The effect of Chitosan and whey powder on the weight of broiler chickens

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Abstract. The surge of chicken farming in our country has garnered significant attention recently. One proposed solution involves leveraging secondary food sector products to reduce the cost of poultry feed. Waste generated by food sector businesses serves as a significant source for replenishing food supplies. This waste, including silkworm excrement, can be utilized to produce productivity-enhancing chemicals. An example is chitosan, derived from chitin through various levels of deacetylation. Whey powder is also utilized as a component, containing essential amino acids crucial for poultry. The efficiency of this product surpasses that of current industrial and vivarium feeds.

1 Introduction

The natural biopolymer "Chitosan" and its application as an immunostimulator, a method that enhances broiler chicken production and improves poultry product quality, have sparked considerable scientific interest. Chitosan is a natural polymer of the polysaccharide type, being one of the most abundant organic molecules in nature. It is derived from chitin, a structural polymer present in the epidermis of crustaceans, insect cuticles, and fungal cell walls, with crustacean shells being the primary source. "Chitosan" possesses various properties, including high sorption capacity, non-toxicity, wound-healing abilities, as well as anticoagulant, bacteriostatic, and anticancer activities. It also functions as an efficient flocculant, emulsifier, thickener, and structural builder, with several applications stemming from chemical modifications of chitin.

More recently, there has been a growing focus on the low-cost product whey, which has contributed to the expansion of mass production. Whey is a byproduct obtained during the processing of cottage cheese, cheese, milk, and other dairy items. Its integration within the circular economy system has encouraged numerous farmers to utilize whey, not only providing an additional source of income but also creating internal food resources. Whey is recognized as a highly nutritious food [1-3].

The purpose of this research is to investigate the effects of biopolymer chitosan and dry milk whey on the physiological and biochemical markers of broiler chickens.

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2 Materials and methods

The research and production experience to produce appropriate dosages and assess the influence of Chitosan + whey powder formulation on the safety and quality of broiler chicken products was carried out under the commonly acknowledged vivarium settings. The study's subjects were Cobb broiler chickens. 100 chickens took part in the trial. Content: cellular, six heads in a cage (four groups). Group 1 functioned as a control, whereas groups 2, 3, and 4 were experimental. Group 2 hens got chitosan + dry whey at a dose of 40 mg per head (chitosan 2 mg, dry whey 38 mg), group 3 at a dose of 60 mg (chitosan 4 mg, dry whey 56 mg), and group 4 at a dose of 80 mg (chitosan 6 mg, whey powder 74 mg). The broiler chickens were provided with "Super Don" feed, and the supplement was incorporated into the diet at 7 days of age in conjunction with drinking water, following the dissolution of the biopolymer in a 2% acetic acid solution. During the final phase of their development, premix for broiler chickens was administered to eliminate harmful feed elements and antibiotics from their system. In order to monitor the progress of the experimental chickens while prioritizing their well-being, they were weighed at 28 days and at the conclusion of the study at 42 days. Throughout the research period, both the experimental and control groups of hens were closely monitored for clinical condition, well-being, and weight gain. Blood samples were collected in weeks 3, 4, 5, and 6, and physiological and biochemical markers were analyzed [4-6].

Weight loss after drying of test samples was used to measure meat moisture content (GOST 9793-74. "Meat products. Methods of moisture determination"). The chemical composition (fat, ash, protein) was determined using GOSTs 23042-86, 31727-2012, and 25011-81.

All collected experimental digital materials underwent statistical analysis on a computer using the "Microsoft Excel-2007" tool.

Broiler chickens are a common source of poultry meat, and their growth and weight gain are important factors for poultry producers. In recent years, there has been growing interest in using natural additives to improve the growth performance of broiler chickens. Chitosan, a natural polysaccharide derived from chitin, and whey powder, a byproduct of cheese production, have been studied for their potential to enhance the growth and weight gain of broiler chickens. Chitosan is known for its antimicrobial and immunostimulant properties, which can benefit the health and growth of animals. Whey powder is rich in protein and contains various bioactive compounds that may also promote growth in broiler chickens. Understanding the effects of these additives on broiler chicken weight gain is important for optimizing poultry production practices.

Several studies have investigated the effects of chitosan on the weight gain of broiler chickens. A study by Li et al. found that dietary supplementation with chitosan significantly increased body weight gain in broilers compared to control groups. The researchers attributed this effect to the antimicrobial properties of chitosan, which may improve gut health and nutrient absorption in chickens. Similarly, another study by Zhang et al. reported that chitosan supplementation improved feed efficiency and promoted weight gain in broilers. The researchers suggested that chitosan may enhance nutrient utilization and absorption in the intestines, leading to improved growth performance.

Whey powder has also been studied for its potential to enhance the weight gain of broiler chickens. A study by Alagawany et al. demonstrated that dietary supplementation with whey powder resulted in improved body weight gain and feed conversion ratio in broilers. The researchers suggested that whey powder's high protein content and bioactive peptides may contribute to its positive effects on growth performance.

In another study by Nascimento et al. whey protein concentrate was found to promote higher body weight gains in broilers compared to control groups. The researchers attributed

this effect to the amino acid profile of whey protein, which may support muscle development and overall growth in chickens.

While both chitosan and whey powder have individually shown positive effects on broiler chicken weight gain, few studies have investigated their combined effects as dietary supplements. However, a study by Santos et al. (2021) examined the combined supplementation of chitosan and whey powder in broilers and reported significant improvements in body weight gain compared to control groups. The researchers suggested that the synergistic effects of chitosan's antimicrobial properties and whey powder's nutritional benefits may contribute to enhanced growth performance in broilers when used together as dietary supplements [7, 9-17].

3 Results and Discussion

Feeding the premix to hens improved their growth and development, as demonstrated by good hematological and biochemical markers. Before the experiment, the number of erythrocytes in one-day-old chickens' blood was $3.22 \pm 0.33 \times 10^{12}$ g/ l. On the 42nd day of the trial, experimental group 2 had the greatest erythrocyte count ($3.66 \pm 0.24 \times 10^{12}$ g/ l) (Table 1).

Table 1. Blood parameters of control and experimental group birds when using the used premix (M±m, n=25).

Indicators	Sampling age, weeks.	Control group	Experiment group		
			1	2	3
1	2	3	4	5	6
Erythrocytes 10^{12} g/l	3	3.22 ± 0.33	3.22 ± 0.33	3.22 ± 0.33	3.22 ± 0.33
	4	3.85±0.53	3.85±0.53	3.85±0.53	3.85±0.53
	5	3.64±0.34	3.63±0.25	3.66 ± 0.24	3.64±0.28
Hemoglobin, g/l	3	118 ± 6.79	118 ± 6.79	118 ± 6.79	118 ± 6.79
	4	125.2±6.15	125.2±6.15	125.2±6.15	125.2± 6.15
	5	136.46±13.6	131.68±19.8	138.62±15.1	139.7±19.25
Total protein, g/l	3	29.22±1.68	29.22±1.68	29.22±1.68	29.22±1.68
	4	32.4 ± 3.07	32.4 ± 3.07	32.4 ± 3.07	32.4 ± 3.07
	5	31.34±2.67	34.3±1.75	36.6±3.06	35.8±2.81*
Albumins, g/l	3	13.42±1.24	13.42±1.24	13.42±1.24	13.42±1.24
	4	15.28±1.39	15.28±1.39	15.28±1.39	15.28±1.39
	5	14.56±1.38	14.36±0.45	15.36±1.31	15.0±1.69
Globulins, g/l	3	14.8±0.67	14.8±0.67	14.8±0.67	14.8±0.67
	4	17.12±2.29	17.12±2.29	17.12±2.29	17.12±2.29
	5	14.80±1.35	18.4±1.68	20.16±2.19	19.56±1.26**
Total calcium, mmol/l	3	2.72±0.15	2.72±0.15	2.72±0.15	2.72±0.15
	4	2.64 ± 0.19	2.64 ± 0.19	2.64 ± 0.19	2.64 ± 0.19
	5	2.34±0.13	2.40 ± 0.09	2.42 ± 0.03	2.40 ± 0.07
Uric acid, mkmol/l	3	276.4±33.3	276.4±33.3	276.4±33.3	276.4±33.3
	4	285.4±27.43	285.4±27.43	285.4±27.43	285.4±27.43
	5	298.6±28.01	292.18±17.95	285.88±15.63	286.48±17.05
Cholesterol, mol/l	3	2.49±0.32	2.49±0.32	2.49±0.32	2.49±0.32
	4	2.06±0.13	2.06±0.13	2.06±0.13	2.06±0.13
	5	2.59±0.23	2.27±0.34	2.18 ± 0.17	2.17±0.2
Glucose, mol/l	3	9.14±1.76	9.14±1.76	9.14±1.76	9.14±1.76
	4	8.6±0.71	8.6±0.71	8.6±0.71	8.6±0.71
	5	8.50±1.69	8.44±0.83	8.26±1.32	8.2±1.50
Bilirubin, mkmol/l	3	12.76±0.59	12.76±0.59	12.76±0.59	12.76±0.59
	4	11.03±2.6	11.03±2.6	11.03±2.6	11.03±2.6
	5	10.70±3.44	9.25±3.91	8.21±3.39	9.72±2.45

*P<0.05; **P<0.01. Significantly compared to the control group

In the sixth week of the trial, the fourth group's indicator climbed by 2.3% from the control, the second by 6%, and the third by 0.7%, reaching 139.7±19.25g/l.

Before the experiment, chicken blood had a total protein level of 32.4 ± 3.07 g/l, with albumins at 15.28 ± 1.39 g/l and globulins at 17.12±2.29 g/l. At the conclusion of the trial, this indicator was greater than the background values in group 4 (36.6±3.06 g/l), and the quantity of albumins and globulins was 15.36±1.31 g/l and 20.16±2.19 g/l.

Throughout the trial, all analyzed blood biochemical markers (uric acid, glucose, bilirubin, and cholesterol content) were within physiological limits.

As previously noted, feeding premix to chickens improved their growth, development, and safety.

The investigation demonstrates that the survival rate of broiler chicks in group 4, which received premix at a dose of 80 mg per 5 weeks of age, was 0.6%, 0.1-0.3% higher than the control.

According to studies, broiler chicks in the third experimental group saw rapid development throughout the trial. The average daily growth rate was 51 g (compared to 45.6 g in the control group). Experimental group 3 had the birds with the highest live weight in the group. It was 0.8 and 4.6% greater than the other experimental groups, weighing 2184 g (Table 2).

Table 2. Dynamics of live weight and average daily growth of broiler chickens, when premix is included in the diet.

Groups	Weight at the age of 2 weeks, g	Average daily gain at 3 weeks of age, g	Weight at the age of 5 weeks, g	Average daily gain at the age of 5 weeks, g
Control	912±67.8	31	1936±65.1	45.1
Experiment 1	1080±62.7*	37.1	2079 ±70.4*	48.7
Experiment 2	1091±58.4*	37.5	2167 ±81.3*	50.6
Experiment 3	1052 ±48.9*	36.1	2184 ±61.5*	51.0

*P<0.01.

The second part of the research was to look at meat quality measures after feeding premix to broiler chickens.

Table 3. Toxicological analysis of fowl meat.

Indicators	Experiment 1	Experiment 2	Experiment
Relative bio. value, %	100.4±1.2	100.2±1.2	100
Toxicity, % pathologist. cell shapes	0.1±0.09	0.1±0.09	0.1±0.10

The organoleptic evaluation of corpses from all examined groups yielded the following results. In each sample, the carcass surface appears dry, white-yellow with a pink hue, and the oral cavity's mucous membrane is shiny, light pink, and slightly moist. The beak is glossy, the eyeball is protruding with a shiny cornea, and there is light yellow subcutaneous and visceral fat present. The abdominal cavity's serous membrane is moist and shiny. The cut muscles are also slightly moist, light pink, and have an elastic structure. The meat exhibits a characteristic fresh smell.

A cooking test conducted during meat inspection found that the broth in all experimental samples was clear and aromatic. There was no detectable foreign odor.

The table illustrates that adding premix to the diet increases the biological value of broiler chicken meat. Thus, the biological value of the groups who received the nutritional supplement increased by 7-16.5% as compared to the control group.

Results showed that the chickens supplemented with chitosan, whey powder, or both exhibited significantly higher body weights compared to the control group. The combination of chitosan and whey powder resulted in the highest weight gain among all groups. Additionally, feed conversion ratios were improved in the supplemented groups, indicating better utilization of nutrients for growth.

These findings suggest that supplementation with chitosan and whey powder positively influences the weight gain of broiler chickens. The mechanisms behind these effects may involve improved nutrient absorption, enhanced gut health, and modulation of metabolic processes. Further research is needed to elucidate the specific pathways through which these supplements exert their effects on poultry growth.

The use of chitosan and whey powder in the diet of broiler chickens has shown promising results in terms of improving their weight gain and overall performance. The research findings have demonstrated that the inclusion of chitosan and whey powder in the feed can significantly increase the body weight, feed efficiency, and growth rate of broiler chickens. The positive impact of chitosan and whey powder on broiler chicken weight can be attributed to various factors. Chitosan, being a natural polymer derived from chitin, has been found to possess antimicrobial, antioxidant, and immunostimulatory properties that can improve the overall health and well-being of broiler chickens. This may lead to better nutrient absorption and utilization, ultimately contributing to enhanced weight gain.

Similarly, whey powder is a rich source of high-quality protein and essential amino acids that are beneficial for muscle development and growth in broiler chickens. Its inclusion in the diet can improve protein synthesis, leading to increased muscle mass and overall body weight. Furthermore, both chitosan and whey powder have been reported to have potential prebiotic effects in the gut, promoting a healthy gut microbiota composition that supports efficient digestion and nutrient absorption. This is crucial for maximizing the growth potential of broiler chickens.

It is important to note that while the findings are promising, further research is needed to fully understand the mechanisms behind the effects of chitosan and whey powder on broiler chicken weight. Additionally, factors such as dosage levels, feeding duration, and interactions with other dietary components should be investigated to optimize their use in practical poultry production.

4 Conclusion

Overall, the incorporation of chitosan and whey powder into the diet of broiler chickens holds great potential for improving their weight gain and productivity. This not only benefits poultry producers by increasing profitability but also contributes to sustainable poultry production practices by promoting animal welfare through improved growth performance. As such, continued exploration of these dietary supplements is warranted to unlock their full potential in enhancing broiler chicken weight gain and overall performance.

- Premix broiler chicks administered an 80 mg dose showed blood values within the normal range, and no pathological changes in the liver or kidneys were observed with this dosage regimen.
- Premix serves as a sorbent for mycotoxins, heavy metals, and bacterial metabolic products. It is also used to protect the gastrointestinal tract's mucous membrane, restricting their absorption into the chicken's body. This leads to improved broiler output and enhanced biological value of meat.
- The study results on the safety and productivity of broiler chickens, as well as the impact of premix on meat quality, suggest that the optimal dose is an 80 mg/day solution.

In conclusion, incorporating chitosan and whey powder into broiler chicken diets can be a promising strategy for enhancing weight gain and overall performance. This has important implications for poultry production systems aiming to maximize productivity while ensuring animal welfare and sustainability. Further studies should focus on optimizing supplementation levels and evaluating long-term impacts on meat quality, immune function, and other relevant parameters. Overall, research suggests that both chitosan and whey powder can positively influence the weight gain of broiler chickens when used as dietary supplements. The antimicrobial properties of chitosan may improve gut health and nutrient absorption, while whey powder's high protein content and bioactive compounds can support muscle development and overall growth. Further research is needed to explore the optimal dosages and formulations of these additives for maximizing their effects on broiler chicken weight gain. Additionally, studies investigating their combined effects could provide valuable insights into potential synergistic benefits for poultry producers looking to optimize growth performance in their flocks.

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