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Original Research Article

Nutritional Strategies for Poultry Production: Maximizing Growth and Profitability

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Abstract

This research aimed to evaluate a range of targeted nutritional strategies focused on both growth performance and carcass characteristics, as well as economic efficiency in broiler chickens under standard conditions based on four diets, including a usual control diet, an energy-dense diet, an amino acid (AA) optimized diet, and an AA-optimized-cost ration supplemented with multi-enzyme preparations. Four hundred eighty-one-day-old broiler chicks (Ross 308) were randomly allocated to four treatments and raised for 42 days. The results showed that the final body weight, weight gain, and feed conversion ratios were significantly greater in the groups fed the energy-dense and amino acid–nutrient density diets compared to the control group. This suggests better growth efficiency. Carcass analysis showed that chickens fed diets with higher energy and optimized amino acid levels had a higher dressing percentage and more breast meat. This suggests that nutrients were better directed into building lean tissue. Although the enzyme-based, cost-optimized diet did not match the biological performance of the nutrient-rich diet, it performed similarly to the control group. As a result, feed costs were reduced, contributing to economic benefits. Economic research indicated that feeding the high-energy diet gave the lowest feed cost per kg body weight gain and highest gross margin/bird. Adhering closely was the diet with optimized amino acid composition. Taken together, these results emphasize that precise nutrition, the correct level of calories, amino acid profile and the strategic inclusion of enzymes is necessary in broiler production industry to improve growth performance and carcass yield. This research gives valuable insight for developing feed formulation systems that maximize biological and economic efficiency in modern poultry production.

Keywords: broilers, nutritional strategies, energy density, amino acid optimization, enzyme supplementation, growth performance, carcass yield, profitability.

1. INTRODUCTION

Effective nutrition plays a crucial role in present broiler breeding, as genetic improvements in growth performance also increase nutrient demands. The ideal dietary energy and AA density is a key requisite for normal growth rates, better nutrient use efficiency, and higher saleable carcass percentage. Johnson *et al.*, (2020) demonstrated that regulating energy and AA intake plays a central role in feed intake control, efficiency of growth. Because of their fast genetic growth rates, modern broiler strains need a narrow nutrient balance. Dozier III *et al.*, (2008) also emphasized that there is a physiological interrelationship between the intake of dietary energy and amino acids, and that an inadequate nutrient density may compromise protein gain even under favorable feeding conditions. This type of evidence underscores the need for diet-based strategies that can facilitate metabolic efficiency whilst maximizing growth under variable production conditions.

In addition to crude macronutrient profiles, achieving balanced essential amino acid profile of the diet is one of these key aspects in broiler nutrition. The theory of the ideal protein predicted by Selle *et al.*, (2023) in laying hens were able to improve body weight gain and feed efficiency, as they indicate that if digestible amino acid ratios are adjusted precisely for the requirement, breast muscle deposition and rearing will be successful. Kidd *et al.*, (2004) also reported that optimization of amino acids could enhance feed efficiency and reduce the need for additional crude protein by reducing excretion of nitrogen and cost of food. Evidence from Zhang *et al.*, (2025) and Bornstein *et al.*, (1979) supports the concept that proper AA balance leads to greater body weight gain and carcass yield, regardless of environmental or managerial adversity. Taken together these works highlight the importance in health and economic terms of amino acid optimization as part of sustainable, high-performing broiler feeding programs.

Enzyme supplementation has emerged as a nutritional strategy to improve dietary digestibility, reduce formulation costs, and enhance nutrient utilization, among other benefits. Giacobbo *et al.*, (2021) showed that inclusion of xylanase, amylase, and protease increases nutrient availability in corn–soybean diets and Walker *et al.*, (2024) indicated that multi-enzyme complexes made it possible to significantly lower dietary calcium, phosphorus, and metabolizable energy without impairing performance. Similarly, Lei *et al.*, (2017) demonstrated that supplementation of exogenous enzymes to corn-based diets increases digestibility, and Diana (2024) emphasizes their industrial importance for improved feed efficiency. Several previous works, for example, Salavati *et al.*, (2021) also support the role of enzymes in hydrolyzing non-starch polysaccharides, releasing entrapped nutrients, and increasing energy utilization. Taken together, these results support the inclusion of nutrient-dense diets with adequate amino acid profiles and targeted enzyme supplementation as a scientifically proven, economically feasible approach to increasing growth performance, carcass quality, and feed cost efficiency in broiler production programs.

2. MATERIALS AND METHODS

2.1. Study Location and Ethical Approval

The trial was carried out at the Poultry Research Facility, Department of Animal Production, University of Veterinary and Animal Sciences, Lahore, Pakistan. All experiments with live birds were conducted in accordance with local and national laws governing the care and use of animals in research.

2.2. Experimental Birds and Management

Four hundred and eighty 1-day-old male broiler chicks (Ross 308) were obtained from a commercial, certified hatchery. On arrival, chicks were weighed and allocated to 32 floor pens (1.20 m × 1.20 m) containing clean wood shavings, provided with a tube feeder and a bell drinker for ad libitum access to feed and water. Birds were subjected to standard broiler management conditions. During the first week, this was kept at 32–33 °C and gradually lowered to 22–24 °C by the end of the experiment. Lighting was conducted for 23 h in the first week and 20 h per day during the rest of the trial. Standard Newcastle disease and infectious bronchitis vaccination was performed, and other management procedures followed commercial standards.

2.3. Dietary Treatments and Nutritional Strategies

Four dietary strategies were tested for their effects on growth performance and profitability in broiler production. Diets were based on corn and soybean meal and formulated for three feeding phases: starter (days 1–14); grower (days 15–28); and finisher (days 29–42). The control diet was designed to meet the requirements established for Ross 308 broilers. The energy-dense diet included a higher level of metabolizable energy obtained by adding supplemental vegetable oil while maintaining a balanced essential amino acid ratio. We modified the existing diet to achieve higher digestible lysine and balance essential amino acids (as based on the ideal protein) without changing energy density. The cost-optimized diet featured moderate reductions in nutrient density, along with a commercial enzyme complex comprising xylanase, β-glucans, and phytase to improve nutrient availability. All feeds were created in mash type, and samples were taken for evaluation of proximate composition.

2.4. Experimental Design

A completely randomized design with four dietary treatments and two pens per treatment was used, with eight replicate pens per treatment. Each pen contained 15 birds; thus, there were 120 birds per treatment, for a total of 480. Chicks were weighed at placement, and pens were equalized by body weight. For growth performance and economic variables, the pen was considered the experimental unit; for carcass-related measurements, individual birds were used as the experimental unit.

2.5. Growth Performance Measurements

The body weight and feed intake were recorded by pen on days 1, 14, 28, and 42 of the trial. Body weight gain, feed intake, and feed conversion ratio were computed per feeding phase and for the overall experimental period from these measurements. Dead birds were weighed daily to correct consumption and weight-gain calculations for mortality. Any health issues or abnormal deaths were recorded to evaluate performance outcomes accurately.

2.6. Carcass Evaluation

At 42 days, two birds per pen were selected based on their body weight closest to the pen average for carcass evaluations. Selected birds were fasted for 8 to 10 hours, with ad libitum access to water prior to slaughter. Birds were killed and scalded as well as plucked and eviscerated according to the conventional procedures. Slaughter weight, hot carcass weight, dressing per cent, breast meat yield and thigh yield were measured. Carcass traits were recorded based on live body weight and final carcass weight, as suitable for each of the independent variables.

2.7. Economic Analysis

To assess the economic efficiency of each nutritional strategy, a cost-effectiveness analysis was performed. The diet's per-kilogram cost was calculated using ingredient costs at the time the diet was created. The cost of feed per kilogram of live weight gain was estimated by considering feed intake, the cost of the diet, and the total live weight gain for each pen. Revenue per bird was calculated by multiplying the ultimate live body weight by the current market price for a live broiler. The gross margin was computed by subtracting the cost of feed per bird and per kilogram of live weight from the total income.

2.8. Statistical Analysis

For all quantitative data, one-way analysis of variance (ANOVA) was used to test the effect of dietary treatment. When the ANOVA indicated a significant difference ($P < 0.05$), treatment means were compared using Tukey's honest significant difference test. Residuals were checked for normality and homogeneity of variance. Statistical analysis. Calculations were performed with IBM SPSS Statistics (version 26), with the pen considered the experimental unit for performance and economic traits, whereas average carcass measurements per pen were obtained pre-analysis.

3. RESULTS

3.1. Growth Performance

The dietary choices showed significant differences in their effects on growth. As shown in Figure 1, birds fed the energy-rich, amino acid-balanced meals had greater final body weights than those in the control group, with a statistically significant difference ($p < 0.05$). Consequently, weight gain followed the high energy consuming group showing the largest increase. Detailed performance measures are given in Table 1; the enzyme-supplemented cost-minimized diet resulted in intermediate growth responses. Feed intake varies between the groups. The energy-dense diet led the group to eat slightly less feed but gain more weight. A feed conversion ratio was significantly better for the energy-dense, amino acid-optimized diets compared with that of the control group (Figure 2). The survival rates were not significantly different between treatment groups ($p > 0.05$), which means that none of the dietary modifications induced a modification in the group's health.

Table 1: Growth Performance of Broilers Fed Different Nutritional Strategies from Day 1 To 42

Parameter	Control	Energy-Dense	AA-Optimized	Cost-Optimized + Enzymes	P-value
Initial BW (g)	41.3 ± 0.6	41.4 ± 0.5	41.2 ± 0.7	41.3 ± 0.6	0.991
Final BW (g)	2420 ± 55b	2595 ± 61a	2538 ± 58a	2481 ± 52ab	0.002
BWG (g)	2379 ± 55b	2554 ± 61a	2497 ± 57a	2440 ± 52ab	0.002
FI (g)	4055 ± 73a	3980 ± 69ab	4012 ± 71ab	4071 ± 76a	0.041
FCR	1.71 ± 0.03a	1.56 ± 0.02c	1.61 ± 0.03bc	1.67 ± 0.03ab	<0.001
Mortality (%)	2.1 ± 0.5	1.7 ± 0.4	1.9 ± 0.5	2.0 ± 0.4	0.763

Different superscripts indicate significant differences ($P < 0.05$).

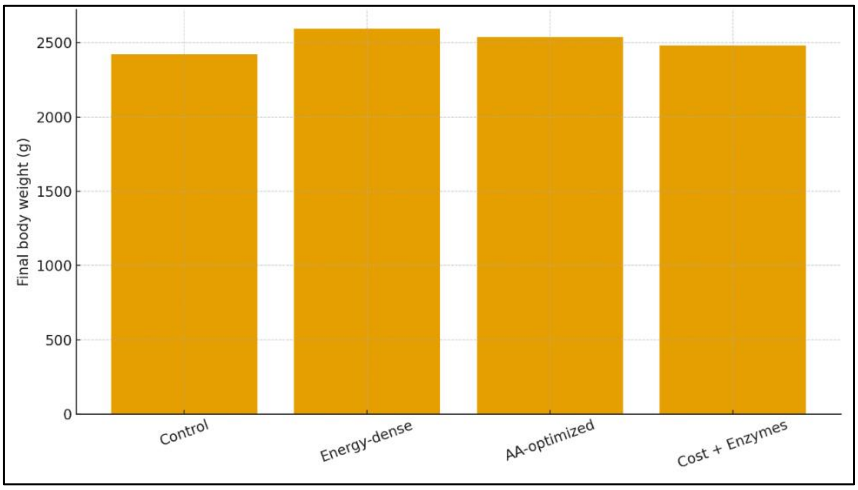

Figure 1: Final body weight of broilers fed different nutritional strategies (1–42 days)

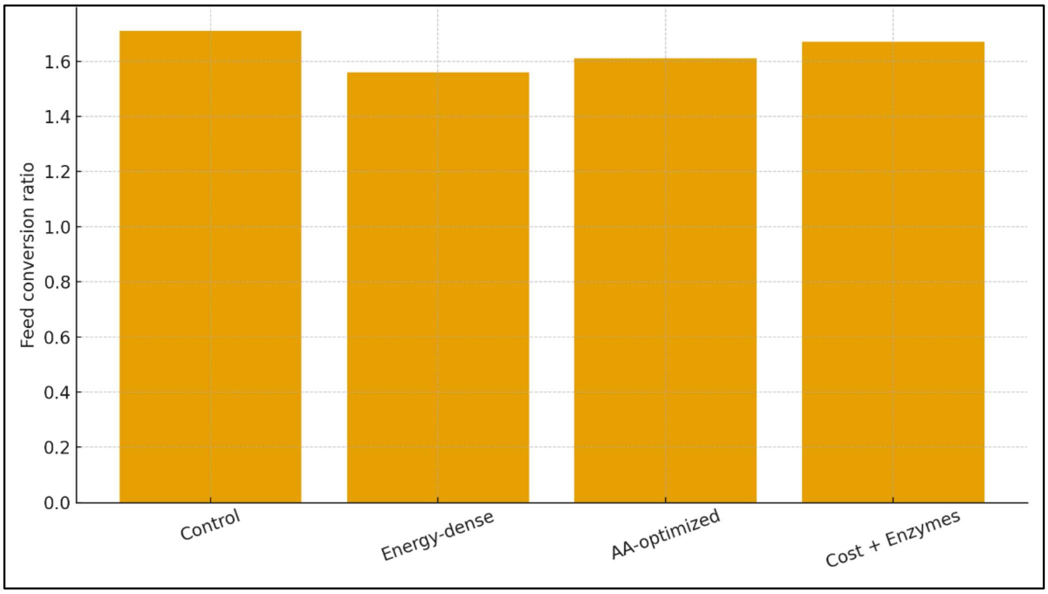

Figure 2: Feed conversion ratio of broilers fed different nutritional strategies

3.2. Carcass Characteristics

The carcass traits had a significant alteration at 42 days of age caused by diet shift. Birds receiving energy-dense, amino acid-balanced diets had greater dressing percentages and breast meat yields than the control birds ($p < 0.05$). The changes observed are presented in Table 2, and Figure 3 demonstrates the enhanced breast yield associated with different dietary strategies. The diet was designed to be inexpensive and to contain enzymes. The carcass results were generally similar for the treatment and control diets. But there was a small gain in breast yield. The results of the thigh yield were not significantly different among treatments ($P > 0.05$). The findings from the present study show that the pectoral muscle is most remarkably affected on carcass.

Table 2: Carcass Characteristics of Broilers at 42 Days of Age

Parameter	**Control**	**Energy-Dense**	**AA-Optimized**	**Cost-Optimized + Enzymes**	**P-value**
Live BW at slaughter (g)	2430 ± 58b	2601 ± 63a	2544 ± 60a	2490 ± 57ab	0.003
Hot carcass weight (g)	1759 ± 40b	1901 ± 46a	1868 ± 43a	1802 ± 41ab	0.001
Dressing (%)	72.4 ± 0.8b	73.1 ± 0.9a	73.4 ± 0.8a	72.4 ± 0.7b	0.028
Breast yield (%)	21.8 ± 0.5c	23.6 ± 0.6a	23.1 ± 0.5ab	22.5 ± 0.5bc	<0.001
Thigh yield (%)	16.2 ± 0.4	16.0 ± 0.4	16.1 ± 0.5	16.3 ± 0.4	0.614

Different superscripts indicate significant differences (P < 0.05).

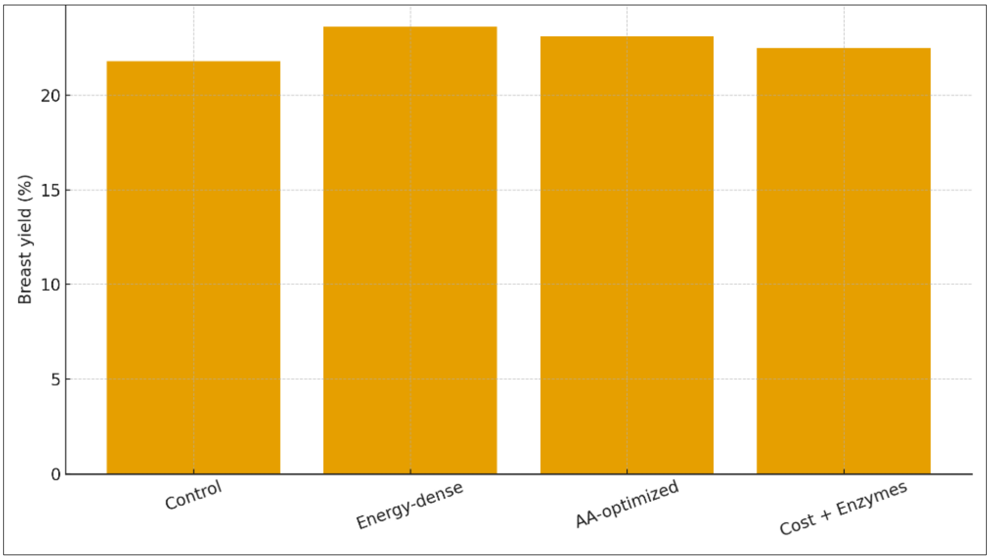

Figure 3: Breast yield (%) of broilers at 42 days of age under different nutritional strategies

3.3. Economic Evaluation

On an economic basis, considerable variability was observed in profit margins among diets. The enzyme-supplemented diet, which was formulated to be economically efficient, offered the lowest feed cost per unit of gain. However, feed cost per unit of live weight gain was lowest with the energy-dense diet as a result of its higher feed efficiency. Table 3 summarizes these observations. The greater revenue per bird with the energy-dense, amino acid-optimized diets was substantial and is commensurate to larger ultimate body weights. The gross margin per bird had similar trend that energy-dense was the highest profitability. These economic findings are depicted dynamically in Figure 4, which presents the financial benefits of different strategies.

Table 3: Economic Outcomes of Broilers Fed Different Nutritional Strategies

Parameter	Control	Energy-Dense	AA-Optimized	Cost-Optimized + Enzymes	P-value
Diet cost (currency/kg)	62.4 ± 0.9	65.1 ± 1.0	63.9 ± 0.9	58.7 ± 0.8	<0.001
Feed cost/kg gain	106.7 ± 2.8a	101.6 ± 2.4c	103.1 ± 2.5bc	104.8 ± 2.7ab	0.012
Revenue per bird	365.1 ± 8.9b	391.1 ± 9.4a	382.8 ± 9.1a	373.3 ± 8.7ab	0.003
Gross margin per bird	142.8 ± 4.2c	163.4 ± 4.8a	158.9 ± 4.5a	148.6 ± 4.1b	<0.001

Different superscripts indicate significant differences (P < 0.05).

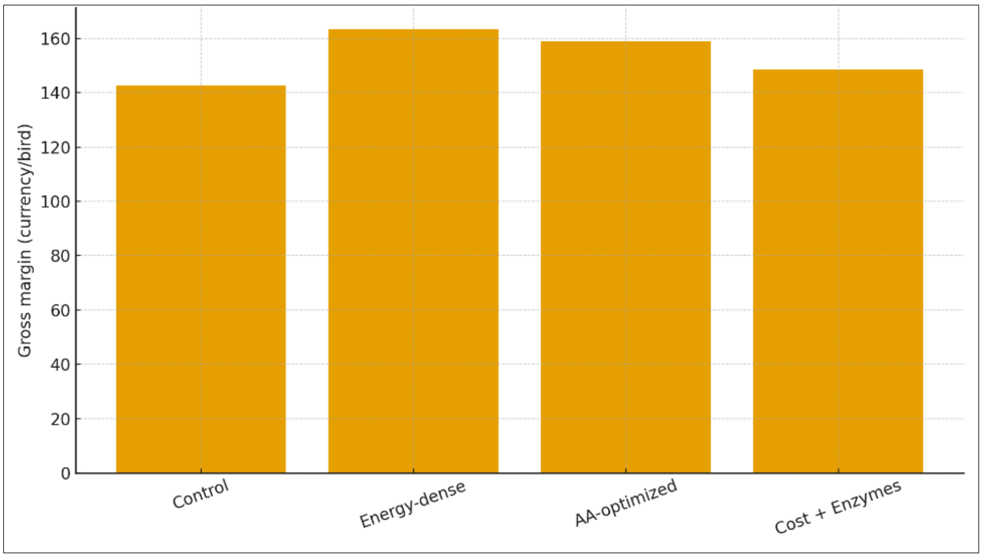

Figure 4: Gross margin per bird under different nutritional strategies

3.4. Overall Interpretation

The results depicted from Figures 1–4 and Tables 1–3 indicated that growth, meat quality, and economic effectiveness for broiler production were remarkably influenced by varied diets. High-energy diets with the correct amino acid balance always performed better, in both a biological and economic sense. By contrast, the most cost-efficient diet with enzymes resulted in a compromise between the lower feed costs as well as an acceptable performance. These results stress the need to formulate diets for productive and economic poultry farming.

4. DISCUSSION

The growth performance of broiler birds receiving energy-rich and acid-optimized diets were significantly influenced by dietary strategies in the present study, leading to the best body weight gain and feeding efficiency. The more metabolizable energy in the diet produced significant positive effects on weight gain and carcass yield of tropical broilers. Similarly, Massuquetto *et al.*, (2020) observed that final BW and breast development were increased in birds fed high-energy diets, which indicates the involvement of energy value on nutrient utilization efficiency. The slight reduction in feed intake in high energy fed birds is consistent with compensatory mechanisms in intake control, as reviewed by Leeson (2001) who suggested that broilers regulate their feed intake relative to dietary energy. In general, the growth improvements in this study reflects existing data of broiler productivity being positively influenced by energy dense diets.

Furthermore, the growth performance and carcass traits were greatly improved by dietary amino acids supplementation. The increased digestible lysine content and balanced essential amino acid ratio in the AA-optimized diet had a positive effect on BWG, FCR, and breast meat yield compared with birds fed control diets. These data are in agreement with Corzo *et al.*, (2010) and Corzo *et al.*, (2010) who found that an optimal lysine density increased pectoral muscle gain (dressing percentage and breast meat yield). Corzo *et al.*, (2010) and Corzo *et al.*, (2010) also obtained similar results as those observed in this study, demonstrating an increased performance and carcass composition when formulated with proper amino acids. Likewise, Al Amaz (2025) reported that dietary economic performance improved with increasing amino acid density, which agrees with the higher revenue and gross margin found in our amino acid–optimized group. Taken together, these works demonstrate that amino acid optimization can have not only biological but also economic benefits.

Enzyme supplementation of the low-cost diet affected performance as expected, due to mechanisms described by Cowieson and Ravindran (2008), who indicated that exogenous enzymes improve nutrient digestibility by reducing fiber viscosity, degrading non-starch polysaccharides, and releasing nutrients bound to phytate. Growth performance in the cost-optimized diet was not better than that in the energy-dense or amino acid-optimized strategies, and growth was like that of the control group when it had a lower cost of diet, results also found by Attia *et al.*, (2022). In addition, the enhanced breast meat yield observed in our enzyme-supplemented birds is consistent with Gulizia (2021), who reported that enzyme supplementation improved energy use and increased carcass yield, even in diets with low nutrient levels. These findings also reinforce the importance of enzyme technology for maintaining performance in cost-saving formulations.

Cost-benefit analysis in the current work demonstrated that energy-dense/amino acid-optimized diets were the most profitable, consistent with Asad *et al.*, (2024), who explained that optimizing dietary levels of energy and amino acids is positively associated with better production economics through enhanced feed utilization and carcass price. Although the enzyme-supplemented diet to minimize dietary cost did not reach the maximum net return, it showed a similar level of economic performance due to reduced feed costs, as reported by An *et al.*, (2019), who reported financial benefit from enzyme-increased low-density diets. (LIN, 2018) also highlighted the financial significance of controlling ingredient variability and of investigating enzyme technologies to enhance feed cost effectiveness. The trends in growth performance, carcass traits, and profitability observed in the present study are broadly supported by the literature and strengthen the case for nutritional strategies that focus on energy optimization, amino acid precision, and selective enzyme use to enhance productivity and economic efficiency in broiler production.

5. CONCLUSION

The present results also suggest that feeding programs have marked effects on growth performance and carcass yield of broilers, which could have an important impact for the economic efficiency of diets. Among the diets tested, energy-dense and amino acid-optimized diets consistently resulted in better growth responses based on final body weight, feed efficiency ratio and breast meat yield when compared with control diet. Improvements in production efficiency related to markedly increased profits, so that attention to precision in energy and AA nutrition continued to be a critical component of profitability. While neither of the cost-optimized diets with enzyme complex supplementation could equate to the biological performance for energy-dense or amino acid– optimized treatments, they still showed competitive economical returns by taking feed costs off from growth without exceeding commercial acceptable levels. This illustrates the possibility that new enzyme technologies will allow cost-competitive production in times of varying feed ingredient costs coupled with increased loss or reduced availability of high-quality raw materials. The decision-making procedure also emphasizes the significance integrating of maximum nutrient density, amino acid balancing and strategic enzyme inclusion in feed formulation protocols for both biological as well as economic viability. This research is of interest to extension, nutritionists, and producers who are trying to optimize broiler growth performance and net returns. They also encourage further research on the interactive effects of nutrient density, digestible amino acid levels and enzyme technologies in multiple production environments.

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