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IRISH POTATO PEEL AS A MAIZE SUBSTITUTE IN BROILER CHICKEN DIETS: IMPACTS ON GROWTH PERFORMANCE, CARCASS YIELD AND FEED COST

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ABSTRACT

This study assessed the impact of partially replacing maize with graded levels of Irish potato peel meal (IPPM) on the growth performance, carcass traits, and economic efficiency of broiler chickens. Irish potato peels were collected, cleaned, sun-dried, milled, and incorporated into five experimental diets. Diet 1 served as the control with 100% maize, while Diets 2 through 5 replaced maize with IPPM at 10%, 20%, 30% and 40% inclusion levels. A total of 105-day-old Anak 2000 broiler chicks were allocated to treatment groups in a completely randomized design, with three replicates per treatment and 21 birds per group. Feed and water were provided ad libitum over a 42-day feeding trial. Data collected includes feed intake, feed refusals, live weight changes, carcass weight, internal organ weights, and feed ingredient costs were recorded. During the starter phase, birds receiving diets containing 20% Irish potato peel meal (IPPM) exhibited the highest ($P < 0.05$) feed conversion ratio (FCR), whereas those fed the control diet (0% IPPM) recorded the highest ($P < 0.05$) FCR during both the finisher phase and overall trial period. Notably, internal organ weights particularly of the heart, liver, and lungs were greater ($P < 0.05$) in the 20% IPPM group. Birds supplemented with 20% IPPM demonstrated enhanced performance and achieved the lowest feed cost per kilogram of weight gain. These results highlight the potential of IPPM as an effective and cost-efficient alternative energy source in broiler nutrition.

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INTRODUCTION

The growing demand for maize across human nutrition, animal feed, and industrial sectors has created intense competition, contributing to supply shortages and rising costs. In poultry production, where feed accounts for over 70% of total expenses with energy and protein sources comprising the majority, this challenge significantly affects profitability (Adamu et al., 2015; Agbabiaka et al., 2015). Maize, being the primary energy source in broiler diets, is often included at rates of 50–70%, making its cost a major concern for producers. This situation has prompted ongoing efforts to identify alternative feed ingredients that are both affordable and nutritionally adequate. Among these alternatives, agro-industrial by-products have received increasing attention due to their local availability and potential to reduce environmental waste. One such by-product is the peel of Irish potatoes (*Solanum tuberosum*), which is produced in large quantities by food service and processing industries. Often discarded as waste, these peels contribute to environmental pollution, particularly during the rainy season when they decompose rapidly (Bashar, 2012). Despite being underutilized, Irish potato peels are rich in carbohydrates and contain meaningful levels of fiber, vitamins, and minerals (Papanikou, 2023). Their integration into poultry diets could offer dual benefits: lowering production costs and contributing to more sustainable livestock farming practices. Given this context, the present study investigates the effects of replacing maize with graded levels of Irish potato peel meal (IPPM) on the growth performance, carcass characteristics, and feed cost of broiler chickens.

MATERIALS AND METHODS

Location

The study was conducted at the Poultry Research Farm of the Federal University Gashua, located in Bade Local Government Area of Yobe State, Nigeria. The site is positioned at approximately latitude 12°52′5″N and longitude 11°2′47″E, with an elevation of about 299 meters above sea level. March and April are the hottest months, with temperatures ranging from 38°C to 44°C, while the rainy season (June to September) experiences temperatures between 23°C and 28°C and annual rainfall of 500–1000 mm (Climatemp, 2020).

Sourcing and processing of test ingredient

Fresh Irish potato peels were collected from local restaurants and commercial vendors within the Kano metropolitan area. The peels were washed thoroughly to remove dirt and debris, sun-dried to reduce moisture content, and then ground using an RN4500 industrial milling machine to produce Irish Potato Peel Meal (IPPM).

Diets, Animal Management and Experimental Design

Five experimental diets were formulated: Diet 1 (control) contained 100% maize as the energy source, while Diets 2 to 5 included IPPM replacing maize at 10%, 20%, 30% and 40% inclusion levels. The diets were designed to be isonitrogenous and isocaloric. Tables 1 and 2 detail the ingredient composition and calculated nutrient content for both starter and finisher phases. A total of 105-day-old Anak 2000 broiler chicks were obtained from Sovet Agro Veterinary Services, Kano State. Before arrival, pens were cleaned, disinfected and prepared with fresh wood shavings. Pens were pre-heated using electric bulbs to achieve optimal brooding temperatures. Upon arrival, the chicks were randomly assigned to five dietary treatments in a completely randomized design (CRD) with three replicates per treatment and seven birds per replicate. Birds were housed in deep litter pens and fed *ad libitum* throughout the 42-day trial. The economic analysis of production costs was based on prevailing local market prices.

Table 1: Ingredient composition of broiler starter diets containing graded levels of Irish potato peel meal (IPPM)

Ingredients	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)
IPPM	0	4.80	9.46	13.998	18.416
Maize	48.65	43.17	37.84	32.662	27.624
GNC	17.725	18.065	18.40	18.72	19.03
SBM	17.725	18.065	18.40	18.72	19.03
Wheat offal	10.00	10.00	10.00	10.00	10.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00

Table 2: Gross composition of experimental diets with varying levels of Irish potato peel meals (IPPM) fed to broiler chickens at Finisher phase

Ingredients	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)
IPPM	0	5.23	10.31	15.25	30.072
Maize	53.08	47.08	41.24	35.58	30.072
GNC	13.01	13.395	13.775	14.135	14.49
SBM	13.01	13.395	13.775	14.135	14.49
Wheat offal	15.00	15.00	15.00	15.00	15.00
Fish meal	3.00	3.00	3.00	3.00	3.00

Bone meal	2.00	2.00	2.00	2.00	2.00
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100

Data Collection

Growth Performance

Feed intake, feed conversion ratio (FCR), and body weight gain were measured throughout the experimental period. Daily feed intake was determined by subtracting the weight of leftover feed from the quantity initially offered. The feed conversion ratio was computed using the standard formula.

$$FCR = \frac{Feed\ intake}{weight\ gain}$$

Subsequent weight measurements were taken weekly. Weekly weight gain was calculated by subtracting the initial body weight from the final body weight for each period, while average daily weight gain was derived by dividing the weekly gain by seven.

Carcass Traits

At the end of the feeding trial, three birds per treatment group were selected based on their average body weight for carcass evaluation. Prior to slaughter, the selected birds were fasted overnight to ensure evacuation of the gastrointestinal contents. The birds were humanely slaughtered, defeathered, and dressed. Carcass evaluation involved dissection into prime cuts, and the resulting components were expressed as percentages of live weight, slaughter weight, defeathered weight, eviscerated weight, and final carcass weight. Dressing percentage and organ weights including the head, shank, crop, gizzard, small and large intestines, heart, lungs, spleen, liver, proventriculus, pancreas, and abdominal fat were recorded and also expressed relative to live body weight.

Feed intake and body weight gain were monitored and recorded throughout the study. Economic analysis was conducted based on prevailing market prices to assess the cost-effectiveness of the dietary treatments.

Data Analysis

Data were analyzed using one-way analysis of variance (ANOVA). Significant differences among treatment means were separated using Duncan's New Multiple Range Test (DMRT), with statistical significance set at P < 0.05. All statistical analyses were conducted using SAS software, version 6 (SAS Institute, 2016).

Table 3: Growth performance of broiler chickens fed experimental diets during the starter phase

Parameters	IPPM inclusion levels					$LSD_{0.05}$
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	
Average Daily Feed intake (g)	74.86	94.82	93.90	98.43	96 .96	29.42^{NS}
Average Daily Weight Gain (g)	35.89^{b}	40.87^{ab}	46.46^{a}	48.85^{a}	46.60^{a}	8.50*
FCR	2.10	2.35	1.99	1.98	2.05	0.43^{NS}
Mortality	0	0	0	0	0	

Means within the same row bearing different superscripts (a, b) are significantly different (P < 0.05). NS = Not Significant; LSD = Least Significant Difference; FCR = Feed Conversion Ratio.

Table 4: Growth performance of broiler chickens fed experimental diets during the finisher phase

Parameter	IPPM inclusion levels					$LSD_{0.05}$
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	
Average Daily Feed intake (g)	145.99^{b}	159.54^{ab}	161.82^{ab}	170.87^{a}	170.18^{a}	24.04*
Average Daily Weight Gain (g	74.28	71.29	73.30	74.80	63.74	14.93^{NS}
FCR	2.00^{b}	2.32^{ab}	2.22^{b}	2.29^{ab}	2.74^{a}	0.46*
Mortality	0	0	0	0	0	

Means within the same row bearing different superscripts (a, b) are significantly different (P < 0.05). NS = Not Significant; LSD = Least Significant Difference; FCR = Feed Conversion Ratio.

Table 5: Overall growth performance of broiler chickens fed the experimental diets

Parameter	IPPM inclusion levels					$LSD_{0.05}$
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	
Feed intake (g)	110.43	127.18	127.46	134.65	133.57	34.76^{NS}
Weight gain (g)	55.09	56.08	59.88	61.82	55.17	14.58^{NS}
Feed conversion ratio	2.05^{b}	2.33^{ab}	2.11^{b}	2.14^{ab}	2.39^{a}	0.33*
Mortality	0	0	0	0	0	

Means within the same row bearing different superscripts (a, b) are significantly different (P < 0.05). NS = Not Significant; LSD = Least Significant Difference; FCR = Feed Conversion Ratio.

Table 6: Carcass characteristics of broiler chickens fed experimental diets

Parameters	IPPM inclusion levels					**$LSD_{0.05}$**
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	
Live weight (g)	2106.70	1810.00	1890.00	2163.30	1770.00	418.48^{NS}
Slaughter weight (g)	2000.00	1720.00	1810.00	2020.00	1656.70	393.60^{NS}
Plucked weight (g)	1920.00	1663.30	1736.70	1846.70	1623.30	356.44^{NS}
Eviscerated weight (g)	1623.30	1413.30	1390.00	1643.30	1346.70	377.37^{NS}
Carcass weight (g)	1490.00	1306.70	1270.00	1503.30	1216.70	346.14^{NS}
Dressing percent (%)	70.58	72.10	67.18	66.07	68.77	8.07^{NS}
Head (g)	2.62	2.62	2.59	2.49	2.74	0.43^{NS}
Shank (g)	3.81^{ab}	3.56^{b}	3.83^{ab}	4.03^{ab}	4.28^{a}	0.65*
Crop (g)	0.18	0.28	0.30	0.28	0.36	0.25^{NS}
Gizzard (g)	1.56^{b}	1.87^{a}	1.62^{ab}	1.60^{ab}	1.55^{b}	0.31*
Small intestine (g)	4.97	6.14	6.40	5.57	5.62	2.46^{NS}
Large intestine (g)	0.13	0.17	0.18	0.15	0.16	0.06^{NS}
Heart (g)	0.54^{ab}	0.44^{b}	0.58^{a}	0.50^{ab}	0.55^{ab}	0.13*
Lungs (g)	0.62^{ab}	0.52^{b}	0.65^{a}	0.50^{b}	0.52^{b}	0.12*
Spleen (g)	0.11	0.13	0.13	0.09	0.12	0.04^{NS}
Liver (g)	2.05^{ab}	2.07^{ab}	2.40^{a}	2.00^{ab}	1.84^{b}	0.50*
Proventriculus (g)	0.49	0.65	0.58	0.51	0.50	0.21^{NS}
Pancreas (g)	0.33	0.37	0.37	0.37	0.28	0.15^{NS}
Abdominal fat (g)	1.18	1.34	1.16	0.87	0.73	1.03^{NS}

Means within the same row bearing different superscripts (a, b) are significantly different (P < 0.05). NS = Not Significant; LSD = Least Significant Difference.

Table 7: Economic analysis of broiler chicken performance under different experimental diets

Parameter	IPPM inclusion levels				
	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)
Total feed intake/bird/kg	43.29	49.86	49.96	52.78	52.36
Feed cost/kg (₦)	108.09	106.23	104.39	102.61	100.89
Total feed cost/bird/kg (₦)	4679.22	5296.63	5215.32	5415.76	5282.60
Total weight gain/bird/ kg	21.59	21.99	23.47	25.18	21.63
Total feed cost/kg gain (₦)	238.88	248.58	220.26	220.61	242.14

RESULTS AND DISCUSSION

The slight variation in dietary energy levels among the treatments, particularly the higher energy content in the maize-based control diet, likely influenced feed intake behavior. Broiler chickens instinctively regulate their intake to meet energy needs, often consuming larger quantities of low-energy diets (Akinola and Sese, 2011). Although no significant differences were observed in feed intake across treatments, higher consumption was noted in groups fed maize-based diets, consistent with earlier findings by Maidala et al. (2013) and Onunkwo et al. (2015). These outcomes suggest that certain alternative ingredients such as maize may contained negligible antinutritional factors that might typically hinder feed consumption and nutrient absorption. Weight gain was significantly affected during the starter phase, aligning with reports from Yunusa et al. (2015), who demonstrated that dietary energy variations impact early growth. However, no significant differences were recorded during the finisher and overall phases. Similar findings by Bashar et al. (2012) and Kpanja et al. (2020) confirm that moderate levels of Irish potato peels, particularly at 30%, can support optimal growth. Poor performance at the highest inclusion level (T5) may be due to presence of antinutritional compounds in the potato peels. Feed conversion ratios were comparable across treatments in the starter phase but favored the control diet overall. Poorer FCR values in IPPM-based diets, particularly at high inclusion levels, may be attributed to reduced digestibility and antinutritional compounds such as tannins and phytic acid, which interfere with nutrient utilization (Raphael et al., 2017; Perpetual et al., 2017). Nevertheless, birds on the 30% IPPM diet showed a competitive FCR, indicating its potential as a cost-effective substitute for maize in broiler diets. Carcass traits such as live weight, slaughter weight, and dressing percentage were generally unaffected by the dietary treatments. However, variations in specific organ weights such as the proventriculus, intestines, and abdominal fat suggest that IPPM inclusion influences internal organ development particularly in the lungs, liver, heart, and gizzard. This could be due dietary antinutritional factors such as phytic acid present in Irish potato peels and shown to negatively affect the physiological development of poultry (Ekeocha et al., 2023). Similar observations were reported by Raphael and Luka (2017), indicating that Irish potato peel meal, when included at moderate levels, does not compromise overall carcass quality and may contribute to efficient poultry production. The total feed cost per kilogram (₦) was lowest in the 20% and 30% IPPM treatment groups. This outcome aligns with previous findings (Onabanjo et al. (2024) indicating that supplementation with cassava peel meal reduces overall feed costs by enhancing nutrient efficiency and lowering reliance on conventional energy.

CONCLUSION AND RECOMMENDATION

This study demonstrates that partial replacement of maize with 30% Irish potato peel meal (IPPM) as a dietary energy source significantly enhances broiler growth performance while reducing feed cost. Birds fed 30% IPPM exhibited superior feed conversion efficiency and overall productivity, translating to improved economic viability. The enhanced performance is attributable to the diet's lower energy density, which promoted greater voluntary feed intake and optimized nutrient utilization compared to the high-energy maize control diet. Based on these findings, 30% IPPM inclusion represents a viable alternative to conventional maize in broiler nutrition. This approach offers a sustainable strategy to reduce feed costs and enhance profitability in poultry operations without adversely affecting growth or carcass indicators.

Ethical Approval

The animal study protocol was reviewed and approved by the Animal Research Ethics Committee of Federal University Gashua, under protocol number FUGA/C/ANS/2023/000, dated 07 June 2023.

Competing Interests

All authors have declared that there are no competing interests that could have influenced the conduct, outcomes, or interpretation of this research.

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