GSAR Journal of Agriculture and Veterinary Sciences ISSN: 3048-9075 (Online)

GSAR Journal of Agriculture and Veterinary Sciences
ISSN: 3048-9075 (Online)
Abbreviated key title: Glob.J. Agri.Vet.Sci.
Frequency: Monthly
Published By GSAR Publishers
Journal Homepage Link- https://gsarpublishers.com/journal-gjavs-home/

Growth Performance and Bioeconomic Evaluation of Broiler Chickens Fed Diets Containing Graded Levels of Alternanthera sessilis leaf meal (ASLM)

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Article History

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

Vol – 2 Issue –8

PP: -24-30

Abstract

This study was designed to evaluate the effect of dietary inclusion of graded levels of Alternanthera sessilis leaf meal *(ASLM), commonly known as Sessile Joyweed, on the growth performance and bioeconomic efficiency of broiler chickens. A total of one hundred and fifty (150) day-old Arbour Acre broiler chicks were used for the 56-day feeding trial. The birds were randomly allocated to five dietary treatments (T1–T5) in a completely randomised design (CRD), with each treatment having three replicates of 10 birds per replicate. The control group (T1) received a basal diet without ASLM (0%), while T2, T3, T4, and T5 were formulated to include 5%, 7.5%, 10%, and 12.5% ASLM, respectively. All diets were supplemented with a commercial multi-enzyme complex (Maxigrain®) to enhance nutrient digestibility. The parameters assessed included growth performance indices (final body weight, total weight gain, average daily gain, total feed intake, average daily feed intake, and feed conversion ratio), haematological indices, and economic indicators (cost per kg weight gain, cost of feed per kg, and gross margin). Results showed that increasing dietary inclusion of ASLM significantly (P < 0.05) influenced all measured parameters. Birds on the control diet (T1) had the highest final body weight, total weight gain, and average daily gain, whereas those on the highest inclusion level (T5) had the lowest values. Total feed intake was also highest (5201.33g) in T1 and lowest (4186.33g) in T5. A similar trend was observed in average daily feed intake, where T5 recorded the lowest value. Feed conversion ratio was significantly better (2.58) in the control group compared to other treatments. Although the cost per kg feed was reduced with increasing ASLM levels, lowest in T5, the cost per kg weight gain remained significantly higher (₦399.33) in the treatment groups compared to the control. The gross margin was highest in T1 (₦896.00) and progressively decreased across treatments, with the lowest (₦539.67) recorded in T5. In conclusion, while the inclusion of ASLM in broiler diets reduced feed cost per kilogram, it adversely affected growth performance and economic returns. Therefore,* Alternanthera sessilis leaf meal, *at the inclusion levels tested, is not recommended as a major dietary component for optimal broiler performance and profitability.*

***Keyword**: Growth Performance, Bio-economics evaluation,* Alternanthera sessilis leaf meal, *Sessile Joyweed, Arbor Acre broiler chicken*

Introduction

The science of animal nutrition plays a pivotal role in sustaining livestock production by ensuring that the dietary nutrient supply meets the physiological needs of animals for maintenance, growth, reproduction, and production. In poultry production, balanced nutrition is critical for achieving optimal growth rates, feed efficiency, meat quality, and economic profitability (NRC, 1994; Leeson and Summers, 2001). With the increasing global demand for animal protein, especially in developing countries like Nigeria, poultry has emerged as one of the most efficient and fastest-growing sources of high-quality animal protein due to its short production cycle, low capital investment, and adaptability to various agro-ecological zones (Akinmutimi, 2004; Bot, 2013).

However, the escalating cost of conventional feed ingredients—such as soybean meal, groundnut cake, and fish

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meal—poses a major challenge to sustainable poultry production in Nigeria. These ingredients are often in direct competition with human food consumption and industrial uses, thereby making them both scarce and expensive (Olomu, 2011; Ani and Okorie, 2009). Feed alone accounts for over 70% of the total cost of poultry production, and any strategy to reduce feed cost without compromising performance is of immense value to producers (Abdollahi et al., 2013).

To address this challenge, there is a growing interest in identifying alternative, non-conventional feed resources that are abundant, inexpensive, and non-competitive with human food chains. One such promising candidate is **Alternanthera sessilis**, a fast-growing leafy vegetable commonly found in tropical and subtropical regions of Africa, Asia, and South America (Chandrika et al., 2006; Grubben and Denton, 2004). In Nigeria, it is widely known as Sessile Joyweed and grows naturally without intensive cultivation. Its leaves are rich in protein, vitamins, and minerals and have shown potential in ethnomedicine for their antioxidant and antimicrobial properties (Palanichamy and Nagarajan, 1990; Rahman et al., 2013). Despite its abundance and nutritional profile, its use in poultry feeding is still underexplored and under-documented.

Previous studies have noted that **Alternanthera sessilis leaf meal (ASLM)** contains a considerable amount of crude fibre, which may limit its digestibility and utilisation by monogastric animals such as chickens (Akinmutimi and Essien, 2011). High dietary fibre in monogastric diets can lead to poor nutrient absorption, increased gut fill, and reduced feed efficiency (Choct, 1997). To overcome this limitation, the supplementation of exogenous enzymes such as **xylanase, β-glucanase, and phytase** has been recommended. These enzymes help degrade non-starch polysaccharides (NSPs) and phytates, thereby enhancing nutrient bioavailability and feed efficiency in poultry diets (Adeola and Cowieson, 2011). The enzyme preparation used in this study—**Maxigrain®**—contains these critical enzyme components and is intended to mitigate the anti-nutritive effects of ASLM fibre.

The growing feed-farm-human competition for conventional protein sources has led to high feed costs, limiting the profitability and expansion of poultry enterprises in Nigeria. There is an urgent need to explore locally available and underutilised feedstuffs such as **Alternanthera sessilis**, which are not in direct competition with humans or industries. However, there is inadequate information on the growth performance, economic viability, and haematological impact of broiler chickens fed diets containing ASLM, especially when supplemented with exogenous enzymes.

Although a few studies have hinted at the potential nutritional value of ASLM, there is still a significant knowledge gap regarding its safe inclusion levels, its effects on growth performance, haematological indices, carcass characteristics, and economic returns in broiler chickens. This study is therefore designed to provide scientific data to support the use of ASLM as a cost-effective, alternative vegetable protein source in broiler nutrition.

The successful inclusion of ASLM in broiler diets could provide a cheaper and readily available protein source, thereby reducing feed cost and improving the profitability of broiler production. Moreover, this research will contribute to existing knowledge by documenting the nutritional and antinutritional composition of ASLM and its economic benefits in poultry feeding systems. If proven effective, ASLM could help reduce the pressure on conventional protein feed resources, make poultry meat more affordable for consumers, and increase animal protein intake among Nigerians—thus contributing to food security.

Materials and Methods

Location of the Experiment

The feeding trial was conducted at the Poultry Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. The geographical coordinates of the study area are approximately 5°29′N latitude and 7°32′E longitude, at an altitude of 123 meters above sea level. The region is located within the tropical rainforest zone of southeastern Nigeria, characterised by an average annual rainfall of 2,177 mm, ambient temperatures ranging from 22°C to 36°C, and relative humidity levels between 50% and 90% (NRCRI, 2014).

Preparation of the Test Ingredient (ASLM)

Fresh Alternanthera sessilis plants were harvested from swampy areas and around water bodies in Umudike and its surrounding areas within Umuahia, Abia State. The whole plants were sun-dried for 3 to 5 days on a clean concrete surface. After drying, the leaves were separated from the stems by manual rubbing and shaking. The dried leaves were then pulverised using a sledgehammer over three days into fine particles and stored in clean, airtight polythene bags until required for feed formulation.

Experimental Diets

Five experimental diets were formulated for the grower-finisher phase (2–8 weeks) of broiler production. Diet 1 (T1) served as the control and contained 0% ASLM. Diets T2, T3, T4, and T5 were formulated to contain 5%, 7.5%, 10%, and 12.5% inclusion levels of ASLM, respectively. All diets were iso-nitrogenous and formulated to meet the NRC (1994) nutrient requirements for broilers. A commercial broiler starter diet was fed to all birds during the first week for acclimatisation, after which the experimental diets (Table 1) were introduced from week 2 through week 8.

Table 1 Percentage Composition of Experimental Diets fed to Broiler chickens

Ingredients	D_1	D_2	D_3	D_4	D_5
Maize	50.10	50.00	49.00	48.00	47.50
Wheat offal	7.00	6.10	6.00	5.90	5.85
Soyabean meal	16.00	12.15	10.50	8.95	7.00
Groundnut	14.20	14.20	14.20	14.20	14.20

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cake					
ASLM	0.00	5.00	7.50	10.00	12.50
Bone meal	3.00	3.00	3.00	3.00	3.00
Palm kernel cake	7.00	7.00	7.00	7.00	7.00
Fish meal	2.00	2.00	2.00	2.00	2.00
Enzyme	0.00	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total Calculated Proximate composition (%)	100	100	100	100	100
Crude protein (%)	22.00	22.00	22.00	22.00	22.00
Metabolizable energy (Kcal/kg)	2871.9	2874.2	2861.2	2850.9	2848
Calcium	1.19	1.42	1.54	1.66	1.77
Phosphorus	0.74	0.73	0.71	0.71	0.71
Crude fibre	4.21	4.46	4.90	5.17	5.41

ASLM: *Alternanthera sessilis* leaf meal. D_1= diet containing 0% of ASLM, D_2= diet containing 5% of ASLM, D_3= diet containing 7.5% of ASLM, D_4= diet containing 10% of ASLM, D_5= diet containing 12.50% of ASLM.

Experimental Birds and Management

Source and Grouping of Birds

A total of 150-day-old Arbor Acres broiler chicks were procured from CHI Farms, Ibadan. The birds were allotted randomly to five (5) dietary treatments (T1 to T5) in a Completely Randomised Design (CRD). Each treatment had 3 replicates, with 10 birds per replicate, totalling 30 birds per treatment. Before the experiment, all birds underwent a one-week acclimatisation period during which they were fed a commercial broiler starter diet.

Housing and General Management

The birds were housed in a deep litter system within a well-ventilated poultry house divided into 15 pens. Clean wood shavings were used as bedding material, which was replaced biweekly to maintain hygiene and reduce disease risks. Lighting was provided continuously using electric bulbs and kerosene lanterns where necessary. Feed and clean water were offered ad libitum. Daily feed intake was recorded by subtracting the feed leftover from the feed offered the previous day. Standard vaccination and medication protocols were followed.

Data Collection

Growth Performance Parameters

Feed intake and body weight measurements were taken weekly. These data were used to compute the following parameters:

Daily Feed Intake (g/bird/day)

Daily Feed intake (g)/bird/day = Quantity of feed given - quantity left over Number of birds x number of days

Daily Weight Gain (g/bird/day)

Daily weight Gain (g)/bird/day = Final live weight - initial weight Number of birds x number of days

Feed Conversion Ratio (FCR)

Feed conversion Ratio (FCR) = Quantity of feed consumed per bird Weight gain per bird

Bioeconomic Evaluation

Bioeconomic parameters were calculated based on prevailing local prices of feed ingredients at the time of the experiment. The cost-effectiveness of each treatment diet was evaluated using the following indicators (Sonaiya et al., 1986; Ukachukwu and Anugwa, 1995):

Total Feed Intake /bird/day (g)

This was determined by finding the total quantity of feed given minus the total leftover feed, divided by the number of birds, multiplied by the number of days the experiment lasted.

<u>Total feed given – total feed remaining</u> x 56
Number of birds

Cost/kg of Feed (₦/kg)

Proportion of each ingredient in the diet multiplied by the cost per kg of ingredients and divided by hundred**:**

<u>Total cost of producing 100kg of feed</u>
100

Cost of Production (₦/bird)

The cost of production was determined by calculating the total quantity of feed consumed multiplied by the unit cost of feed.

Cost per kg Weight Gain (₦/kg)

The cost of feed consumed is divided by the kg of weight gain.

<u>Cost of feed consumed</u>
Kg Weight gain

Revenue (₦/bird)

This was determined by the market Price of 1kg live weight of Broiler (₦850/kg).

Gross Margin (₦/bird)

This was determined by finding the difference between Revenue and the cost of production per bird**. (Revenue – cost of production per bird).**

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RESULTS AND DISCUSSION

Proximate Composition of Alternanthera sessilis Leaf Meal (ASLM)

The laboratory analysis of the test ingredient, **Alternanthera sessilis Leaf Meal (ASLM)**, is presented in Table 2. The results show the following proximate values on a dry matter basis:

Table 2: Analysed Proximate Composition of ASLM (Dry Matter Basis)

Parameter	Composition (%)
Dry Matter	88.14
Crude Protein	20.99
Crude Fibre	17.87
Crude Fat (Ether Extract)	3.77
Moisture	11.86
Ash	9.29
Gross Energy (kcal/kg)	3995
Phytate (mg/g)	3.23
Tannin (mg/g)	8.56
Saponin (mg/g)	22.04

The **crude protein (CP) content of 20.99%** suggests that ASLM can serve as a viable alternative protein source for poultry diets. This value aligns with other leafy vegetable meals previously studied for poultry feed, such as *Moringa oleifera* and *Leucaena leucocephala*, which typically contain between 20%–30% CP (Fasuyi, 2006; Olugbemi et al., 2010).

The **gross energy value of 3995 kcal/kg** indicates a high energy potential, making ASLM not only a protein source but also a contributor to the energy component of the diet. However, the presence of anti-nutritional factors (ANFs) such as tannins, saponins, and phytates, though relatively moderate, must be considered. These compounds can bind essential nutrients and reduce their bioavailability (Cheeke, 1998; Francis et al., 2001). The extent of their effect depends on their concentration and the composition of the rest of the diet.

Proximate Composition of Experimental Diets

The proximate composition of the formulated diets fed to broiler chickens is shown in Table 3. The inclusion of ASLM at increasing levels led to slight changes in nutrient composition, particularly in crude protein, fibre, and metabolizable energy.

Table 3: Proximate Composition of Experimental Diets (% Dry Matter)

Parameter	D1 (0%)	D2 (5%)	D3 (7.5%)	D4 (10%)	D5 (12.5%)
Dry Matter (%)	90.64	89.80	89.62	89.44	89.26
Crude Protein (%)	21.85	21.60	20.95	20.45	20.15
Crude Fibre (%)	4.12	4.36	4.49	5.08	5.74
Ether Extract (%)	4.39	4.14	4.08	4.02	3.98
Ash (%)	7.48	7.85	7.90	7.98	8.16
Nitrogen-Free Extract (%)	52.80	51.85	52.20	51.89	51.23
Metabolizable Energy (kcal)	2821.94	2775.02	2760.89	2749.03	2735.26

The **metabolizable energy (ME)** of the control diet (D1) falls within the recommended 2800–3000 kcal/kg range for broiler chickens (Skinner-Noble et al., 2000). Diets D2–D5 showed a slight reduction in ME with increasing levels of ASLM. This reduction may be due to higher fibre content and the presence of anti-nutritional factors that reduce nutrient digestibility (Ravindran et al., 2005).

Crude protein in all diets met the minimum requirement of **20%–22% CP** for broiler finisher diets, as suggested by Edet (2008) and NRC (1994). The crude fibre content, although increasing with ASLM inclusion, remained within the tolerable range (≤5%) for broiler diets (NRC, 1994).

Growth Performance of Broiler Chickens

The effect of graded levels of ASLM on the growth performance of broiler chickens is presented in Table 4.

Table 4: Growth Performance of Broiler Chickens Fed Diets Containing ASLM

Parameter	T1 (0%)	T2 (5%)	T3 (7.5%)	T4 (10%)	T5 (12.5%)	SEM
IW (g/b)	112.57	112.56	112.22	110.50	109.24	0.51
FBW (g/b)	2093.33^{a}	2023.33^{a}	1706.67^{b}	1506.67^{c}	1416.67^{c}	75.33
TWG (g/b)	1980.67^{a}	1910.67^{a}	1594.67^{b}	1396.33^{c}	1307.33^{c}	74.98
ADWG (g/b)	35.37^{a}	34.12^{a}	28.48^{b}	24.94^{c}	23.34^{c}	1.34
TFI (g/b)	5201.33^{a}	5098.67^{b}	4523.00^{c}	4190.00^{c}	4186.33^{c}	136.18

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Parameter	T1 (0%)	T2 (5%)	T3 (7.5%)	T4 (10%)	T5 (12.5%)	SEM
ADFI (g/b)	91.05[ab]	92.88[a]	80.76[bc]	74.82[c]	74.76[c]	2.43
FCR	2.58[b]	2.72[ab]	2.83[ab]	2.77[ab]	3.20[a]	0.08

Note: Superscripts with different letters across rows indicate significant differences ($p < 0.05$).

Birds on the control diet (T1) and 5% ASLM (T2) showed **significantly higher (p < 0.05)** final body weight (FBW), total weight gain (TWG), and average daily weight gain (ADWG) compared to those on higher ASLM levels (T3–T5). This suggests that a **5% inclusion** did not negatively affect growth, aligning with similar findings by Olugbemi et al. (2010), who reported acceptable performance in broilers fed *Moringa oleifera* at levels of ≤5%.

The decrease in performance at higher ASLM inclusion levels could be attributed to:

- **Reduced palatability** and feed intake due to high fibre and ANFs like tannins and saponins (Cheeke, 1998).
- **Poor amino acid profile** and potential protein imbalance, affecting protein synthesis (Banerjee, 2013).
- **Depressed nutrient absorption**, a common effect of high tannin content, is also reported in neem leaf meal diets (Opara et al., 2006).

The feed conversion ratio (FCR) was **lowest (best) in the control group (2.58)** and **highest (poorest) in T5 (3.20)**. This implies that the **efficiency of feed utilisation decreased with increasing ASLM inclusion**, a trend also observed by Akinmutimi and Essien (2011), and Ogbonna et al. (2000). Nonetheless, the FCR values for T1–T4 remain within acceptable limits (<3.0) for broiler production.

Alternanthera sessilis leaf meal can be included in broiler diets **up to 5% without adverse effects** on growth performance. Higher levels (≥7.5%) may compromise feed intake and efficiency, likely due to the presence of anti-nutritional factors and nutrient imbalances. Further studies involving **processing methods to reduce ANFs** (e.g., fermentation or enzyme supplementation) may enhance the utility of ASLM in poultry nutrition.

BIOECONOMICS OF BROILER CHICKENS FED STRAIGHT DIETS CONTAINING *Alternanthera sessilis* LEAF MEAL

Table 5: Feed Cost and Bioeconomic Analysis of Broiler Chickens Fed Diets Containing *Alternanthera sessilis* Leaf Meal (ASLM)

Parameters	T1 (Control)	T2 (5%)	T3 (7.5%)	T4 (10%)	T5 (12.5%)	SEM
Cost/kg of feed (₦)	154.00[a]	151.00[a]	146.00[b]	142.00[c]	137.00[d]	1.68
Cost of feed consumed (₦)	790.33[a]	784.67[a]	661.00[b]	594.67[b]	574.33[b]	26.65
Cost/kg weight gain (₦)	399.33[b]	413.70[ab]	411.67[ab]	426.33[a]	438.00[a]	4.94
Revenue (₦)	1686.33[a]	1626.67[a]	1357.33[b]	1187.33[c]	1114.00[c]	63.82
Gross Margin (₦)	896.00[a]	842.00[a]	698.33[b]	592.67[c]	539.67[c]	38.52

Means in the same row followed by different superscripts are significantly different (p<0.05). SEM = Standard Error of Mean.

Discussion

The bioeconomic analysis of broiler chickens fed diets containing graded levels of *Alternanthera sessilis* Leaf Meal (ASLM) showed **significant differences (P<0.05)** in all measured economic parameters. This aligns with findings from Ojewola et al. (2005) and Akinmutimi and Essien (2011), who reported that dietary inclusion of unconventional feed ingredients often alters both nutritional and economic efficiencies of poultry rations.

Feed Cost per Kilogram

The **cost per kilogram of feed decreased progressively** with increased ASLM inclusion, from ₦154.00 in the control (T1) to ₦137.00 in the highest inclusion diet (T5). This significant (P<0.05) reduction can be attributed to the **lower market cost of ASLM compared to conventional protein sources** like soybean meal and groundnut cake (Agbede, 2006; Fasuyi, 2006). Similar cost-saving effects were reported when alternative plant-based ingredients were used to replace expensive conventional ingredients (Esonu et al., 2006).

Cost of Feed Consumed

The cost of feed consumed followed the same trend, decreasing with higher inclusion levels of ASLM. Diets T3, T4, and T5 showed significantly (P<0.05) lower feed cost than diets T1 and T2. This can be linked to **lower feed intake by birds on higher ASLM diets**, likely due to high fibre content and the presence of anti-nutritional factors (Chandrika et al., 2006; Olugbemi et al., 2010). As feed intake decreases, so does the total cost of consumed feed, although at the risk of reduced growth performance.

Cost per Kilogram Weight Gain

Cost per kilogram of weight gain was lowest for birds on T1 (₦399.33), which was significantly (P<0.05) more economical than T4 and T5. Birds on higher ASLM diets (T4 and T5) had **higher feed costs per unit weight gain**, owing to

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reduced weight gains (as shown in growth performance data). This confirms previous reports that poor protein quality or the presence of anti-nutritional compounds like saponins and tannins can reduce protein utilisation and growth efficiency (D'Mello, 2000; Opara et al., 2006).

According to Ojewola et al. (2005), **a superior feed is characterised by a lower cost per unit weight gain**, as it implies higher feed efficiency and economic return. Therefore, diet T1 remains the most cost-effective among all treatment groups.

Revenue Generated

Revenue generated from the sale of broilers was significantly (P<0.05) influenced by dietary treatments. The **highest revenue (₦1686.33)** was recorded in T1, while the **lowest (₦1114.00)** was observed in T5. Given that the market price per kg of broiler is generally fixed, revenue is primarily a function of final body weight. Reduced weight gain in birds fed higher ASLM levels directly led to lower revenues, consistent with findings by Aletor and Omodara (1994) and Banerjee (2013) that **lower quality diets result in suboptimal growth and returns**.

Gross Margin

Gross margin, which reflects **total profit after deducting feed cost**, followed a similar pattern. Diet T1 had the **highest gross margin (₦896.00)**, followed by T2 (₦842.00), while diets T4 and T5 had the lowest margins (₦592.67 and ₦539.67, respectively). This suggests that although the cost of feed was reduced with ASLM inclusion, the poor weight gain at higher inclusion levels undermined profitability. This finding supports the results of Ekenyem and Madubuike (2006), who cautioned against excessive inclusion of fibrous plant materials without proper nutrient balancing or enzyme supplementation.

Conclusion

From an economic perspective, the inclusion of *Alternanthera sessilis* leaf meal at **5% level (T2)** appears to strike a balance between cost reduction and acceptable growth performance, making it a feasible partial substitute for conventional protein sources in broiler diets. Higher inclusion levels (≥10%) negatively impacted revenue and profitability due to reduced feed intake and poor weight gain, likely caused by the **high crude fibre and anti-nutritional compounds** in the leaf meal. Enzyme supplementation may mitigate some of these effects, but it did not fully compensate at higher inclusion rates.

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