

EFFECT OF THE CHITOSAN AND WHEY POWDER COMBINATION ON PROTEIN METABOLISM AND AMINO ACID ABSORPTION IN BROILER CHICKS

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Abstract

This study evaluated the effect of a chitosan and whey powder combination on protein metabolism, amino acid absorption, and intestinal barrier function in broiler chicks. Along with the unsupplemented control group, the trial compared diets containing 0.2% chitosan, 5% whey powder, and the combined supplementation. The results demonstrated that the combined additive increased serum total protein, albumin, and free amino acid fractions, enhanced intestinal proteolytic activity, and improved enteral amino acid utilization. The combined treatment showed greater efficacy than either component alone and contributed to improved protein synthesis and growth performance.

Keywords: Chitosan, whey powder, broiler chicks, protein metabolism, amino acid absorption, total protein, albumin, protease, intestinal microbiota, nutraceutical additive.

Introduction

In intensive broiler production, protein metabolism and amino acid supply are among the most critical determinants of growth rate, feed efficiency, and tissue accretion. The nutritional value of dietary protein depends not only on crude protein level, but also on digestibility, peptide release kinetics, epithelial transport, and post-absorptive utilization in liver and muscle tissues [1; 3; 6]. Therefore, feed additives capable of improving intestinal conditions while simultaneously supplying highly digestible protein substrates are of particular practical interest [4; 8; 11].

Chitosan, a cationic biopolymer, has been shown to modulate intestinal microbial balance, support mucosal integrity, and bind certain toxic metabolites [2; 5; 9]. Whey powder is a high-biological-value protein source rich in lysine, threonine, methionine, and branched-chain amino acids, thereby providing a valuable substrate for muscle accretion and enzymatic systems [3; 4; 14]. In the present manuscript, emphasis is placed not on descriptive literature review, but on experimentally oriented interpretation of biochemical outcomes associated with the combined use of these feed components.



Main

The efficiency of protein metabolism in broiler chicks is governed by the coordinated interaction of intestinal proteolysis, peptide and amino acid transport, hepatic protein synthesis, and anabolic signaling in peripheral tissues [6; 13]. The combination of chitosan and whey powder may affect these stages through several complementary mechanisms. Chitosan may improve villus architecture and stabilize the gut microbial environment, thereby expanding the effective absorptive surface, whereas whey powder provides rapidly digestible peptides and amino acids to satisfy the metabolic demands of enterocytes and skeletal muscle [4; 10; 12]. As a result, the combination may improve net protein retention and shift nitrogen balance in a positive direction [7; 8].

Methodology

The experiment was conducted in Ross-308 broiler chicks reared under identical zoohygienic conditions from 1 to 35 days of age. Chicks were randomly assigned to four groups: Group I — control (basal diet), Group II — 0.2% chitosan, Group III — 5% whey powder, Group IV — 0.2% chitosan + 5% whey powder. Each group contained 25 birds. At day 35, blood serum and small-intestinal chyme samples were collected. Serum total protein was measured by the biuret method, albumin by the bromocresol green method, and free amino acid fractions by a ninhydrin-based colorimetric procedure. Intestinal protease activity was assessed by the Anson method, whereas trypsin-like activity was quantified using a substrate-specific colorimetric assay and expressed as mg tyrosine/min/g [6; 13; 15]. Data were presented as $M \pm m$. Intergroup differences were evaluated using Student's t-test, and $p < 0.05$ was considered statistically significant.

Analysis

The positive dynamics observed in the combined-supplement group can be explained by three major mechanisms. First, improved trophic state of the intestinal mucosa likely enhanced active amino acid transport through enterocytes [9; 11; 16]. Second, rapidly digestible whey proteins and bioactive peptides increased the portal amino acid supply, thereby stimulating protein synthesis in the liver and muscle tissues [3; 4; 14]. Third, chitosan likely optimized the intestinal environment and supported a physiological pattern of proteolysis while restricting formation of toxic amines [2; 5; 9; 18].

In addition, Rakhmonov Farkhod's published works on broilers supplemented with chitosan and whey powder support broader improvements in mineral, physiological, and biochemical traits, indirectly strengthening the interpretation of the present data [20–23].

Results

The experimental results showed that the combined additive exerted the strongest positive effect on protein metabolism markers in broiler chicks. The simultaneous increase in serum total protein, albumin, and free amino acid fractions, together with enhanced intestinal protease activity, indicated improved digestion and absorption of dietary protein.



Table 1. Serum protein metabolism indicators under supplementation with chitosan and whey powder (M±m, n=25)

Indicator	Control	Chitosan 0.2%	Whey powder 5%	Chitosan+Whey
Total protein, g/L	35.8±1.2	38.9±1.3*	40.6±1.4*	43.7±1.5*
Albumin, g/L	16.2±0.6	17.8±0.7*	18.9±0.7*	20.4±0.8*
Free amino acids, mmol/L	2.84±0.10	3.12±0.11*	3.29±0.12*	3.61±0.14*
Nitrogen retention, %	56.4±1.8	60.8±1.9*	62.7±2.1*	66.9±2.0*

Note: * – significant difference relative to the control group ($p<0.05$); increased albumin indicates activation of protein synthesis.

In the combined group, the increases of 22.1% in total protein, 25.9% in albumin, and 27.1% in free amino acids indicate improved protein absorption and postabsorptive utilization.

Table 2. Enzymatic activity in small-intestinal chyme and growth performance indicators

Indicator	Control	Chitosan 0.2%	Whey powder 5%	Chitosan+Whey
Protease activity, mg tyrosine/min/g	1.82±0.07	2.03±0.08*	2.15±0.09*	2.37±0.10*
Trypsin-like activity, U/g	124.5±5.2	137.9±5.8*	145.6±6.1*	159.8±6.4*
Average daily gain, g	53.1±1.9	56.7±2.0*	58.6±2.1*	61.8±2.2*
FCR, kg/kg	1.82±0.05	1.75±0.04	1.71±0.04*	1.66±0.03*

Note: the increase in protease and trypsin-like activity indicates improved digestion of dietary protein.

The positive shifts in enzymatic indicators and FCR demonstrate that the combination provides not only biochemical but also zootechnical benefits.

Conclusion

The study confirmed that the combination of chitosan and whey powder exerts a favorable effect on protein metabolism and amino acid absorption in broiler chicks. Compared with single-component supplementation, the combined treatment produced higher serum total protein and albumin values, expanded the free amino acid pool, enhanced intestinal protease activity, and improved growth performance. These findings indicate that the combination acts as a synergistic metabolic modulator of practical relevance.

Chitosan optimizes the intestinal environment, whereas whey powder provides a high-biological-value protein substrate, thereby creating the conditions for more complete protein utilization. Consequently, this nutritional approach may be recommended as a safe and promising nutraceutical feed additive in broiler production.



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