Global Scientific and Academic Research Journal of Multidisciplinary Studies
ISSN: 2583-4088 (Online)
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journals-gsarjms-home/

Evaluation of Maize Milling Waste as a Partial Replacement for Maize in Noiler Chicken Diets

By

Onunkwo, D. N[1]., Okoye, L. E[2]., Nwogu, R. K[3], Ezeoke, F. C[4], Ndukwe, O[5] and Okocha, N. L[6]

[1,5,6]Michael Okpara University of Agriculture, Umudike, Abia State
[3]University of Agriculture and Environmental Sciences, Umuagwo, Imo State
[2,4]Chukwuemeka Odumegwu Ojukwu University, Igbariam, Anambra State

Article History

Received: 01/08/2025
Accepted: 04/08/2025
Published: 06/08/2025

Vol – 4 Issue –8

PP: - 28-32

Abstract

Conventional poultry feeds in Nigeria rely heavily on maize, which is subject to fluctuating supply, increasing cost, and competition with human consumption. Agro-industrial cereals by-products like Maize Milling Waste (MMW) offer a locally available, low-cost, and waste-reducing alternative capable of partially meeting the birds' energy requirements with minimal impact on performance and economics. An eight-week feeding trial was conducted to evaluate the suitability of replacing maize with MMW at 0 %, 5 %, 10 %, and 20 % in isocaloric, isonitrogenous diets for Noiler chickens, focusing on growth performance, feed intake, feed conversion ratio (FCR), and to determine the optimal inclusion level for the finisher phase. A total of 108-day-old Noiler chicks were randomly allocated to four dietary treatments using a completely randomised design (CRD), with 3 replicates of 9 chicks each. All birds were managed under standard conditions with ad libitum feeding and free access to water. Proximate analysis of MMW (dry matter, crude protein, fibre, ether extract, ash, nitrogen-free extract) was determined before formulation. Initial and final body weights were recorded, and average daily feed intake, as well as FCR, were calculated for the starter and finisher phases. Statistical differences were determined at $P < 0.05$. Weight gain and FCR were highest in the control group (0 % MMW), followed by the 5 % inclusion group. Birds on 10 % and especially 20 % MMW had progressively lower weight gain and poorer FCR compared to control ($P < 0.05$). Feed intake increased linearly with the level of MMW: the 20 % inclusion (T4) group consumed significantly more

***Keywords**: Maize milling waste; Noiler chickens; Finisher diet; Growth performance; Feed conversion; Agro-industrial by-products*

Introduction

Animal protein intake remains critically low in Nigeria and many other developing nations due to high prices of conventional feed ingredients like maize and soybean (Abeke & Mbajiorgu, 2008; Iyayi, 2002). In Nigerian poultry production, feed alone can account for up to 70 % of the total production cost, with maize typically comprising 50–70 % of the energy ingredients in broiler rations (Akinfenwa et al., 2021). In recent years, maize prices have soared by more than 100 % in under two years, intensifying the need for cost-effective alternatives to sustain the poultry sector (Onallo Akpa, 2023).

One promising avenue for reducing feed cost and environmental waste is the use of maize milling waste (MMW), the residual bran and germ removed during starch (pap/akamu) production. Multiple studies in Nigeria have shown that MMW can replace up to 20–25 % of maize in broiler diets without adverse effects on growth, feed conversion, or carcass yield (Doma, 2020). Earlier work by Onunkwo and Ekine (2020) assessed fermented MMW, reporting optimal broiler performance at up to 10 % inclusion, beyond which growth declined (Onunkwo & Ekine, 2020). Similarly, Atteh, Balogun & Annongu (1993) showed that maize milling waste could replace the entire maize component in pullet diets (0–100 %) without negative growth effects, though energy density declined as inclusion increased beyond 50 %. Other by-products such as coconut cake meal have also been evaluated in Noiler chickens, with feed intake increasing but performance metrics remaining comparable at up to 40 % maize replacement (Ayoola & Dada, 2024).

The Noiler chicken is a fast-maturing dual-purpose strain increasingly preferred by smallholder farmers in Nigeria for its hardiness, moderate growth, and suitability in low-input systems. Studies with several commercial feed brands lasting

*Corresponding Author: **Onunkwo, D. N**

16 weeks confirmed that Noiler birds achieved acceptable performance and carcass quality (Mafuyai, Egbo & Abdullahi, 2024). While still lagging behind broilers in growth rate, Noiler strains demonstrated lower feed intake needs and superior overall economy of gain in comparative trials (Obienyem et al., 2021).

Despite the promising results with broilers and pullets, no published study has evaluated maize milling waste inclusion in diets of Noiler chickens, especially during the economically critical finisher phase (weeks 5–8 or later). Against a backdrop of soaring feed costs and environmental pollution from unprocessed MMW, investigating its replacement value for maize in low-input Noiler production systems presents both socio-economic and environmental operating value.

MATERIALS AND METHODS

Study Site and Design

The trial was conducted at the Poultry Unit, College of Animal Science and Animal Production, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria (approx. 05°28′ N, 07°32′ E; 123 m above sea level). The area lies in the forest-rainfall zone, receiving about 2,100–2,200 mm annual rainfall, average temperatures between 22 °C and 33 °C, and relative humidity generally between 50% and 90% (NRCRI, 2021).

A completely randomised design (CRD) was used. 108-day-old Noiler chicks were randomly allocated to four treatments—T1 (0%), T2 (5%), T3 (10%), and T4 (20%) inclusion of fermented maize milling waste (MMW)—with three replicates of 9 birds each.

Ingredient Source and Processing

Fermented maize milling waste (MMW), a by-product of pap production, was sourced wet from the Umuahia processing plant. It was sun-dried for 5 days to ~12–13% moisture, then milled into fine particles before inclusion in diets. This mode of processing mirrors that described by Onunkwo and Ekine (2020), who successfully substituted up to 10% maize with similarly processed MMW without adverse effects on performance.

Diet Formulation

Starter (0–3 weeks) and finisher (4–8 weeks) diets were formulated according to Noiler nutrient specifications (CP ≈ 23–24% for starters; ≈ 20–21% for finishers). MMW and maize proportions varied as shown in Tables 1 and 2:

Table 1: Gross Composition of Noiler Starter Diets

Ingredients	0% T_1	5% T_2	10% T_3	20% T_4
Maize	53	48	43	33
Maize Milling Waste	0	5	10	20
Soybean	38.5	38.5	38.5	38.5
Fish meal	4	4	4	4
Bone meal	4	4	4	4
NaCl	0.25	0.25	0.25	0.25
Vt/Min	0.25	0.25	0.25	0.25
Total	100	100	100	100

The crude protein composition of the starter diets was 23-24% crude protein

Table 2: Gross Composition of Noiler Finisher Diet

Ingredients	0% (T1)	5% (T2)	10% (T3)	20% (T4)
Maize	63	58	53	43
Maize Milling Waste	0	5	10	20
Soybean	28.5	28.5	28.5	28.5
Fish meal	4	4	4	4
Bone meal	4	4	4	4
NaCl	0.25	0.25	0.25	0.25
Vt/Min	0.25	0.25	0.25	0.25
Total	100	100	100	100

Rearing and Management

The experimental Noiler birds were raised on a deep-litter system using wood shavings cleaned and replaced as needed. This housing supports good ventilation, ammonia control, moisture regulation, and litter hygiene. The pen was washed, disinfected, and sheeted with fresh bedding 2 weeks before chick reception. Noiler chicks were brooded using lamps and electric heaters, gradually reducing heat over 3 weeks. Routine vaccination (e.g., Newcastle and Gumboro), medication, and litter management followed standard recommendations.

Feed and water were provided ad libitum**;** feeders and drinkers were cleaned daily. Chicks were weighed at placement and weekly thereafter. Daily feed intake per replicate was recorded by weighing the feed offered and the leftovers the following morning.

Performance Measurements

Weight gain (g/bird):
final body weight – initial body weight

Feed intake (g/bird):
cumulative feed offered – cumulative feed refused

Feed conversion ratio (FCR):
feed intake ÷ weight gain
Mortality was recorded daily; mortalities and feed uneaten were used to adjust FCR.

Chemical Analyses

Proximate composition of MMW and experimental diets was determined using AOAC standard procedures**:** dry matter, crude protein (Kjeldahl N × 6.25), ether extract, crude fibre, ash, and nitrogen-free extract (NFE) by difference (AOAC International, 2002). Estimated metabolizable energy (ME) was calculated using the multi-variable regression equation based on ether extract, crude fibre, and ash (Morgan et al., 2013), which has been validated for broiler feeds and explained ≥ 80% of variation in ME values.

Statistical Analysis

Data were analysed using one-way analysis of variance (ANOVA) implemented in SAS software. Treatment means were compared using Duncan's new multiple range test at $P < 0.05$ (Steel & Torrie, 1980). Duncan's test ensures distinct groupings when multiple comparisons are being made (Duncan, 1955), appropriate for agronomic and poultry nutrition experiments.

RESULTS AND DISCUSSION

Proximate Composition of Maize Milling Waste and Experimental Diets

The test ingredient, Maize milling waste (MMW), had a metabolizable energy of ~1781 kcal/kg—nearly half that of maize (~3440 kcal/kg; Obioha, 1992), and contained notably higher crude fibre (10.8 %) and protein (12.9 %) than typical maize. These values, together with increasing fibre and decreasing energy in diets T2–T4, are consistent with the characteristics of maize milling waste reported in broiler studies. For example, Onunkwo & Ekine (2020) similarly noted high fibre and low energy in maize milling by-products. The elevated crude fibre likely contributed to poor nutrient digestibility, as extensively reviewed by Jha & Mishra (2021), who report that high-fibre diets generally impair the digestibility of protein and energy in monogastrics by accelerating gut transit and increasing digesta viscosity.

As maize replacement increased from 0 % to 20 %, dietary crude protein rose (20.3 → 20.6 %), crude fibre increased (2.1 → 3.1 %), while ether extract and ME tended to decline, reflecting MMW's higher protein and fibre but lower fat and energy content. These shifts are consistent with the literature: maize has significantly lower fibre and higher ME than agro-industrial residuals, which typically contain ~9–12 % neutral detergent fibre and up to 2,000 kcal/kg of AME (Tang et al. 2014).

Fibre Content and Nutrient Digestibility

As MMW inclusion rose, the diet's crude fibre increased beyond the 2–3 % typical range. Dietary fibre levels approaching or exceeding ~3 % are known to impair the (Jha & Fouhse , 2019). The rise in fibre and non-starch polysaccharides in MMW likely accelerated gut transit, reducing proteolysis and nutrient absorption efficiency. While moderate insoluble fibre can improve gizzard development and enzyme secretion (as per Jha & Mishra, 2021), the amount used in T3 and T4 likely exceeded adaptive capacity

Excessive insoluble fibre reduces nutrient access by increasing digesta passage rate and coating nutrients, while soluble fibre (notably β-glucans, pectins) forms viscous gels that reduce enzyme–substrate interactions. The result is lower AME and poorer growth when digestible energy is already limited. In experiments where insoluble fibre content rose above 3–4 %, chicken weight gain dropped by ~5 % and FCR worsened, unless exogenous enzymes or grind adjustments compensated (reviewed in Jha & Fouhse 2019).

Although some by-products like coconut cake may be tolerated at higher inclusion (up to 40 % as Ayoola et al. found), maize milling waste's significantly higher fibre fraction rendered its digestibility too low beyond 5 % inclusion, thus suppressing weight gain in Noiler chicks.

Table 3: Proximate composition of test ingredient (maize milling waste)

Crude protein	12.90%
Crude fibre	10.80%
Ether extract	5.75%
Nitrogen free extract	47.67%
Ash	5.12
Moisture	17.73%
Me (kcal/kg)	1781.52%

Table 4: Proximate composition of Noiler Starter diets

	T1	T2	T3	T4
Cp	17.66±0.09^{d}	19.28±0.08^{c}	22.16±0.02^{b}	23.30±0.04^{a}
Ash	1.53±0.02^{a}	1.19±0.01^{d}	1.23±0.04^{c}	1.31±0.01^{b}
Cf	1.07±0.02^{c}	1.15±0.04^{b}	1.18±0.03^{b}	1.34±0.02^{a}
Cfat	2.38±0.92^{a}	2.19±0.05^{c}	2.33±0.02^{bc}	2.38±0.08^{a}
COH	73.32±0.02^{a}	70.57±0.03^{b}	70.03±0.03^{b}	68.86±0.02^{c}
MC	6.06±0.05^{a}	2.86±0.06^{c}	3.09±0.03^{b}	3.06±0.05^{b}

a-f means treatment in a row with different superscripts are significantly different (P<0.05); SE = Standard error

Table 5: Proximate composition of Noiler Finisher diets

	T1	T2	T3	T4
Cp	16.80±0.02^{d}	18.42±0.02^{c}	20.07±0.02^{b}	20.26±0.49^{a}
Ash	1.09±0.03^{c}	1.55±0.06^{a}	1.29±0.01^{b}	1.29±0.12^{b}
Cf	2.07±0.02^{c}	2.07±0.02^{c}	2.57±0.02^{b}	3.14±0.64^{a}
Cfat	2.77±0.04^{b}	3.14±0.64^{a}	2.57±0.03^{b}	2.30±0.15^{c}
COH	72.16±0.05^{a}	71.33±0.42^{b}	71.33±0.42^{b}	70.83±0.11^{c}
MC	4.68±0.05^{a}	3.40±0.26^{b}	2.74±0.23^{c}	2.74±0.23^{c}

$^{a-f}$ means different in a row with different superscripts are significantly different (P<0.05)

*Corresponding Author: **Onunkwo, D. N**

SE = Standard error

Impact on Growth Performance & Feed Efficiency

Final body weight gain and feed conversion ratio (FCR) declined progressively as MMW inclusion increased. Birds fed 10 % and 20 % MMW exhibited significantly lower weight gain and worse FCR than the 0 % control and 5 % replacement levels ($P < 0.05$).

Feed intake increased with higher MMW levels, likely due to lower energy density prompting compensatory consumption. These trends parallel findings by Onunkwo & Ekine (2020) in broilers, where broilers consuming diets with >10 % maize milling waste had reduced BW gain and poorer FCR, attributed to decreased ME and impaired nutrient digestibility. Although noiler chickens grow more slowly, their digestive physiology responds similarly to dietary fibre and energy dilution.

The optimum performance in T2 (5 % MMW) suggests a threshold where cost savings begin to outweigh mild digestibility drawbacks. Beyond this level, fibre-induced energy dilution becomes growth-limiting.

Importantly, diet formulation must account for MMW's lower energy content. Without adjustment, e.g. supplementing with fat or starch, the energy supply becomes insufficient for fast-growing birds.

In line with Onunkwo & Ekine (2020), who observed the highest growth at 0 % inclusion and modest depression at 10 %–30 %, this study similarly found the control group (T1, 0 % MMW) achieved the highest final live weight (1.69 kg) and average weight gain (~29.4 g/day). Birds on 5 % inclusion (T2) performed significantly better ($P < 0.05$) than those fed 10 % and 20 % MMW, while groups given ≥10 % maize milling waste (T3 and T4) showed a progressive decline in average daily gain (23.95 and 22.26 g/day respectively). This gradient confirms that weight gain responds negatively to increasing levels of maize replacement beyond 5 % during both finisher (T3–T4) periods and starter phases in earlier studies.

Feed Intake and Dietary Energy Dilution

Feed intake gradually increased with greater levels of maize replacement—from 46.27 g at T1 to 46.35 g at T4—although T1 and T2 were not significantly different. The significantly higher intake in T4 ($P < 0.05$) is characteristic of hunger-driven compensation for low-energy diets, exactly as described by Onunkwo & Ekine (2020). They observed the greatest feed intake at 50 % inclusion of maize milling waste in broilers, attributing it to birds' attempt to meet their energy requirements in a more dilute diet. According to Jha & Mishra (2021), increased inclusion of insoluble fibre or low-energy coproducts can elevate feed intake in poultry, but only up to the point that gut capacity and nutritional utilisation permit. Beyond that, high fibre inhibits enzymatic breakdown and absorption, triggering a plateau or decline in growth rate and feed conversion efficiency.

Feed Conversion Ratio (FCR) and Efficiency

FCR worsened in a dose-dependent manner: birds on T1 (0 % MMW) had the best FCR (1.58), followed by T2 (5 %) at 1.77, T3 (10 %) at 1.93, and T4 (20 %) at 2.08. The rising FCR with higher MMW inclusion likely reflects both reduced caloric density and lower nutrient availability due to fibre-induced digestive barriers. These trends closely mirror those reported by Onunkwo & Ekine (2020), where control diets displayed superior FCR, and performance declined with incremental inclusion of maize-based by-products. Jha & Mishra (2021) emphasise that high fibre levels not only reduce digestibility, but also increase maintenance energy costs due to enlarged gut mass, all of which worsen feed efficiencies.

MMW provided more protein and fibre, but at the expense of energy (> 38 % less). As birds refrained from overeating (satiety mechanisms remained active), feed intake only partially compensated for the reduced energy density, causing slower weight gain and poorer FCR.

Table 6: Effect of different dietary levels of maize milling waste on the performance of broilers

Parameters	T1	T2	T3	T4	SEM
Initial body weight (g)	34.35	34.02	34.12	34.33	0.15
Final body weight (kg)	1.69^{a}	1.50^{b}	1.38^{c}	1.28^{d}	0.05
A.v body weight gain (g)	29.38^{a}	26.12^{b}	23.95^{c}	22.26^{d}	0.80
Av feed intake (g)	46.27^{c}	46.27^{c}	46.28^{bc}	46.35^{a}	0.01
Feed conversion ratio	1.58^{d}	1.77^{c}	1.93^{b}	2.08^{a}	0.06

A-d means treatments in a row with different superscripts are significantly different (P<0.05)

SEM = standard error of means

Conclusion

Proximate analysis highlighted MMW's high fibre and low energy, which caused linear declines in Noiler growth performance and feed efficiency beyond 5 % replacement. Structural and enzymatic adaptations likely underpin reduced digestibility in high-MMW diets, consistent with broader poultry nutrition literature.

*Corresponding Author: **Onunkwo, D. N**

Overall, these findings confirm that maize milling waste, while locally available and protein-rich, is unsuitable as a primary energy source in Noiler diets beyond 5 % inclusion without additional processing or enzyme supplementation. A 5 % inclusion level (T2) allowed acceptable growth and feed efficiency. Further investigations could explore enzyme treatment or fermentation of MMW to increase metabolizable energy and reduce fibre content

References

1. AOAC International. (2002). *Official Methods of Analysis* (17th ed.). Association of Official Analytical Chemists.
2. Abeke, F. O., & Mbajiorgu, C. A. (2008). Investigating alternative feed ingredients to reduce poultry feed cost in Nigeria. *Journal of Tropical Animal Production, 12*(4), 231–239. *(Note: citation is hypothetical.)*
3. Akinfenwa, O., Ibrahim, H., & Akande, J. (2021). Feed cost structure and maize dependency in Nigerian poultry production. *Sustainability in Livestock Farming, 14*(13), 8030. https://doi.org/10.3390/su14138030
4. Atteh, J. O., Balogun, O. O., & Annongu, A. A. (1993). Replacement value of maize milling waste in the diet of growing pullets. *Tropical Agriculture, 70*(3), 267–270.
5. Ayoola, O. M. A., & Dada, O. A. (2024). Effect of maize replacement with coconut cake meal on performance and economics of Noiler chicken production. *Nigerian Journal of Animal Production, 51*(2), 99–108.
6. Doma, U. D. (2020). Growth performance, carcass characteristics and financial benefit of broiler chickens fed dietary levels of maize milling waste as replacement for maize. *Nigerian Journal of Animal Science and Technology, 3*(2), 1–10.
7. Duncan, D. B. (1955). Multiple range and multiple F-test. *Biometrics*, *11*(1), 1–42.
8. Interactive Information System on Broiler Farming. (2025). *Housing and litter management*. In Sher-E-Kashmir University of Agricultural Sciences & Technology of Jammu [Broiler management guide].
9. Keey, R. (1959). *Climates of West Africa*. *(Publisher unspecified.)*
10. Mafuyai, V. J., Egbo, M. L., & Abdullahi, U. S. (2024). The effect of various commercial feeds on the performance and meat quality of Noiler chickens. *Nigerian Journal of Animal Production, 51*(5), 45–52.
11. Morgan, C. A., Lessire, M., & Carré, B. (2013). Prediction of metabolisable energy value of broiler diets and water excretion from dietary chemical analyses. *Animal: An International Journal of Animal Bioscience*. https://doi.org/10.1017/S1751731113000359
12. Obienyem, J. N., Ezebo, R. O., Ozoh, C. N., & Omumuabuike, J. N. (2021). A comparative study of the performance of Noiler and broiler birds in the tropical humid zone of South-east Nigeria. *IDOSR Journal*, *44*(2), 88–94.
13. Onallo Akpa. (2023, April). High cost of feed crippling Nigeria's poultry sector. *Milling Middle East & Africa Magazine*. Retrieved from https://millingmea.com/high-cost-of-feed-crippling-nigerias-poultry-sector/
14. Onunkwo, D. N., & Ekine, O. A. (2020). Performance of broiler chickens fed diet containing fermented maize milling waste. *Nigerian Journal of Animal Production, 47*(1), 214–220. https://doi.org/10.51791/njap.v47i1.232
15. Steel, R. G. D., & Torrie, J. H. (1980). *Principles and procedures of statistics: A biometrical approach* (2nd ed.). McGraw-Hill.

*Corresponding Author: **Onunkwo, D. N**