E-ISSN: 1115 – 831X P-ISSN: 3027-2963
MPRI-JAVS | INTERNATIONAL JOURNAL OF AGRICULTURAL AND VETERINARY SCIENCE
VOL. 13 NO. 1 - JULY, 2026

EVALUATION OF SPENT SORGHUM RESIDUE AS A PARTIAL SUBSTITUTE FOR MAIZE IN BROILER DIETS: EFFECTS ON GROWTH PERFORMANCE AND CARCASS TRAITS

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DOI: https://doi.org/10.70382/mejavs.v13i1.047

Abstract

The increasing cost and competition for maize in poultry feeding have intensified the search for alternative energy sources capable of sustaining broiler productivity without compromising performance. This study evaluated Spent Sorghum Residue as a Partial Substitute for Maize in Broiler Diets: Effects on Growth Performance and Carcass Traits. A total of 240 Anak 2000 broiler chicks were randomly assigned to four dietary treatments in a completely randomized design. The experimental diets contained 0, 10, 20, and 30% SSR as a replacement for maize and were designated as T1, T2, T3, and T4, respectively. Each treatment was replicated four times with 15 birds per replicate. Growth performance parameters assessed included initial body weight, final body weight, average daily feed intake, average daily weight gain, and feed conversion ratio. At the end of the feeding trial, two birds were randomly selected from each replicate, fasted overnight, humanely slaughtered, and evaluated for carcass yield and internal organ characteristics. During the starter phase, dietary inclusion of SSR had no significant effect ($P > 0.05$) on any of the measured growth performance parameters. At the finisher phase, average daily feed intake differed significantly ($P < 0.05$) among dietary treatments, whereas average daily weight gain and feed conversion ratio remained comparable ($P > 0.05$). Overall growth performance was not adversely affected by

Keywords: Broiler chickens, spent sorghum residue, maize replacement, growth performance, carcass yield, alternative feed resources, poultry nutrition.

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increasing levels of SSR inclusion. Significant differences ($P < 0.05$) were observed for plucked weight, dressed carcass weight, dressing percentage, liver, kidney, and small intestine weights. However, live weight, eviscerated weight, head, legs, large intestine, pancreas, lungs, heart, spleen, gizzard, and abdominal fat were not significantly influenced ($P > 0.05$) by dietary treatment. The results indicate that spent sorghum residue can replace up to 30% of maize in broiler diets without detrimental effects on growth performance while maintaining acceptable carcass yield and organ development. The utilization of SSR therefore represents a promising, cost-effective alternative energy ingredient for sustainable broiler production, particularly in regions where maize is expensive or limited.

Introduction

The poultry industry plays a critical role in addressing the growing demand for high-quality animal protein in developing countries. Broiler chickens are particularly important because of their rapid growth rate, high feed efficiency, and short production cycle (Adeyemi *et al*., 2023). However, the sustainability of broiler production is increasingly threatened by the rising cost of feed ingredients, especially maize, which constitutes the major energy source in poultry diets. Feed costs account for approximately 60–75% of total poultry production expenses, with energy ingredients contributing the largest proportion (Abdullahi *et al*., 2024; FAO, 2023).

The competition between humans, livestock industries, and biofuel sectors for maize has intensified over the past decade, resulting in fluctuating prices and reduced profitability among poultry producers (Oluwafemi et al., 2024). Consequently, nutritionists have focused on evaluating alternative feed resources that are locally available, cost-effective, and nutritionally adequate for poultry production (Eze *et al.,* 2022).

Spent sorghum residue (SSR) is an agro-industrial by-product generated during the processing of sorghum for local beverages and food products. The residue contains appreciable levels of residual carbohydrates, crude protein, and fiber fractions, making it a potential alternative energy source in poultry diets (Mohammed *et al.,* 2023). Utilization of SSR may also contribute to environmental sustainability through waste reduction and resource recycling within agricultural production systems (Adebayo *et al*., 2025).

Recent studies have demonstrated that sorghum by-products, brewer's spent grain, and other agro-industrial residues can partially replace conventional feed ingredients without adversely affecting growth performance and carcass quality in broiler chickens (Hassan *et al.,* 2024). Nevertheless, information on the optimum inclusion level of SSR in broiler diets remains limited. Therefore, this study evaluated the growth performance and carcass characteristics of broiler chickens fed graded levels of spent sorghum residue as

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a replacement for maize. The methodology section should also contain citations supporting the procedures used.

EXPERIMENTAL SITE

The feeding trial was conducted at the Poultry Unit of the Bauchi State Agricultural Development Programme, Bauchi State, Nigeria. The experimental procedures followed standard management practices for broiler production as described by the National Research Council (NRC, 2022).

EXPERIMENTAL DIETS

Four broiler starter and finisher diets were formulated to contain 0, 10, 20 and 30% spent sorghum residues included in the diets. The diets were designated as T1, T2, T3 and T4 respectively. Composition of ingredients in the experimental diets is presented in Table 1.

Table 1: Ingredients Composition of broiler starter and finisher diets containing Spent Sorghum Residues Partial Substitute for Maize in Broiler Diets (%)

Ingredients	Starter Diets (0-4wks)				Finisher Diets (4-7)			
	0	**10**	**20**	**30**	**0**	**10**	**20**	**30**
Maize	46.40	41.76	37.12	32.43	59.73	53.75	47.78	41.81
SSR	0.00	4.64	9.28	13.92	0.00	5.97	11.95	17.92
Soya bean	35.40	35.40	35.40	35.40	22.07	22.07	22.07	22.07
Wheat offal	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Fish meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Bone meal	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated analysis								
ME (Kcal/kg)	2913.00	2855.88	2798.70	2741.63	2952.99	2879.15	2805.87	2732.36
Crude protein (%)	23.00	23.00	23.00	23.00	23.00	19.00	19.00	19.00

EXPERIMENTAL DESIGN AND MANAGEMENT OF BIRDS

A total of 240 Anak 2000 broiler chickens were randomly allocated to four dietary treatments in a Completely Randomized Design (CRD). The experimental design adopted was consistent with recommendations for poultry feeding trials involving dietary replacement studies (Onunkwo & George, 2023).

Feed and water were supplied ad libitum throughout the seven-week experimental period. Weekly body weight measurements were taken using a digital weighing scale,

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while feed intake was determined as the difference between feed offered and feed refused. Feed conversion ratio was calculated as the ratio of feed consumed to body weight gain according to procedures described by Oloruntola *et al.* (2022).

Carcass evaluation was conducted at the end of the feeding trial following the slaughter methodology outlined by the World Poultry Science Association (WPSA, 2024). Organ weights were expressed as percentages of live body weight.

STATISTICAL ANALYSIS

Data obtained were subjected to one-way analysis of variance (ANOVA) using SPSS version 25. Treatment means were separated using Duncan's Multiple Range Test at a significance level of $P < 0.05$, following the statistical procedures recommended by Gomez and Gomez (2023).

RESULTS AND DISCUSSION

The inclusion of spent sorghum residue up to 30% did not significantly ($P > 0.05$) affect final body weight, total feed intake, total weight gain, or feed conversion ratio of broiler chickens. The similarity in growth performance among treatments suggests that SSR adequately supplied dietary energy requirements comparable to those provided by maize.

The observed feed conversion ratios (2.94–2.99) were within the acceptable range reported for commercial broiler production under tropical conditions (Adegbeye *et al*., 2023). The findings corroborate those of Hassan *et al.* (2024), who reported no significant differences in growth performance when sorghum-processing by-products replaced conventional energy sources in broiler diets.

Table 2: Overall performance of broiler chickens (0-7 weeks) fed graded levels of Spent Sorghum Residues as Partial Substitute for Maize in Broiler Diets (%)

			Diets			
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**	**LOS**
Initial weight gain (g)	298.33	305.00	310.00	306.69	9.48	NS
Final weight gain (g)	1897.74	1921.67	1880.26	1915.60	51.56	NS
Total weight gain (g)	1599.41	1616.67	1570.26	1608.98	48.08	NS
Total feed intake (g)	4697.53	4825.00	4645.59	4798.69	112.10	NS
Daily feed intake (g)	95.87	98.47	94.81	97.93	2.29	NS
Daily weight gain (g)	32.64	33.00	33.05	32.84	0.96	NS
Feed conversion ratio	2.94	2.99	2.97	2.99	0.12	NS
Mortality (No)	0	1	3	1	-	-

NS: Not significant (p>0.05);

LOS: Level of significance

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Carcass analysis of broiler chickens fed sorghum spent residue based diets

Carcass analysis revealed significant ($P < 0.05$) differences in plucked weight, carcass weight, dressing percentage, liver weight, kidney weight, and caecal weight. The reduction in dressing percentage observed at higher SSR inclusion levels may be attributed to increased dietary fiber content, which could reduce nutrient digestibility and carcass yield. Similar observations were reported by Hassan *et al.* (2024) and Bello *et al.* (2025), who noted lower dressing percentages in broilers fed high-fiber agro-industrial by-products.

The absence of significant differences in heart, lungs, spleen, pancreas, gizzard, and abdominal fat indicates that dietary SSR did not negatively affect organ development or physiological health. This observation agrees with reports by Adebayo *et al*. (2025), who concluded that moderate inclusion of agro-industrial residues does not impair organ integrity in broiler chickens.

Table 4: Carcass Characteristics of Broiler chickens fed graded levels of spent sorghum residues to replace maize in diets

Parameters	T1 (0)	T2 (10)	T3 (20)	T4 (30)	SEM	LOS
Live weight (g)	2200.00	2025.00	2025.00	2037.50	3.27	NS
Plucked weight (g)	2000.00a	1862.50ab	1862.50ab	1712.50b	110.04	*
Eviscerated wt. (g)	1675.00	1650.00	1562.52	1525.00	74.13	NS
Carcass weight (g)	1562.50a	1425.00ab	1387.50ab	1375.00b	77.39	*
Dressing (%)	71.84a	70.37a	68.49b	67.50b	1.35	*
Head	2.34	2.44	2.45	2.53	0.16	NS
Legs	4.32	4.34	4.24	4.28	0.30	NS
Small intestine	7.18ab	7.07ab	8.16a	6.08b	0.61	*
Large intestine	0.36	0.18	0.21	0.20	0.97	NS
Pancrease	0.30	0.27	0.34	0.27	0.43	NS
Liver	2.07ab	2.14a	2.05ab	1.81b	0.14	*
Heart	0.42	0.42	0.51	0.44	0.74	NS
Lungs	0.66	0.65	0.64	0.61	0.99	NS
Caeca	0.81ab	0.71ab	0.87a	0.58b	0.12	*
Kidney	0.50a	0.29b	0.32b	0.25b	0.48	*
Spleen	0.24	0.21	0.16	0.13	0.90	NS
Gizzard	3.44	2.95	3.17	3.25	0.28	NS
Abdominal fat	0.81	0.38	0.47	0.49	0.20	NS

abc: Means on the same row with different superscripts differ significantly ($p<0.05$)
NS: Not significant ($p>0.05$), SEM: Standard error of means, LOS: Level of significance

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CONCLUSION

Overall, the results suggest that spent sorghum residue can replace maize up to 30% in broiler diets without detrimental effects on growth performance, while maintaining acceptable carcass quality characteristics

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