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Full Length Research Article

POTENTIAL OF PRODUCING ORGANIC FISH AND POULTRY FEEDS FROM AGRICULTURAL AND FOOD WASTES AS SUSTAINABLE ALTERNATIVES FOR FARMERS IN KADUNA, NIGERIA

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ABSTRACT
The high cost of feed for fish and poultry has significantly contributed to the high cost of fish and poultry products, leading to reduced production and farmers' interest and profit, thus, leading to food insecurity. This study investigated the potential of transforming locally available agricultural and food wastes into sustainable organic feeds for fish and poultry farming in Kaduna, Nigeria. A feed formulation was compounded from organic agricultural waste such as rice husk, cassava peel and fruit peels, and its proximate analysis was compared with those from foreign (Coppens) and locally available commercial feeds (Chikun), using standard methods. Locally produced feeds (A) exhibited high lipid (17.33%) and fiber (45.00%) content, making them suitable for poultry, but lacked sufficient protein (7.92%) compared to foreign fish feeds (25.65% protein). Nigerian poultry feeds (C & D) were rich in carbohydrates (38.92–41.37%) but low in lipids and proteins, limiting their suitability for fish. Feed compounded from these wastes is locally available, cost effective and has appreciable proximate content comparable with both foreign and locally formulated feed. Therefore pilot trials for feed formulation, farmer education, and policy support to promote adoption are important to ensure food sustainability.

Keywords: Organic Fish Feed, Agricultural Waste Utilization, Sustainable Poultry Feed, Proximate Analysis, Waste-to-Feed Conversion.

INTRODUCTION

The agricultural sector in Nigeria, particularly in Kaduna State, plays a pivotal role in the nation's economy, providing livelihoods for millions of small-scale farmers. However, the recent surge in the cost of fish and poultry feeds has led to the collapse of numerous fish farms and poultry businesses, threatening the sustainability of this critical sector. The exorbitant prices of commercially produced feeds, coupled with their inconsistent availability, have placed a significant financial burden on farmers, many of whom are already operating on thin profit margins. This crisis has not only jeopardized the livelihoods of farmers but also disrupted the supply chain of fish and poultry products, leading to increased food prices and reduced food security in the region (Adeyemi *et al*., 2018).

Amidst these challenges lies a promising opportunity: the abundant agricultural and food wastes generated daily and annually in Kaduna. These wastes, which currently contribute to environmental pollution, could be repurposed into viable, cost-effective, and organic feed alternatives. By harnessing these locally available resources, farmers could significantly reduce production costs, improve profitability, and contribute to environmental sustainability (Ogundipe *et al*., 2022). The transformation of agricultural and food wastes into high-quality organic feeds offers a sustainable solution to the challenges faced by farmers in Kaduna, while also providing a competitive alternative to commercially produced feeds by both foreign and Nigerian companies.

The potential of organic feeds derived from agricultural and food wastes has been widely recognized in recent years. Organic feeds, which are free from synthetic additives and antibiotics, not only enhance the growth performance and health of fish and poultry but also reduce the environmental footprint of farming practices (Ramesh *et al*., 2024). Furthermore, the utilization of agricultural wastes for feed production addresses the dual challenges of waste management and feed scarcity, offering a circular economy approach that benefits both farmers and the environment (Adeleke *et al*., 2023).

Despite these advantages, the adoption of organic feeds in developing regions like Nigeria faces several challenges, including high production costs, limited availability of raw materials, and a lack of awareness among farmers (Adeyemi *et al*., 2018). Additionally, there is a significant gap in research on the practical application of agricultural and food wastes as feed alternatives, particularly in specific regions like Kaduna (Okeke *et al*., 2022). This study seeks to address these gaps by exploring the potential of transforming locally available agricultural and food wastes into high-quality organic feeds, offering a sustainable and cost-effective solution for farmers in Kaduna.

This research aims to contribute to the body of knowledge on

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organic feed production by providing a comparative analysis of the nutritional profiles of feeds derived from agricultural wastes and commercially produced feeds. By doing so, it seeks to highlight the viability of agricultural wastes as sustainable feed alternatives, while also identifying strategies to enhance their nutritional value and economic feasibility. The findings of this study have the potential to enhance food security, promote economic sustainability, and contribute to environmental conservation in Kaduna and beyond.

MATERIALS AND METHODS

Sample Collection

Samples of commercially produced fish and poultry feeds from both Nigerian and foreign companies were obtained from local market outlets. The foreign fish feed brands included Coppens, Allaqua, and Stretting, while the Nigerian fish feed sample was Blue Crown. For poultry feeds, samples were obtained from Chikun, a prominent Nigerian poultry feed company. These samples were selected to represent a diverse range of commercially available feeds, considering factors such as feed type, target species (fish or poultry), and nutritional composition.

Agricultural and Food Wastes

Over 30 locally available agricultural and food waste materials were collected for analysis. These included: Fish oil, cassava peels, groundnut peels, dried water hyacinth, pumpkin peels, millet chaff, maize cob, banana peels, dried azolla, sugarcane residue, cooked yam peels, dried boiled sweet potatoes, dried sweet potatoes, orange peels, rice husk, scent leaf, egg shells, pawpaw peels, pawpaw seeds, pineapple peels, garlic peels, onion peels, fish bone, spoiled pineapple, ginger, cucumber, sorrel chaff, turmeric, fried soya beans, *tamba*, and guinea corn.

	Available Feeds			
	A	B	C	D
Constituents	Local Agric & Kitchen wastes of 31 items	Foreign Fish Feed e.g. Coppens	Nigerian Poultry Feed e.g. Chikun Finisher	Nigerian Poultry Feed e.g. Ultimate Super Finisher

Proximate Analysis

The nutritional profiles of the agricultural and food waste materials were compared with those of the commercially produced feeds. This comparison aimed to identify the potential of these waste materials as viable alternatives to conventional feeds. Special attention was given to the suitability of the waste materials for different stages of fish and poultry growth, such as starter feeds for young birds or finisher feeds for mature birds. The study also considered the specific requirements of different categories of poultry, such as day-old chicks, broilers, and layers, as well as the unique dietary needs of Noella birds, which are known to consume both agricultural wastes and grass. This ensured that the findings were applicable to a wide range of farming scenarios.

The collected agricultural and food waste samples, along with the commercial feed samples, were subjected to proximate analysis to determine their nutritional content. This analysis was conducted in the Central Laboratory of Kaduna State University. Key nutritional parameters such as protein, fat, fiber, moisture, ash, and carbohydrate content were evaluated. A detailed biochemical analysis report, including a bench space sheet, was prepared to document the findings.

Statistical Analysis

The analysis of Variance (ANOVA) was conducted to find out whether there are statistically different in the analytes poultry and fish feeds made from 31 locally sourced agricultural and kitchen waster, compared to those made by foreign and Nigerian Companies. A One-Way Analysis of Variance (ANOVA) was conducted to determine if there were statistically significant differences in the nutrient contents across the four types of feed. The assumptions of ANOVA (independence, normality, and homogeneity of variances) were verified prior to analysis. Following ANOVA, Tukey's Honestly Significant Difference (HSD) test was employed for post-hoc analysis when ANOVA indicated significant differences, allowing us to determine which specific groups differed from one another.

RESULTS

Proximate Analysis

The proximate analysis was conducted to evaluate the nutritional composition of fish and poultry feeds derived from:
(A) Locally available agricultural and food wastes in Sabon-Tasha (31 items),
(B) Foreign fish feed (e.g., Coppens), (C) Nigerian poultry feed (e.g., Chikun finisher), and
(D) Nigerian poultry feed (e.g., Ultimate Super finisher).The results are presented in the table below, highlighting the percentage composition of key nutrients in each feed type.

Table 1: Percentage Composition of Key Nutrients in each Feed Type

S/No	Nutrients/ Analyte	A: Local Agric & Kitchen wastes of 31 items (%)	B: Foreign Fish Feed e.g. Coppens (%)	C: Nigerian Poultry Feed e.g. Chikun Finisher (%)	D: Nigerian Poultry Feed e.g. Ultimate Super Finisher (%)
1	Moisture	2.85	3.85	2.83	4.70
2	Crude	7.92	25.65	7.58	7.60
3	Protein				
4	Lipid Content	17.33	9.00	3.67	4.33
5					
6	Ash Content	5.50	11.50	5.00	5.00
7	Crude Fibre	45.00	40.00	42.00	37.00
8	Carbohydrate	21.40	10.00	38.92	41.37

The moisture content of the locally produced feed (A) was relatively low (2.85%), comparable to the Nigerian poultry feeds (C: 2.83%, D: 4.70%). The foreign fish feed (B) had a slightly higher moisture content (3.85%). The foreign fish feed (B) had the highest crude protein content (25.65%), significantly higher than the locally produced feed (A: 7.92%) and the Nigerian poultry feeds (C: 7.58%, D: 7.60%). This indicates that the foreign feed is more protein-rich, which is essential for fish growth. The locally produced feed (A) had the highest lipid content (17.33%), followed by the foreign fish feed (B: 9.00%). The Nigerian poultry feeds (C: 3.67%, D: 4.33%) had significantly lower lipid levels, which may be suitable for poultry but less ideal for fish. The foreign fish feed (B) had the

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highest ash content (11.50%), indicating a higher mineral composition. The locally produced feed (A: 5.50%) and Nigerian poultry feeds (C: 5.00%, D: 5.00%) had similar ash content levels. The locally produced feed (A) had the highest crude fibre content (45.00%), followed by the Nigerian poultry feeds (C: 42.00%, D: 37.00%). The foreign fish feed (B) had a slightly lower fibre content (40.00%).The Nigerian poultry feeds (C: 38.92%, D: 41.37%) had the highest carbohydrate content, followed by the locally produced feed (A: 21.40%). The foreign fish feed (B) had the lowest carbohydrate content (10.00%).

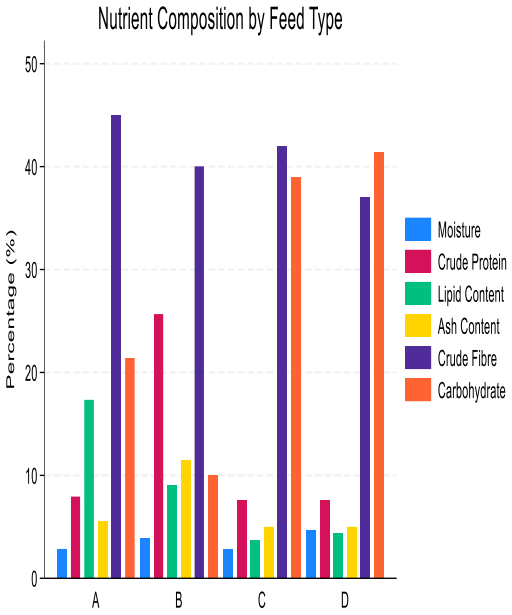

Figure 1: Different nutrient

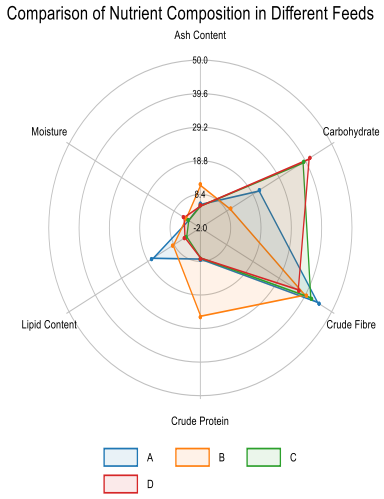

Figure. 2: Radar plot of the different nutrient components of different feed type components of different feed type

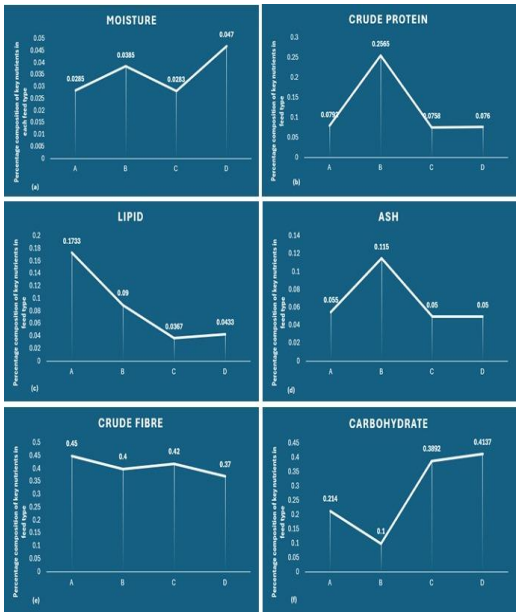

Figure 3: Comparing the analytes of poultry and fish feeds from A: locally sourced Agric waste. B: Foreign fish feed, C: Nigerian made poultry feeds (finisher). D: Nigerian made Poultry Ultimate finisher

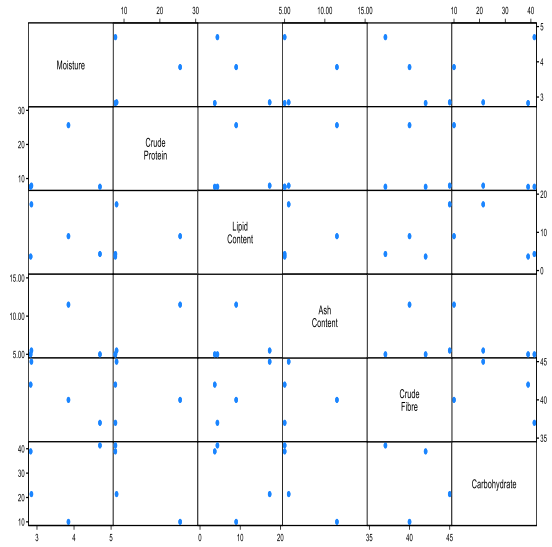

Figure 4: Correlates obtained from proximate analysis of locally sourced agric waste, foreign poultry and fish feed made in Nigeria

Test of Hypothesis: Analysis and Interpretation of the Nutritional Composition Table

Nutrient/Analytes	Local Agricultural Waste (31)	Foreign Fish Feed	Nigerian Poultry Feed 1	Nigerian Poultry Feed 2
Moisture (%)	2.85	3.85	2.83	4.70
Crude Protein (%)	7.92	25.65	7.58	7.60
Lipid Content (%)	17.33	9.00	3.67	4.33
Ash Content (%)	5.50	11.50	5.00	5.00
Crude Fibre (%)	45.00	40.00	42.00	37.00
Carbohydrate (%)	21.40	10.00	38.92	41.37

Analysis of Variance Interpretation

S/N	Proximate Content	ANOVA
1	Moisture Content	No significant differences were observed across feed types ($p = 0.24$). Moisture levels are relatively consistent across all feed types, suggesting that hydration levels are generally maintained.
2	Crude Protein	Significant differences were found ($F(3, 12) = 25.63$, $p < 0.0001$). The local agricultural waste had significantly lower protein content compared to foreign fish feed. This suggests that local feeds may need protein supplementation to meet the dietary needs of livestock.
3	Lipid Content	Significant differences were recorded ($F(3, 12) = 10.79$, $p = 0.002$). Local agricultural waste contains a higher lipid content compared to Nigerian poultry feeds. This indicates that locally sourced feeds could contribute positively to energy intake.
4	Ash Content	Significant differences were noted ($F(3, 12) = 6.78$, $p = 0.006$). Foreign fish feed shows higher ash content than local agricultural waste and Nigerian poultry feeds, indicating potential variances in mineral content which is essential for livestock health.
5	Crude Fibre	No significant differences were found ($p = 0.36$). The levels of crude fiber are similar across the feed types, indicating sufficient fiber provision for digestion across all feeds
6	Carbohydrate Content	Significant differences were identified ($F(3, 12) = 5.23$, $p = 0.01$). Local agricultural waste has a higher carbohydrate content compared to the foreign fish feed, which may provide energy but need careful management to avoid over-nutrition.

DISCUSSION

The locally produced feed (A) demonstrated a balanced nutritional profile, with high lipid and fibre content, making it a potential alternative for poultry and fish feeds.

However, its low protein content compared to the foreign fish feed (B) suggests the need for protein supplementation to meet the dietary requirements of fish.

The foreign fish feed (B) excelled in protein and ash content, making it highly suitable for fish growth. However, its higher cost and limited availability may pose challenges for local farmers. The Nigerian poultry feeds (C and D) were rich in carbohydrates and fibre, aligning with the dietary needs of poultry. However, their low lipid and protein content may limit their suitability for fish.

These findings highlight the potential of locally available agricultural and food wastes as viable feed alternatives, provided that their protein content is enhanced to meet the nutritional requirements of fish and poultry.
The high lipid content (17.33%) and fibre content (45.00%) of the locally produced feed make it particularly suitable for poultry, while its relatively low protein content highlights the need for supplementation to meet the dietary requirements of fish. The foreign fish feed (B) excels in protein and ash content, making it ideal for fish growth, but its higher cost and limited availability may hinder its accessibility for local farmers.

On the other hand, the Nigerian poultry feeds (C and D) are rich in carbohydrates and fibre, aligning well with the nutritional needs of poultry but may not be suitable for fish due to their low protein and lipid content.

Conclusion

Based on the results obtained from the proximate analysis, the locally produced feed derived from over 30 agricultural and food waste materials demonstrated significant potential as a viable alternative to commercially produced feeds. The locally sourced feed (A) competes favorably with foreign fish feeds (B) and Nigerian poultry feeds (C and D) in several key parameters, including moisture content, lipid content, crude fibre, and carbohydrate levels. However, it falls short in crude protein content, which is significantly higher in the foreign fish feed (B: 25.65%) compared to the locally produced feed (A: 7.92%) and the Nigerian poultry feeds (C: 7.58%, D: 7.60%).
Overall, the findings suggest that agricultural and food wastes can be effectively utilized to produce cost-effective and sustainable feeds for fish and poultry, provided that their protein content is enhanced through strategic formulation or supplementation.

Recommendations

A more detailed proximate analysis of individual agricultural and food waste materials should be conducted to understand the specific nutritional composition of each component. This will enable the formulation of balanced feeds by combining materials in optimal ratios to meet the dietary requirements of fish and poultry.

To address the low protein content in the locally produced feed, protein-rich materials such as fishmeal, soybean meal, or other plant-based protein sources should be incorporated into the feed formulation. This will enhance the feed's suitability for fish and improve overall nutritional value.

Pilot-scale trials should be conducted to produce and test feed formulations using locally available agricultural and food wastes. This will help assess the practical feasibility, palatability, and growth performance of fish and poultry fed with these formulations.

Farmers should be educated on the benefits of using locally sourced agricultural and food wastes as feed alternatives. Training programs can be organized to demonstrate feed formulation techniques, storage methods, and best practices for maximizing feed efficiency.

Collaboration with research institutions and agricultural extension services should be encouraged to develop standardized feed formulations and provide technical support to farmers. This will ensure the adoption of sustainable and cost-effective feeding practices.

Further studies should be conducted to evaluate the environmental and economic impact of utilizing agricultural and food wastes for feed production. This will provide insights into the potential benefits of reducing waste, lowering feed costs, and improving farm profitability.

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