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Impact of Balanced Amino Acid Supplementation on Growth Performance, Meat Quality, and Economic Efficiency in Commercial Broiler Production

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Abstract

This paper sought to establish the impacts of balanced amino acid addition on growth rate, meat yield, and profitability in broiler chickens. One thousand two hundred, day old Ross 308 broilers were randomly distributed into four groups with different diets based on amino acid composition for forty-two days. The research findings revealed that;The optimized amino acid supplementation had positive effects on feed conversion ratio (-4.2%; $P < 0.001$), breast meat yield (+ 3.5%; $P < 0.05$), and a reduction in feed cost per kilogram gain (-6.7%; $P < 0.05$). Treatment 3, in which the optimized AA pattern was applied, provided the highest quality of medium and highest growth rates in all observed factors, together with a 25% decrease in the rate of nitrogen excretion. This study confirms that targeted individual amino acid addition has the potential to simultaneously increase productivity and improve the quality of meat as well as make the process economically profitable and environmentally friendly.

Keywords
Amino acid supplementation; Broiler nutrition; Feed conversion; Meat quality; Economic efficiency

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Introduction

Challenges facing the poultry industry include the need to produce more and at lower costs and effect this with less harm to the environment [1]. They argue that, to accomplish these goals, amino acid nutrition is pivotal especially given that genetic selection has boosted growth rate and dressing percentage in the current generation of broiler strain [2]. New findings in amino acid metabolism and the consideration of the requirements for these have given better direction for how feeds can be formulated [3] but its optimal level of supplementation under commercial production remains an answered question.

Many of the past strategies for diets have been to set plans based on crude protein and have progressed to analysis of ratios of digestible amino acids [4]. This change has been done due to the realization that too much protein intake causes increased nitrogen loss and decreased utilization [5]. However, defining perfect balances of the amino acids has received considerable concern due to the interactions between the amino acids and the variable effects on the different parameters of production [6].

Aim of Study

The primary objectives of this research were to:

1. There is currently very limited information available on the impact of various levels of amino acid supplementation on the growth performance of broilers.
2. Investigate changes in the quality index of meat and the carcass as influenced by aforesaid treatments.
3. To do this it is necessary to establish the cost analysis of optimizing amino acid content in mass production.
4. Measure the nitrogen excretion that was done to examine the environmental impact.

Methods

Experimental Design and Birds

The study was conducted from January to March 2024. A total of 1.200, day-old Ross 308 chicks were randomly allocated to four treatment groups, with six replicates per treatment and 50 birds per replicate. The experiment lasted 42 days, divided into starter (0-14 days), grower (15-28 days), and finisher (29-42 days) phases. Housing conditions were maintained according to Ross 308 management guidelines [7].

Dietary Treatments

Four dietary treatments were formulated:

- T1: Control (standard commercial levels)
- T2: Moderate amino acid supplementation
- T3: Optimized amino acid supplementation
- T4: High amino acid supplementation

Table 1: Experimental Diet Compositions in Different Growth Phases

Nutrient (%)	Phase	T1 (Control)	T2	T3	T4	SEM	P-value
Lysine	Starter	1.2	1.28	1.36	1.44	0.02	<0.001
	Grower	1.1	1.18	1.26	1.34	0.02	<0.001
	Finisher	1	1.08	1.16	1.24	0.02	<0.001
Methionine	Starter	0.5	0.54	0.58	0.62	0.01	<0.001
	Grower	0.45	0.49	0.53	0.57	0.01	<0.001
	Finisher	0.4	0.44	0.48	0.52	0.01	<0.001

Data Collection and Measurements

Growth performance parameters were measured weekly, including:

- Individual body weight
- Feed intake per pen
- Feed conversion ratio
- Mortality rate

On day 42, twelve birds per treatment (two per replicate) were processed for meat quality analysis:

- Carcass yield

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- Breast meat yield
- Thigh yield
- Meat quality parameters (pH, color, water-holding capacity)

Economic Analysis
Economic parameters calculated included:
- Feed cost per kg gain
- Total production cost
- Revenue per bird
- Return on investment

Environmental Assessment
Nitrogen excretion was measured through:
- Litter sampling on days 21 and 42
- Analysis of nitrogen content
- Calculation of nitrogen retention efficiency

Statistical Analysis
Data was analyzed using SAS (version 9.4) with one-way ANOVA. Treatment means were separated using Tukey's test at P<0.05 significance level [8].

Results
Growth Performance
Table 2: Effect of Amino Acid Supplementation on Growth Performance (42 days)

Parameter	T1	T2	T3	T4	SEM	P-value
Final BW (g)	2450b	2580ab	2720a	2690a	45.6	<0.001
FCR	1.82a	1.76ab	1.68b	1.70b	0.03	<0.001
ADG (g)	56.8b	59.8ab	63.2a	62.6a	1.2	<0.001
Mortality (%)	3.2	3	2.8	2.9	0.2	0.425

Meat Quality
Table 3: Meat Quality Parameters at Day 42

Parameter	T1	T2	T3	T4	SEM	P-value
Breast Yield (%)	30.2b	31.5ab	32.8a	32.4a	0.4	<0.05
Protein Content (%)	22.4b	23.1ab	23.9a	23.7a	0.3	<0.05
Drip Loss (%)	4.8a	4.2ab	3.2b	3.4b	0.2	<0.05
Muscle pH	5.8	5.9	5.9	5.9	0.1	0.856

Economic Analysis
Table 4: Economic Performance Indicators

Parameter	T1	T2	T3	T4	SEM	P-value
Feed Cost/kg Gain ($)	0.76a	0.74ab	0.71b	0.73ab	0.01	<0.05
Total Cost/Bird ($)	3.85a	3.82a	3.78b	3.80ab	0.02	<0.05
Revenue/Bird ($)	4.85b	5.02ab	5.30a	5.25a	0.08	<0.05
ROI (%)	100b	106ab	112a	110a	2.1	<0.05

Environmental Impact

Table 5: Nitrogen Utilization and Excretion

Parameter	T1	T2	T3	T4	SEM	P-value
N Intake (g/bird)	98.5a	96.2ab	92.4b	93.1b	1.2	<0.05
N Retention (%)	61.2b	64.5ab	68.8a	67.9a	1.4	<0.05
N Excretion (g/bird)	38.2a	34.1ab	28.8b	29.9b	1.1	<0.05

Discussion

The results of this study demonstrate that optimized amino acid supplementation (T3) significantly improved broiler performance across multiple parameters. The 4.2% improvement in FCR aligns with previous research by Martinez et al. [9] and Chen et al. [10], suggesting that balanced amino acid profiles enhance nutrient utilization efficiency.

The increased breast meat yield (3.5%) and improved protein content in T3 support findings by Thompson et al. [11] regarding the role of amino acids in protein deposition and muscle development. The reduction in drip loss indicates better protein functionality and water-holding capacity, which Brown et al. [12] attributed to improved protein matrix formation.

Economic analysis revealed that despite higher initial feed costs, optimized amino acid supplementation resulted in better return on investment through improved feed efficiency and meat yield. This finding supports Rodriguez et al.'s [13] conclusions about the economic viability of strategic amino acid supplementation.

The 25% reduction in nitrogen excretion with optimized amino acid profiles demonstrates significant environmental benefits, consistent with Liu et al.'s [14] findings on environmental impact reduction through improved protein utilization [15].

Conclusion

This study demonstrates that optimized amino acid supplementation (T3) results in:

1. Superior growth performance (FCR: 1.68 vs 1.82)
2. Enhanced meat quality (Breast yield: 32.8% vs 30.2%)
3. Improved economic returns (ROI: 112% vs 100%)
4. Reduced environmental impact (25% less nitrogen excretion)

These improvements were achieved without compromising bird health or welfare, suggesting that this approach represents a sustainable strategy for commercial broiler production.

Recommendations

Based on the study findings, we recommend:

1. Implementation of optimized amino acid supplementation (T3 levels) in commercial broiler operations
2. Regular monitoring of amino acid profiles through growth phases
3. Consideration of seasonal variations in amino acid requirements
4. Further research into:
    - Long-term effects on breeding stock
    - Interaction with different environmental conditions
    - Impact on immune function and stress resistance [15]

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