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BIOCHEMICAL ASSESSMENT OF THE COMBINED USE OF CHITOSAN AND WHEY POWDER FOR MANAGING METABOLIC PROCESSES IN BROILER CHICKENS: AN EXPERIMENTAL RESULTS-BASED APPROACH

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Abstract
This article presents a revised biochemical interpretation of experimental data on the combined use of chitosan and whey powder in broiler chickens. During a 42-day observation period in Ross 308 broilers, live weight dynamics, feed conversion, selected blood biochemical parameters, and the functional condition of the intestinal environment were evaluated. The findings indicate that the combined additive produced a more stable anabolic and sorption-metabolic effect than the separate use of chitosan or whey powder. In particular, the experimental combination group demonstrated an 8-12% higher live weight than the control, a 6-9% improvement in feed conversion, and physiologically favorable shifts in markers related to protein and energy metabolism. These data support the view that chitosan modulates the intestinal environment, whereas whey powder provides rapidly utilizable protein and lactose substrates, resulting in a synergistic metabolic response.

Keywords: Broiler chickens, chitosan, whey powder, metabolism, protein turnover, feed conversion, biochemical indicators, intestinal microbiota.

Introduction

In intensive poultry production, improving feed efficiency while maintaining gut health and reducing dependence on antibiotics has become a central nutritional objective. In this context, natural feed components with multitarget biological activity have attracted increasing interest [1, 5, 10].

Chitosan is a deacetylated derivative of chitin and acts as a cationic biopolymer with sorption, microbiota-modulating, and mucosa-interacting properties. Whey powder, in turn, is a source of rapidly digestible proteins, lactose, minerals, and bioactive peptides capable of supporting both energy supply and plastic metabolism in growing birds [7, 8, 13].

The combined use of these two ingredients may therefore be particularly relevant for regulating protein-energy metabolism, intestinal fermentation, microbiota balance, and growth dynamics in broilers. The purpose of the present article is to systematize the available experimental

findings on chitosan and whey powder supplementation and to interpret them from a biochemical perspective.

Main part

From a biochemical standpoint, chitosan forms a viscous intestinal matrix that modulates transit time and normalizes the uptake kinetics of selected nutrients. Due to its cationic groups, it can bind bile acids, certain toxic metabolites, and microbial cell-wall components, thereby producing a sorption-protective effect within the digestive tract [6, 9, 17]. As a consequence, the pressure of opportunistic microbiota decreases and a more favorable ecological environment emerges for beneficial microorganisms [11, 20].

Whey powder supplies readily digestible proteins, lactose, mineral compounds, and bioactive peptide fractions. These components can rapidly support energy metabolism and provide substrates for protein biosynthesis. In particular, the branched-chain amino acids present in whey proteins promote tissue accretion and improve growth efficiency in rapidly growing birds [8, 13, 22, 23, 24].

When used together, the two ingredients complement one another biologically: chitosan optimizes the intestinal milieu and absorption dynamics, while whey powder delivers readily usable nutrient substrates. Therefore, a more integrated improvement can be expected in live weight, feed conversion, serum protein status, physiological regulation of glucose, and microbiota-associated functions [1, 2, 3, 4, 7, 15].

Methodology

The paper is based on a re-analysis of experimental data obtained over a 42-day production cycle in Ross 308 broiler chickens. Birds were distributed into four analogous groups: control group receiving the basal diet; experimental group 1 receiving basal diet + chitosan; experimental group 2 receiving basal diet + whey powder; and experimental group 3 receiving the combined chitosan + whey powder supplementation.

The following outcome measures were used as the main analytical endpoints: live weight, average daily gain, feed conversion ratio, selected blood biochemical markers related to protein and energy metabolism, the functional condition of the intestinal environment, and tendencies in microbial normalization. The analysis relied on relative changes, percentage differences, and physiological-biochemical interpretation rather than only on isolated absolute values.

Methodologically, the article was not structured as a conventional literature review. Instead, it was written as a results-oriented scientific reconstruction centered on experimental findings, their biochemical explanation, and their practical implications for poultry production.

Table 1. Experimental design and description of groups

Group	Dietary treatment	Biological rationale
Control	Basal diet	Physiological baseline
Exp. 1	Basal diet + chitosan	Sorption and microbiota support
Exp. 2	Basal diet + whey powder	Rapid protein-energy source
Exp. 3	Basal diet + chitosan + whey powder	Synergistic metabolic effect

Note:The table supports a side-by-side comparison of separate and combined biological effects.

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Analysis

The 42-day observations demonstrated that the most stable positive dynamics occurred in experimental group 3, which received the combined additive. The 8-12% increase in live weight relative to the control should not be interpreted merely as a consequence of greater energy intake; rather, it reflects an improvement in nutrient utilization efficiency [1, 3, 4].

The 6-9% improvement in feed conversion suggests coordinated enhancement of intestinal hydrolysis, absorption, and postabsorptive nutrient use. Chitosan likely created a more favorable mucosal environment through its sorption properties, while whey powder served as a rapid substrate source for enterocytes and muscle tissue [7, 8, 11, 13].

Positive shifts in blood biochemical parameters point to a better nitrogen balance and more stable regulation of lipid and carbohydrate metabolism. The reported rise in growth-associated and protein-related markers, together with the absence of marked pathological deviations in liver-associated indicators, supports the adaptive rather than damaging nature of the metabolic response [2, 4, 17, 18].

The normalization of intestinal microbiota and the improvement in gut functional condition also appear to be key links in the response chain. When microbial balance is stabilized, short-chain metabolite formation, epithelial trophism, and enteral immune defense improve, ultimately supporting digestion and postabsorptive metabolism [10, 11, 19, 20].

Table 2. Comparative presentation of principal outcomes versus the control group

Parameter	Exp. 1	Exp. 2	Exp. 3
Live weight dynamics	Moderately positive	Moderately positive	Highest increase: +8-12%
Average daily gain	Stable improvement	Energetic support	Most stable and highest
Feed conversion ratio	Improved	Improved	Best response: -6-9%
Blood biochemistry	Adaptive shift	Improved protein-energy profile	Complex optimization
Intestinal environment	Reduced microbial pressure	Improved substrate supply	Normalization and synergy

Note: Positive percentages indicate higher values than the control, whereas negative percentages indicate a better feed conversion response.

Results

The results show that the combined supplementation strategy produced the most favorable integral response. The combination group achieved the highest live weight and average daily gain, while requiring less feed per unit of growth, thus indicating superior feed conversion.

From a biochemical perspective, this superiority may be explained by optimized intestinal absorption kinetics, improved supply of amino acids and rapid energy substrates, a more stable mucosal-microbial interface, and a physiologically favorable activation of liver-muscle metabolic interactions.

Although the separate supplementation of chitosan or whey powder also generated positive effects, the combined treatment yielded the highest overall response, indicating the presence of functional nutritional synergy.

Table 3. Biochemical interpretation of the observed outcomes

Observed outcome	Probable biochemical mechanism	Practical implication
Increase in live weight	More efficient use of amino acids and energy substrates	Growth rate accelerates
Improved feed conversion	Optimization of intestinal milieu and absorption kinetics	Less feed is required for the same gain
Improved protein-related blood markers	Anabolic protein synthesis and nitrogen balance	Supports tissue accretion
Normalization of intestinal milieu	Sorption-protective effect and support of beneficial microbiota	Digestion and absorption become more stable

Note: The table links measured outcomes with their likely functional biochemical interpretation.

Conclusion

The combination of chitosan and whey powder should be regarded as a promising functional feeding strategy for managing metabolic processes in broiler chickens. The experimental results confirm its positive effects on live weight gain, feed conversion, and selected blood biochemical indices.

At the mechanistic level, the combination acts through modulation of the intestinal environment, sorption-protective support, provision of rapidly digestible protein and lactose, and normalization of protein-energy metabolism. For this reason, it may be considered a practical tool for antibiotic-free intensive broiler production.

Future studies should include deeper quantitative monitoring of digestive enzyme activity, antioxidant status, villus morphometry, and liver-associated metabolic markers in order to refine dose-response relationships and confirm long-term safety.

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