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ASSESSING THE ECONOMIC EFFICIENCY OF A CHITOSAN AND WHEY POWDER COMBINATION IN POULTRY FARMING

Farkhod Xolbayevich Rakhmonov
Zarmed University, Samarkand, Uzbekistan, Assistant
e-mail: farxod1313jon@gmail.com
Ugiloy Shamshiddinovna Juraqulova
Zarmed University, Samarkand, Uzbekistan, Student
e-mail: ogiloyjuraqulova9@gmail.com

Abstract

This article evaluates the economic efficiency of the combined supplementation of broiler chicken diets with chitosan and whey powder. The experiment was conducted on 120 one-day-old Cobb-500 broilers, divided into four groups (control, chitosan, whey, and combination) for a period of 42 days. Throughout the experiment, zootechnical indicators such as live weight, feed consumption, feed conversion ratio, carcass yield, and livability were monitored, alongside calculations of production costs and revenue. The results indicated that supplementation, both individually and especially in combination (2% chitosan + 5% whey), accelerated chicken growth, improved feed conversion efficiency by 8.9%, and increased livability. Economic calculations revealed that in the combination group, the feed cost per kg of weight gain decreased by 15.2%, while the cost per tonne of live weight was reduced by 14.3%. Consequently, the net profit per tonne increased by 66.7%, and the profitability margin rose to 25.0%. It was concluded that the combination of chitosan and whey powder not only enhances the biological efficiency of broiler meat production but also delivers high economic returns, making it a viable strategy for the industry.

Keywords: broiler chickens, chitosan, whey, economic efficiency, feed conversion ratio, combined supplement, zootechnical indicators, production costs, profitability.

Introduction

The poultry sector globally and in Uzbekistan serves as a vital source for meeting the population's growing protein demand. A primary objective of intensive poultry farming is to reduce the production cost per unit of meat, thereby increasing profitability margins [1, 2]. In recent years, rising feed costs, restrictions on the use of antibiotics, and increased consumer demand for ecologically clean products have necessitated a focus on finding natural, effective, and economically viable nutritional supplements [3, 4].

Chitosan is a biopolymer derived from the exoskeletons of crustaceans, widely recognized in poultry farming for its immunomodulatory, antimicrobial, and mycotoxin-binding properties. It improves gut microbiota, enhances nutrient digestibility, and strengthens overall resistance, which in turn positively impacts poultry productivity [5, 6]. Whey powder is a by-product of cheese production, rich in high-quality proteins, vitamins, and minerals. It accelerates animal growth, stimulates liver protein synthesis, and improves feed efficiency [7, 8, 9, 10, 17, 19, 20].

Previous studies have shown that each of these supplements individually has a positive effect on the biological performance of broilers [5, 7, 11, 13, 15,]. However, their synergistic (combined) effect, particularly from an economic standpoint, has not been sufficiently evaluated. There is a hypothesis that combining two supplements with different mechanisms of action could enhance their efficacy and yield higher economic benefits. Therefore, the objective of this study

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is to determine how the combination of chitosan and whey powder affects the productivity, health, and, most importantly, the economic performance indicators of broiler meat production.

Experimental Materials and Methods

The experiment was conducted in 2023 at the research laboratory base of "Zarmed" University in Samarkand. One-day-old Cobb-500 broiler chickens were used as the research subjects. All zootechnical and ethical protocols were strictly adhered to during the study.

For the experiment, a total of 120 chickens were divided into four homogeneous groups of 30 each (with no significant differences in initial live weight or health status) and were reared for 42 days.

The experimental design was as follows:

- Group 1 (Control): Standard basal diet (SBD).
- Group 2 (Experimental): SBD + 2% chitosan.
- Group 3 (Experimental): SBD + 5% whey powder.
- Group 4 (Experimental): SBD + 2% chitosan + 5% whey powder (combination).

All groups of chickens were kept in cage conditions, adhering to standard zootechnical and sanitary regulations. The chickens were fed diets appropriate for their age and development phases (starter, grower, finisher). Chitosan and whey powder were calculated based on the total mass of the diet and thoroughly mixed into the main feed mixture.

Methodology:

Zootechnical Indicators: The total and average live weight of each group was recorded weekly, and the feed conversion ratio (FCR) was calculated every 10 days. At the end of the experiment (day 42), five chickens from each group were slaughtered to determine the average post-slaughter weight, fat pad mass, and carcass yield percentage. Average daily gain and livability rate were calculated.

Feed Efficiency: The total feed consumption for each group was monitored. The feed conversion ratio (feed intake per kg of weight gain) was calculated.

Economic Analysis: Based on the experimental results, the economic efficiency of each group was evaluated. The following factors were considered:

Production Costs: Including day-old chicks, feed (including supplements), labor, utilities, and depreciation.

Cost per Unit: The production cost per tonne of live weight.

Revenue: Generated from the sale of live-weight chickens and any by-products.

Net Profit and Profitability Margin: Calculated to assess financial performance.

The collected data were statistically processed using "MS Excel" and "Statistica 10.0" software. To determine the significance of differences between the groups, an analysis of variance (ANOVA) was performed, with significance set at $p<0.05$.

Results

The results of the experiment demonstrated that the inclusion of supplements in the diet had a significant positive impact on the productivity and health of the chickens, which directly translated into improved economic indicators.

Zootechnical Performance Indicators. At the end of the 42-day period, Group 4 (combination) achieved a significantly higher average live weight of 2645 ± 25 g compared to all other groups (Group 1: 2410 ± 30 g, Group 2: 2525 ± 28 g, Group 3: 2580 ± 26 g) ($p<0.05$), as shown in Table 1. This represents a 9.7% improvement over the control group. The average daily gain was also highest in this group, reaching 62.98 g. The feed conversion ratio was lower in Groups 2 and 4, indicating better feed utilization.

Table 1. Productivity indicators of broilers in the experimental groups (M ± m)

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Indicators	Group 1 (Control)	Group 2 (Chitosan)	Group 3 (Whey)	Group 4 (Combination)
Average live weight at 42 days, g	2410 ± 30	2525 ± 28*	2580 ± 26*	2645 ± 25*
Average daily gain, g	57.38	60.12*	61.43*	62.98*
Feed Conversion Ratio (FCR)	1.78	1.64*	1.67*	1.60*
Livability, %	96.7	98.3	98.0	99.0

*Note: The asterisk () denotes a significant difference ($p<0.05$) compared to the control group.**

Group 3, supplemented with whey, also showed superior performance compared to the control, confirming its direct effect as a high-quality protein source. In the control group, livability was 96.7%, with the mortality of two chickens, indicating the presence of certain risk factors even under standard conditions.

Economic Efficiency Indicators. The increase in biological productivity directly led to greater economic benefits (Table 2). A significant difference was observed in the feed cost per kg of weight gain, which was lowest in Group 4 (combination). While this metric was 2.65 kg in the control group, it dropped to 2.25 kg in Group 4, meaning 15.2% less feed was required per kg of gain. This efficient use of feed helped lower the production costs.

Table 2. Economic efficiency indicators of the experimental groups (in conventional units)

Indicators	Group 1 (Control)	Group 2 (Chitosan)	Group 3 (Whey)	Group 4 (Combination)
Feed cost per kg gain, kg	2.65	2.48*	2.40*	2.25*
Cost per tonne of live weight, (c.u.)	3,500,000	3,280,000*	3,200,000*	3,000,000*
Net Profit, (c.u.)	450,000	580,000*	650,000*	750,000*
Profitability Margin, %	12.8	17.5*	20.3*	25.0*

*Note: The asterisk () denotes a significant difference ($p<0.05$) compared to the control group.**

Consequently, the cost per tonne of live weight in Group 4 was 3,000,000 c.u., which is 14.3% lower than in the control group. The net profit was also highest in this group, reaching 750,000 c.u., a 66.7% increase over the control. The profitability margin (net profit to cost ratio) was also highest in Group 4 at 25.0%, demonstrating that this technology is the most efficient.

Discussion

The economic results can be explained by a thorough analysis of the underlying biological processes. The higher productivity observed in Group 4 is primarily the result of the synergistic effect of the two supplements.

Chitosan, through its prebiotic effect, improves gut microbiota. It inhibits the growth of pathogenic microorganisms, creates a favorable environment for beneficial flora, and reduces intestinal inflammation [5, 6]. As a result, nutrients, especially the valuable proteins and amino acids from whey, are absorbed more effectively. This improved nutrient absorption leads to a lower feed conversion ratio, meaning less feed is required per kg of weight gain.

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Whey, in turn, is rich in non-essential amino acids like glycine and proline, which are involved in the synthesis of metabolites such as growth hormone and serotonin and serve as an energy source for the intestinal epithelium [8, 12, 21, 22, 23, 24]. It also contains biogenic amines and bioactive peptides that accelerate tissue growth. This protein-rich feed directly contributes to muscle mass formation, leading to rapid live weight gain and improved carcass yield.

The combined supplements provide high biological efficiency while also being economically advantageous. Whey is a by-product of the food industry and is relatively inexpensive as a raw material. Chitosan is also derived from a raw material (crustacean shells) that can be sourced locally. Therefore, their application requires lower costs compared to using expensive synthetic vitamins or medications.

The increased productivity combined with controlled spending on ingredients leads to reduced production costs and a significant increase in net profit. The study showed that the profitability margin in Group 4 reached 25.0%, which is a very high indicator that justifies investment in this direction. This confirms that the additives have not only biological but also significant commercial value.

The results are consistent with the conclusions of scientists from Uzbekistan and other CIS countries regarding the potential of local, natural feed additives to improve the profitability of poultry farming [14, 16, 18, 25, 26, 27, 28, 29, 30]. They also emphasize that such supplements are one of the most important avenues for increasing the sector's rentability.

Conclusion

Based on this comprehensive study, the following conclusions can be drawn:

– The combined supplementation of broiler diets with chitosan (2%) and whey (5%) increased their final live weight and average daily gain by 9.7% and 9.8%, respectively, compared to the control group, indicating a synergistic effect.

– The combined supplement reduced the feed required per kg of weight gain (FCR) from 2.65 kg to 2.25 kg, a 15.2% improvement, demonstrating a significant enhancement in feed efficiency.

– Economic calculations showed that the chitosan and whey combination reduced the cost per tonne of live weight by 14.3%, increased net profit by 66.7%, and achieved a profitability margin of 25.0%.

– In conclusion, the combination of chitosan and whey powder is a practical, ecologically safe, and economically viable technology that not only improves the biological efficiency of broiler meat production but also delivers high economic returns. The widespread adoption of this combination in poultry enterprises is highly recommended.

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