were collected). The results revealed significant differences (P< 0.05) in body weights at Weeks 1, 3, and 4, as well as for overall weight gain and average daily weight gain. However, at Week 2, birds fed diets containing RFFMC recorded a total weight of 458.98 g. Birds fed the control diet recorded the highest weight gain, while those on 30% inclusion recorded the lowest. Body weight at Week 4 declined from 1622.25 g (control) to 1394.72 g (30% inclusion). Feed Intake (FI) was significantly influenced (P < 0.05) by dietary treatments. Birds on the 10% inclusion diet recorded the highest FI (1085.35 g/bird), while the control and other inclusion levels recorded lower but comparable values. T1 had the best Feed Conversion Ratio (FCR) of 1.82. This research concluded that rumen-filtrate fermentation can be used to enhance the potential of maize cobs as partial replacement for maize in broiler chicken's diets but at a lower rate.

Keywords: *Broiler chicken, diets, maize cobs, performance, nutrient retention*

Introduction

Poultry production remains one of the fastest-growing sectors of the global livestock industry, offering a sustainable source of high-quality animal protein for human consumption (FAO, 2023). In Nigeria, poultry farming contributes significantly to food security, employment, and national income (Oladele *et al*., 2021). Poultry is one of the most efficient sources of animal protein, with poultry meat and eggs being rich in essential amino acids, vitamins, and minerals that are critical for human growth and health (FAO, 2019). In Nigeria, poultry production has the potential to significantly boost per capita animal protein intake, thus addressing protein-energy malnutrition, especially among vulnerable groups such as children and women (Ogundipe and Sanni, 2020).

The poultry industry in Nigeria faces numerous obstacles that limit its contribution to solving the protein shortage. Key challenges include high feed costs, which account for up to 70% of production expenses, leading to increased prices of poultry products that are out of reach for many Nigerians (Olukosi and Adeyemi, 2019). According to Afolayan *et al*., (2020), the growth of the industry is severely constrained by the high cost of conventional feed ingredients, particularly maize, which accounts for over 50% of poultry feed formulation.

There is a growing emphasis on exploring alternative feed sources that can reduce dependence on conventional ingredients and lower feed costs. One promising approach is the utilization of agricultural wastes and by-products, which are abundant and underutilized in Nigeria Adeyinka, (2022). Oluwafemi (2022) highlights the potential of incorporating agricultural wastes such as cassava peels, rice bran, and palm kernel cake into poultry diets. The author further explained that when properly processed, agricultural wastes can serve as viable substitutes for conventional feed ingredients without significantly compromising the nutritional quality of the feed.

Maize cob, an agro-industrial by-product is not directly utilized by humans. A possible potential benefit of dietary inclusion of maize cob meal is its widely availability as crop residue that is abundant in the tropical areas of the world, and when treated and used in poultry feeding could reduce the cost of production and improve the quality of their carcasses. In the past, maize cobs were being used solely as a source of fuel energy for domestic cooking and sometimes in ruminant feeding due to its high fibre content (Oladele *et al*., 2021). However, in recent times, due the search for alternative and non-conventional energy ingredients, maize cob is being incorporated as partial replacement for maize in chicken diets.

Rumen filtrate fermentation, which is the process of inoculating fibrous biomass with rumen microbes under anaerobic conditions, has shown promise in enhancing the digestibility and crude protein content of crop residues (Yang, 2021). The diverse microbial consortia in rumen fluid are capable of breaking down complex polysaccharides and producing valuable microbial proteins and short-chain fatty acids, thereby upgrading the nutrient profile of fibrous substrates (Badhan, et al., 2022). In Nigeria, studies by Bello *et al.* (2023), Olaleye and Adegoke. (2024), and Onyeneke *et al.* (2020) have demonstrated improved in vitro gas production and nutrient utilization of rumen-filtrate-treated maize residues and rice husks when incorporated into broiler diets. This research therefore seeks to fill this gap by evaluating the growth performance of broiler chickens fed diets containing graded levels of rumen-filtrate fermented and enzyme-supplemented maize cobs as replacement for maize

Materials and Methods

Experimental site

The experiment was carried out at the poultry unit of the University of Abuja Teaching and Research farm, permanent site, Gwagwalada, of the Department of Animal Science, Faculty of Agriculture, Nigeria, Gwagwalada town is situated between latitude 80 55’ and 80 57’ North longitude70 05’ and 70 06’ East. Temperature ranges from 28 – 330C in the day time and 22 – 250C in the night. It is located in the Southern Guinea Savannah Vegetation Zone of Nigeria (Weatherspark, 2019). the study was carried out between August and February

Collection and processing of test ingredients:

White local Maize cobs were collected from farmers in Suleja, Niger-state, Nigeria. The maize cobs were sun dried and reduced to smaller particles by pounding with mortar and pestle to produce maize cob meal. The rumen (Bovine) content was collected from Suleja abattoir into a cellophane lining bag at about 6am in morning and was transported immediately to the farm for further preparation. Some quantity (10 kg) of the bovine rumen content was measured and mixed with (40kg) of distilled water to get the quantity of filtrate required. The liquid was filtered with a plastic sieve and the debris were disposed. The filtrate was poured into a container and the initially prepared maize cob meal was added to the filtrate and mixed properly until there was even mixing, then it was preserved anaerobically in a fifty-kilogram bag with cellophane lining and put on top of a plank for twenty-four hours (24h), then the rumen filtrated fermented maize cobs was shade dried for four days.

Experimental diets and design

The experiment was laid out as a Complete Randomized Design (CRD) with four (4) dietary treatments and three (3) replicates per treatment with ten (10) birds per replicate making a total of thirty (30) birds per treatment. One hundred- and twenty-day old Arbo acre strain broiler chicks were randomly allotted into the four dietary groups The experimental diets were formulated to meet the nutrient requirements of the broiler chickens in line with the nutrient recommendation of the National Research Council (NRC, 1994). The experimental diets were formulated such that Rumen Filtrate Fermented Maize Cob (RFFMC) replaced maize at 0, 10, 20 and 30% on weight for weight basis.

Experimental animals and management

The birds were weighed on upon arrival and weekly thereafter. The chicks were fed broiler starter from 0 to 4 weeks and broiler finisher 5 to 8 weeks. Data were collected on feed intake and weight gain. Feed conversion ratio and mortality rate were also recorded as they occurred. Adequate feeding and watering space was provided to all the birds throughout the experimental period. The birds were given free access to fresh, clean drinking water with immunization against Infectious Bursal Disease (IBD) and Newcastle Disease administered as at when due. Standard management practices were observed throughout the period of eight (8) weeks.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using the procedures of SAS (2001) and means were separated using Duncan Multiple Range Test (Duncan, 1955)

Results

At Week 1 chicks fed the control diet (0 g/kg inclusion) had the highest mean Body Weight (BW) (192.93 g). Inclusion of 10–20 g/kg caused a numerical reduction in Week-1 BW with the lowest value recorded at 20 g/kg (176.37 g). A similar numerical reduction pattern continued into Weeks 2 and 3 where the control group consistently exhibited higher body weights and the lowest values were observed at 30 g/kg inclusion. By Week 4 BW declined in magnitude with increasing inclusion of the test diets falling from 1628.37 g at 0 g/kg to 1396.00 g at 30 g/kg. Overall weight gain (WGS) similarly declined with inclusion indicating a dose-dependent depression in growth performance under RFFMC. The pattern observed during the starter phase continued throughout the finisher phase. Birds on the control diet maintained the highest body weights throughout Weeks 5–8 while birds on 30 g/kg inclusion recorded the lowest weights. Finally, Week-8 BW declined from 4350.23 g at 0 g/kg to 3660.20 g at 30 g/kg. Finisher weight gain (WGF) was markedly higher in the control (2037.90 g) compared to 30 g/kg inclusion (1662.60 g). ADG showed the same pattern dropping from 72.78 g/day at 0 g/kg to 59.38 g/day at 30 g/kg reflecting a consistent depression in performance at higher inclusion levels.

Table 1: Composition of Experimental Broiler Starter Diets

Ingredients (%)	T1 (Control)	T2 (10%)	T3 (20%)	T4 (30%)
Maize	49.00	44.10	39.20	34.30
RFFMC	0.00	4.90	9.80	14.70
Blood meal	1.50	1.50	1.50	1.50
Maize offal	5.00	5.00	5.00	5.00
BDG	2.00	2.00	2.00	2.00
Fish Meal	2.00	2.00	2.00	2.00
G/Cake 44%	7.65	7.65	7.65	7.65
Soya cake	28.00	28.00	28.00	28.00
Limestone	1.80	1.80	1.80	1.80
Bone meal	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25
Vit TM Premix	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00
Determined nutrient Composition (%)				
Dry matter	92.14	91.88	92.28	91.90
Crude protein	23.88	22.98	23.00	23.00
Crude fibre	3.01	3.22	3.98	3.18
Ether extract	4.35	4.81	4.66	4.98
Ash	6.44	6.81	7.12	6.80
NFE	62.32	62.18	61.24	61.72
ME:Kcal/kg	3448.71	3447.74	3402.95	3445.94

Vit. TM premix contains: Vitamin A 10,500,000 I.U, Vitamin D3 2,500,000 I.U, Vitamin E 40,000mg, Vitamin K 2,500mg, Vitamin B1 1,750mg, Vitamin B2 5,000mg, Vitamin B6 4,000mg, Vitamin B12 20mg Niacin 40,000mg, Panth Acid 10,000mg, Folic Acid 3,000mg, Biotin 100mg, Choline 400,000mg, Manganese 80,000mg, Zinc 60,000mg, Iron 40,000mg, Copper 8,000mg, Iodine 1,200mg, Selenium 200mg, Cobalt 300mg, Antioxidant 125mg. ESMC- Enzyme Supplemented Maize cob, BDG: Brewers Dried Grain, GNC- Groundnut cake, RFFMC: Rumen-Filtrate Fermented Maize Cobs

Discussion

The results of this study reveal clear and persistent effects of inclusion levels on the performance characteristics of broiler chickens. Growth performance was strongly and negatively influenced by increasing inclusion levels, particularly at 20–30%, which significantly reduced body weight gain starter and finisher (WGS/WGF), and average growth rate (AGR) across both starter and finisher phases. This outcome is consistent with recent studies showing that high inclusion of phytogenic or fibre-rich feed additives depresses growth due to nutrient dilution, increased indigestible fractions, or the presence of residual anti-nutritional factors (Adegbeye *et al*., 2020; Al-Khalaifah, 2023). Importantly, ESMC consistently improved growth performance at the finisher phase, which suggests that processing mitigates the anti-nutritional burden of the additive, this is consistent with the findings of Chen *et al*. (2020) and Toghyani *et al*. (2021).

Table.2: **Composition of Experimental Broiler Finisher Diets**

Ingredients, %	T1(Control)	T2 (10%)	T3 (20%)	T4(30%)
Maize	55.00	49.50	44.00	38.50
RFFMC	0.00	5.50	11.00	16.50
Maize offal	4.00	4.00	4.00	4.00
BDG	2.40	2.40	2.40	2.40
G/Cake	8.00	8.00	8.00	8.00
Soya cake	25.00	25.00	25.00	25.00
Fish Meal	1.50	1.50	1.50	1.50
Toxin binder	0.10	0.10	0.10	0.10
Limestone	1.00	1.00	1.00	1.00
Bone meal	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25
Vit TM Premix	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Determined nutrient composition (%)				
Dry matter	93.33	92.67	92.58	92.36
Crude protein	21.90	21.11	20.88	21.55
Ether extract	5.85	4.94	5.60	5.81
Crude fibre	7.20	8.01	7.63	7.13
Ash	8.05	7.79	7.95	7.15
NFE	57.00	58.15	57.88	58.36
ME:Kcal/kg	3308.24	3246.03	3281.46	3340.32

Vit. TM premix contains: Vitamin A 10,500,000 I.U, Vitamin D3 2,500,000 I.U, Vitamin E 40,000mg, Vitamin K 2,500mg, Vitamin B1 1,750mg, Vitamin B2 5,000mg, Vitamin B6 4,000mg, Vitamin B12 20mg Niacin 40,000mg, Panth Acid 10,000mg, Folic Acid 3,000mg, Biotin 100mg, Choline 400,000mg, Manganese 80,000mg, Zinc 60,000mg, Iron 40,000mg, Copper 8,000mg, Iodine 1,200mg, Selenium 200mg, Cobalt 300mg, Antioxidant 125mg. RFFMC- Rumen-filtrate fermented Maize cob, BDG: Brewers Dried Grain, GNC- Groundnut cake

Table 3: Weekly Body change of Broilers fed RFFMC based Diets at the Starter phase

Variable	T1 (0 g/kg)	T2 (10 g/kg)	T3 (20 g/kg)	T4 (30 g/kg)	SEM
Initial Body W (g)	40.00	36.67	40.00	38.00	0.69
Week 1 BW (g)	192.93a	176.87ab	176.37ab	182.63b	5.30
Week 2 BW (g)	493.07a	461.97b	450.93bc	429.97c	12.00
Week 3 BW (g)	992.90a	918.30b	879.00c	833.53d	25.00
Week 4 BW (g)	1628.37a	1559.90ab	1431.43c	1396.00c	40.50
WG (g)	1588.37a	1523.23ab	1391.43c	1358.00c	45.00
ADG (g/day)	56.66a	54.21b	49.62c	48.36c	1.00

abc: Treatment means in the same column, (with a particular criterion) having different superscripts letters, are significantly different (P< 0.05). BW: Body weight WG: Total weight gained ADG: Average daily gain

Table 4 Growth Performance of Broilers at Finisher Phase fed RFFMC based Diets

Variable	T1 (0 g/kg)	T2 (10 g/kg)	T3 (20 g/kg)	T4 (30 g/kg)	SEM
Week 5 BW (g)	2312.33a	2268.63ab	2118.50c	1997.60d	45.00
Week 6 BW (g)	3176.07a	2923.03b	2866.87bc	2765.00c	95.00
Week 7 BW (g)	3671.77a	3416.03ab	3386.53bc	3230.87c	120.00
Week 8 BW (g)	4350.23a	3783.67b	3832.13bc	3660.20c	150.00
WG (g)	2721.86a	2233.77b	1713.63bc	2400.70c	95.00
ADG (g/day)	72.78a	54.11b	61.20c	59.38c	3.00

abc: Treatment means in the same column, (with a particular criterion) having different superscripts letters, are significantly different (P< 0.05).BW: Body weight WG: Total weight gained ADG: Average daily gain

Increasing treatment levels led to a clear dose-dependent decline in body weight, weight gain, and AGR, confirming that excessive inclusion negatively impacted performance. This aligns with Adeyemi *et al*. (2021) and Akinola *et al*. (2023), who observed that phytogenic or fibre-rich feed additives can depress growth at high inclusion due to reduced digestibility and nutrient utilization. These findings are consistent with Okoro *et al*. (2020), who emphasized that optimum inclusion levels of unconventional feed ingredients vary with growth stage. At starter phases, lower tolerance is observed, while at finisher stages, birds may adapt metabolically but still under perform relative to controls.

Conclusion

The findings indicate that increasing treatment levels adversely affected body weight and growth performance of broilers, especially beyond 10 % inclusion. These results are consistent with recent reports that excessive inclusion of certain non-conventional feed additives or poorly processed ingredients may depress growth due to antinutritional factors or reduced nutrient digestibility (Adeyemi *et al*., 2021; Hassan *et al*., 2022). Similarly, Okoro *et al*. (2020) found that growth performance was maximized at moderate inclusion levels but declined significantly at higher dosages.

Recommendations

1. Inclusion level is recommended to be limited to ≤10% to avoid adverse effects on growth performance.
2. Farmers should balance availability and growth performance when considering dietary inclusion of maize cobs in broiler chicken diet.
3. Future research should explore synergistic use with enzymes or probiotics to mitigate anti nutritional effects

References

Adegbeye M. J. Elghandour M. M. Monroy J. C. Abegunde T. O. Salem A. Z. & Laudadio V. (2020). Potential influences of dietary strategies on broiler production: A review. Animal Biotechnology 31(2) 89–98. https://doi.org/10.1080/10495398.2019.1634983

Adeyemi, O. A., Oke, E. O & Adebiyi, O. A. (2021). Effects of phytogenic feed additives on broiler performance and gut health. Journal of Applied Poultry Research, 30(2), 100–109. https://doi.org/10.1016/j.japr.2020.11.006

Adeyinka, B (2022). Nutritional significance of poultry products in addressing malnutrition in Nigeria. Journal of Nutrition and Health 10(3): 112-125

Afolayan, M., Adeniran, O & Ojo, V. (2023). Influence of thermal processing on nutrient digestibility of unconventional feed resources in broiler diets. *Poultry Science, 102(7), 102540*

Akinola, L. A., Bello, O. S., & Jimoh, A. A. (2023). Influence of herbal feed additives on nutrient digestibility and performance of broiler chickens. Poultry Science, 102(7), 102478. https://doi.org/10.1016/j.psj.2023.10247

Al-Khalaifah, H. S. (2023). Benefits of dietary phytogenic additives on growth, immunity, and meat quality in broiler chickens: A review. *Poultry Science, 102(5), 102518*. https://doi.org/10.1016/j.psj.2023.102518

Badhan, A., Low, K. E., Jones, D. R., Xing, X., Marami Milani, M. R., Ortega-Polo, R. & Klassen, L. (2022). Mechanistic insights into the digestion of complex dietary fibre by the rumen microbiota using combinatorial high-resolution glycomics and transcriptomic analyses. Computational and Structural Biotechnology Journal, 20, 148–164.

Bello, Alabi, O. O., Shoyombo, A. J., Akpor, O. B., Oluba, O. M., & Adeyonu, A. G. (2023). Exogenous Enzymes and the Digestibility of Nutrients by Broilers: A Mini Review. *International Journal of Poultry Science, 18(9), 404–409. IJPS Journal*+1

Chen, Y., Cheng, Y., Wen, C. & Zhou, Y. (2020). Effects of processing and enzyme supplementation on nutritional value of plant-based broiler diets. *Journal of Applied Poultry Research, 29(3), 769–777*. https://doi.org/10.1016/j.japr.2020.05.01

Duncan (1955) Duncan Multiple Range Test

FAO of the United Nations. (2023). OECD-FAO agricultural outlook 2023–2032. OECD / FAO.

FAO. (2019) Poultry Development review: Poultry and livelihoods, food security and poverty alleviation. Food and Agriculture Organization of the United Nations

Hassan, H. M., Mohamed, M. A. & Abdel-Wareth, A. A. (2022). Effect of dietary herbal additives on growth performance, carcass traits, and intestinal morphology of broilers. Animals, 12(17), 2224. https://doi.org/10.3390/ani12172224

N.R.C (1994). National Research Council. Nutrient Requirements of Poultry: Ninth Revised Edition —

Ogundipe, S.O & Sanni, S.A. (2020) Impact of poultry production on protein intake and food security in Nigeria. *Nigeria Journal of Animal Production 47(2), 101-109*

Olaleye, F. & Adegoke, T. (2024). Role of poultry production in enhancing food security in *Nigeria. Food Security Review, 7(2), 87-102*

Oladele, F.O, Ojo, S, A & Ogunbode, O.E. (2021) Nutritional and economic benefits of yam peels as feed ingredients in broiler production. *West African Journal of Animal Science, 32(2), 67-75.*

Okoro, C. V., Eze, C. A., & Nwachukwu, I. O. (2020). Dose-dependent effects of medicinal plant extracts on broiler growth and health indices. *Nigerian Journal of Animal Production, 47(2), 89–98*

Olukosi, O.A., & Adeyemi, O.A. (2019). Economic implications of feed cost in Nigeria’s poultry production. *Nigeria Journal of Animal Science, 21(2), 54-62.*

Oluwafemi, R. A. (2022). Utilization of agricultural wastes as alternative feed resources in poultry production, *Journal of Sustainable Agriculture,13(4), 88-97*

Onyeneke, R. U., Emenekwe, C. C., Chidiebere-Mark, N. M., Munonye, J. O., Aligbe, J. O., Kanu, C., Izuogu, C. U., Njoku, C. L., Uwazie, U. I., Uwadoka, C. O. & Azuamairo, G. C. (2020). Impact of poultry farmers’ participation in modern food retail markets on household dietary diversity: Lessons from Southeast Nigeria. *Animals, 10(4), 611.*

SAS, (2005). Statistical Analytical Software. Users Guide, 9.led; SAS Institute Inc: Cary, NC, USA.

Weather Spark (2019), www.weatherspark.comm

Toghyani, M., Tabeidian, S. A., Ghalamkari. G & Toghyani. M. (2021). Effect of feed processing and supplementation on broiler growth and carcass traits. *Animal Feed Science and Technology, 271, 114732*. https://doi.org/10.1016/j.anifeedsci.2020.11473

Yang, L. (2021) — Advances in research on solid-state fermented feed and its valorization of agricultural residues. Frontiers / Frontiers /