Growth Performance and Manure Characteristics of Broilers Fed Graded Levels of Spirulina platensis

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ABSTRACT

In this study, the effect of varying concentrations of Spirulina platensis powder (0, 0.5, 1, and 1.5%) to broilers from day 14 to 32 on the growth performance and characteristics of manure from day 14 to 32 were examined. A total of 360 day-old Ross 308 broilers were used, arranged using a completely randomized design. The results showed that the addition of the 1% Spirulina treatment increased the weight (2156g compared to the control at 1983g), average daily weight gain (85.1g/d compared to the control at 77.5g/d), and the feed conversion rate (1.54 compared to the control at 1.67). These factors were all significantly higher compared to the control (P<0.05). Moreover, the addition of Spirulina at all concentrations, specifically at the 1% level, alleviated the manure output (37.8g/bird/d compared to the control at 41.5g/bird/d), pH (8.2 compared to the control at 8.9), ammonia content (167mg/kg compared to the control at 245mg/kg), and the emission of hydrogen sulfide (11.4ug/kg compared to the control.

Keywords: *Microalgae, feed additive, nitrogen excretion, sustainable poultry, waste management*

1. *INTRODUCTION*

The trend among the poultry sector now is to promote productivity, with less emphasis on environment impact. Among these alternatives is Spirulina platensis, which contains high amounts of protein, pigments, and antioxidants. Spirulina platensis, which has high protein, pigment, and antioxidant content, has already revealed beneficial effects for growth performance in broilers (Herath et al. in 2023), immuno-stimulatory effects in chickens (Qureshi et al. in 2008), as well as improvement in meat characteristics in meat chickens. On the other hand, it can also decrease nitrogenous compound release in manure (Khalid et al. in 2022, Wang et al. in 2020). Creation of Spirulina platensis varied levels study was conducted to explore differing levels of growth performance for Spirulina platensis in broilers.

2. MATERIALS AND METHODS

2.1. Experimental Design and Birds

The experiment employed a completely randomized design with four dietary treatments and three replicates per treatment. A total of 360 one-day-old male Ross 308 broiler chicks were housed in a controlled-environment facility. After a 13-day adaptation period on a standard starter diet, birds were weighed and randomly allotted to 12 pens (30 birds per pen) on day 14.

2.2. Dietary Treatments

Four isonitrogenous and isocaloric grower diets (days 14-32) were formulated. Treatments were:

T1 (Control): Basal corn-soybean meal diet.

T2: Basal diet + 0.5% Spirulina platensis powder.

T3: Basal diet + 1.0% Spirulina platensis powder.

T4: Basal diet + 1.5% Spirulina platensis powder.

The commercial Spirulina platensis powder (crude protein: ~65%) replaced equivalent proportions of soybean meal and corn. Feed and water were provided ad libitum throughout the 18-day experimental period.

2.3. Data Collection

Growth Performance: Pen weights and feed consumption were recorded weekly. Average daily gain (ADG), feed intake (ADFI), and feed conversion ratio (FCR) were calculated for the period from day 14 to 32.

Manure Characteristics: On day 32, fresh manure was collected from each pen over 24 hours. Total production (g/bird/day) was recorded. Manure pH was measured immediately using a digital pH meter. Ammonia (NH_3) concentration was analyzed using the micro-diffusion method and hydrogen sulfide (H_2S) was quantified using detector tubes and a spectrophotometric method.

2.4. Statistical Analysis

All data were analyzed using one-way Analysis of Variance (ANOVA) in the GLM procedure of SAS software (version 9.4). Treatment means were compared using Duncan's Multiple Range Test. Statistical significance was declared at \(P < 0.05 \). Results are presented as mean ± standard error of the mean (SEM).

3. RESULTS

3.1. Growth Performance

Spirulina supplementation linearly improved the growth parameters (Table 1). T3 (1%) exhibited the highest final BW, ADG, and best FCR that was significantly different from the control, $P < 0.05$. T2 and T4 also improved the performance but were intermediate between T1 and T3.

Means in a column with different superscripts are significantly different ($P < 0.05$).
BW = Body weight; ADG = Average Daily Gain; FI = Feed intake; FCR = Feed conversion ratio

Item	Final BW (g)	ADG (g/d)	FI (g/bird)	FCR
T1	1983	77.5	3310	1.67
T2	2087	81.7	3355	1.61
T3	2156	85.1	3322	1.54
T4	2138	84.3	3368	1.58
SEM	12.5	0.6	28.3	0.01
P-value	1	2	457	3

Table 1. Growth performance of broilers fed different Spirulina levels (days 14–32)

Means in a column with different superscripts are significantly different ($P < 0.05$).
BW = Body weight; ADG = Average Daily Gain; FI = Feed intake; FCR = Feed conversion ratio

3.2. Manure parameters

Addition of all Spirulina concentrations decreased the amount of manure and emissions (Table 2). The lowest production rate of manure, pH, NH_3, and H_2S was observed in T3 with reductions of 8.9%, 7.9%, 31.8%, and 27.8%.

Item	Manure (g/bird/d)	pH	NH_3 (mg/kg)	H_2S (µg/kg)
T1	41.5	8.9	245	15.8
T2	39.2	8.5	190	12.3
T3	37.8	8.2	167	11.4
T4	38.5	8.4	175	11.9
SEM	0.5	0.05	6.2	0.5
P-value	4	<0.001	<0.001	2

Table 2. Manure characteristics of broilers fed different Spirulina levels (day 32)

Means within a column with dissimilar superscripts differ significantly ($P < 0.05$).

4. Discussion

The increased growth in the Spirulina-fed birds agrees with the previous studies of Abd El-Hady et al. (2022) and Park et al. (2021). Optimal response at the 1%-inclusion rate might be due to increased nutrient digestibility, anti-inflammatory effects of phycocyanin, and gut health improvement. Further increase, 1.5% inclusion, did not give a better response, probably due to the correct balance of nutrients or some palatability problem. The large decrease in manure emissions points to the potential role that Spirulina can play in promoting nitrogen retention and gut microbiota composition with less proteolytic activity, as suggested by Park et al. (2022) and Alwaleed et al. (2023). It is likely that acidity depressed urease activity, which further reduced ammonia volatilization in manure.

5. Conclusion

incorporating 1% Spirulina platensis into broiler diets represents a notable step forward in promoting sustainable and environmentally conscious poultry production. This approach offers dual benefits by boosting productivity while significantly minimizing the environmental impact of broiler operations. With an 8.9% reduction in manure output and notable decreases in ammonia and hydrogen sulfide emissions (31.8% and 27.8%, respectively), Spirulina supplementation helps safeguard terrestrial and aquatic ecosystems from the harmful effects of nitrogen pollution and acidification. Lower airborne ammonia concentrations improve respiratory conditions within housing systems, enhancing animal welfare, while reduced nitrogen runoff protects water quality and aquatic ecosystems in surrounding areas. This strategy aligns with the One Health framework, emphasizing the interconnectedness of animal nutrition, environmental health, and ecosystem sustainability. As such, integrating 1% Spirulina into broiler feed offers a practical solution that supports both economically viable livestock farming and long-term environmental preservation.

6. References

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