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Effect of Chia Seed Supplementation on the Growth Performance and Retention of Nutrients in Layer Pullets

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ABSTRACT

The effect of chia seed supplementation on body weight, body weight gain (BWG), average daily feed intake (ADFI), and feed conversion ratio (FCR) was investigated in layer pullets over 18 weeks. Commercial white leghorn chicks (n=72) were separated into three treatment groups based on body weight: T1, T2, and T3. Each group contained four replicates, each of which contained six birds, for a total of 24 birds in each group. T1 was given maize-soybean based basal diet, in T2 group chia seed was supplemented @1% and in T3 group chia seed was supplemented @2%. The layer pullets were fed starter diet from 0 to 8 weeks, then grower ration from 8 to 16 weeks of age. During the starter and grower phases, daily feed offered, weekly reside left, and fortnightly body weight was measured and documented. During the starter phase, chia seed had no significant effect on body weight, body weight gain, average daily feed intake (ADFI), or feed conversion ratio (FCR), but during the grower phase, chia seed supplementation significantly improved final body weight at the 2% level. Furthermore, chia supplemented groups gained more body weight ($P<0.05$) and had a better FCR ($P<0.05$) than the control group. Ether extract digestibility was significantly higher in chia seed supplemented treatments (T2 & T3) compared to the control (T1). Chia supplementation had a substantial effect on apparent mineral consumption, with calcium retention ($P<0.05$) being higher in the T3 group where chia seed was supplemented @ 2%. So overall, chia supplementation improved growth performance of layer pullets during growth phase of the trial.

KEYWORDS: Body weight, Chia seed, Feed conversion ratio, Feed intake, Nutrient retention.

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INTRODUCTION

Chia seeds have emerged as a promising dietary supplement to enhance the growth phase of layer pullets, a crucial period that significantly influences their future performance as egg-laying hens. Packed with essential nutrients—such as omega-3 fatty acids, proteins, fiber, vitamins, and minerals—chia seeds offer a valuable addition to poultry diets (Ayerza and Coates, 2001).

Omega-3 fatty acids, particularly alpha-linolenic acid (ALA), are well-known for their health benefits, including promoting heart health and reducing inflammation (Harauma et al., 2017). By incorporating omega-3-rich chia seeds into the diet of layer pullets, producers can support optimal growth, enhance immune function, and improve the overall resilience of the birds against diseases (Bhardwaj et al., 2016). Additionally, the high protein content in chia seeds contributes to muscle development, which is essential during this growth phase.

Moreover, chia seeds are rich in antioxidants that help combat oxidative stress, promoting better health outcomes in young birds (Uribe et al., 2011). Their unique gelling property when mixed with water can enhance gut health and nutrient absorption, potentially leading to improved feed conversion rates (Ayerza, 2013).

In light of the European Union's ban on antibiotics as growth promoters, there is a concerted effort to explore natural feed additives, such as herbal plants and their extracts, as alternatives. These additives

contain bioactive compounds that can positively impact animal growth and health (Alagawany et al., 2019). Additionally, the administration of herbal plants or cold-pressed oils can improve health outcomes and help prevent various diseases in both humans and animals (Dhama et al., 2018; Mahgoub et al., 2019). As the poultry industry seeks to improve production efficiency and sustainability, integrating innovative and nutritious ingredients like chia seeds into pullet diets presents a strategic opportunity. This approach not only supports the healthy growth of the birds but also aligns with the growing consumer demand for eggs produced in a health-conscious and environmentally friendly manner. By harnessing the benefits of chia seeds, poultry producers can enhance the growth performance of layer pullets, setting the stage for higher egg production and quality in the future. Consequently, this study aims to assess the impact of chia seeds on the growth performance of layer pullets.

MATERIALS AND METHODS

Feeding and housing

The study spanned 16 weeks and was separated into two phases: starter (0-8 weeks) and grower phase (9-16 weeks). Seventy-two (n=72) day-old commercial white leghorn birds (BV-300) were acquired from Venkateshwara Hatcheries Pvt. Ltd. (Venky). The chicks were reared in a standard setting at the Guru Angad Dev Veterinary and Animal Sciences (GADVASU) poultry farm. Upon arrival, chicks were individually tagged and weighed using an electronic digital weighing balance. Based on their body weight, the birds were divided into three treatment groups - T1, T2, and T3. Each group involved four replicates, with each replicate consisting of six birds. In total, there were 24 birds in each group. The layer pullets were provided with starter feed throughout the age range of 0-8 weeks, and then transitioned to grower feed between 9-16 weeks of age.

The treatments were as follows:

T1 Maize soyabean based basal diet (CONTROL)

T2 Basal diet + Chia seed 1%

T3 Basal diet + Chia seed 2%

Throughout the starter and grower stages, the birds were raised in a deep litter system following conventional management practices, including unrestricted feeding. A layer of bedding material, roughly 6-8 cm in height, was laid on the floor to provide thermal insulation for the chicks. The formulated diets were both isonitrogenous and isocaloric.

Ingredients and chemical composition of experimental diets

The ingredient and chemical composition of starter and grower diets is given in table 1 and 2, respectively. Starter diets were formulated for 2900 kcal/kg ME, 20.5% CP, Lysine 1.12%, Methionine 0.53%, Ca 1.05% and Phosphorous 0.48% whereas diet formulated for grower period contained 2800 kcal/kg ME, 18% CP, 0.96% lysine, 0.44% methionine, 1.05% Ca and 0.42% phosphorous. Soybean meal and meat cum bone meal were the primary protein sources used during formulation, while maize and rice polish served as energy sources.

Table 1. Ingredient composition of starter diet

Ingredient	T1	T2	T3
Maize (%)	64.8	63.4	62.7
Soybean meal (%)	21.7	21.2	20.9
Chia seed (%)	0	1	2
Meat cum bone meal (%)	5	5	5
Rice Polish (%)	6	7	7
Dicalcium Phosphate (%)	0.65	0.6	0.58
Limestone Powder (%)	0.85	0.81	0.85
Salt (%)	0.26	0.26	0.26
Lysine (%)	0.17	0.18	0.18
Methionine (%)	0.18	0.19	0.18
Vitamin/mineral premix (%)	0.31	0.31	0.31
Total	100	100	100
Calculated Analysis			
Metabolisable Energy (Kcal/kg)	2900	2900	2900
Crude Protein (%)	20.5	20.5	20.5
Lysine (%)	1.12	1.12	1.12
Methionine (%)	0.53	0.53	0.53
Calcium (%)	1.05	1.05	1.05
Phosphorous (%)	0.48	0.48	0.48

Table 2. Ingredient composition of Grower diet

Ingredient	T1	T2	T3
Maize (%)	62	58.5	57
Soybean meal (%)	20.9	19.7	19.0
Chia seed (%)	0	1	2
Meat cum bone meal (%)	5	5	5
De-oiled Rice Bran (%)	10	13.8	15
Dicalcium Phosphate (%)	0.25	0.2	0.15
Limestone Powder (%)	1.1	1.1	1.1
Salt (%)	0.26	0.26	0.26
Lysine (%)	0.01	0.02	0.02
Methionine (%)	0.1	0.09	0.09
Vitamin/mineral premix (%)	0.31	0.31	0.31
Total	100	100	100
Calculated Analysis			
Metabolisable Energy (Kcal/kg)	2800	2800	2800
Crude Protein (%)	18	18	18
Lysine (%)	0.96	0.96	0.96
Methionine (%)	0.44	0.44	0.44
Calcium (%)	2.05	2.05	2.05
Phosphorous (%)	0.42	0.42	0.42

Body weight of chicks

Once every two weeks, each layer pullet was individually weighed using a computerized electronic weighing balance. The mean body weights and body weight gains for the starter phase (0-8 weeks) and grower phase (9-16 weeks) were subsequently computed.

Feed intake

Each replicate of birds was given an appropriate and adequate quantity of feed. A weekly collection

of residue was conducted. The mean weekly feed consumption of each group was determined by deducting the feed residue from the overall feed provided, and then dividing the total feed intake for that week by the number of birds (hen days), while accounting any mortality, if present.

Feed conversion ratio

The Feed Conversion Ratio (FCR) was calculated by dividing the total amount of feed consumed during the particular period by the cumulative gain in weight during the same period.

$$FCR = \frac{\text{Feed Intake (g)}}{\text{Body weight gain (g)}}$$

Metabolizability of nutrients

A metabolic experiment was carried out at the end of the starter phase. Four birds with similar body weight were chosen from each treatment/group and kept in battery brooders. Each group consisted of two duplicates, with two birds in each replication. Prior to commencing the metabolic assessment, comprehensive cleaning of all the faeces collection trays and feeding trays was undertaken. The birds were provided with a same diet for duration of 4 days in order to get them accustomed with the closed cage environment. Following a 4-day adaption period, a measured amount of feed was provided to each replicate systematically for the following 3 days, both in the morning and evening. The remaining feed was collected on the fourth day and weighed to record the precise amount of feed consumed for each replicate. Daily in the morning hours, the faecal matter excreted by each duplicate was collected and weighed. To avoid nitrogen loss, 25 mL of 10% Sulphuric acid was weighed and mixed in the faeces, then dried separately in a hot air oven at 80°C. Faeces collected for three consecutive days of each replicate were mixed properly. For faeces, a three-day total collection method was used. To determine the Metabolizability of nutrients, the feed, feed residue, and faeces samples were pulverized and analyzed for various proximate principles, calcium (Talpatra et al., 1940), and phosphorus (AOAC, 2005) content. It was determined as the difference between the amount of nutrient consumed and the amount of nutrient expelled in the faeces and expressed as a percentage.

$$\% \text{ Metabolizability} = \frac{\text{Amount of nutrient intake - Amount of nutrient excreted}}{\text{The amount of nutrient intake}} \times 100$$

*Amount of nutrient intake = (Amount of nutrient in feed offered) – (Amount of nutrient in feed residue)

Statistical analysis

Data was analysed by one-way ANOVA, as described by Snedecor and Cochran (1994), using SPSS (2012) version 21. The differences in means were tested by Duncan's multiple range test (Duncan, 1955) at a 5 % level of significance (P d" 0.05).

RESULTS AND DISCUSSION

Chemical composition of chia seeds

Chemical composition of chia seed is given in Table 3. Proximate analysis of chia seed revealed crude protein, crude fiber, ether extract, calcium, and phosphorus contents of 23.43%, 30.75%, 34.08%, 0.6%, and 0.47%, respectively. The values for chia seed's proximate components are equivalent to those reported by Jin et al. (2012) and USDA (2011). According to the USDA (2011), chia seeds contain high oil content (30.74%) as well as a significant amount of fiber (34.40%), calcium (0.63%), lysine (0.97), and methionine (0.59). According to Jin et al. (2012), chia seeds include 24.2% protein, 40.2% fat, 4.77% ash, and 30.2% fiber.

Table 3. Chemical composition of chia seeds

Particulars	Chia seed
Crude protein (%)	23.4
Crude Fibre (%)	30.7
Ether Extract (%)	34.1
Calcium (%)	0.6
Phosphorous (%)	0.47
Lysine (%)	0.97
Methionine (%)	0.59

Impact on body weight, body weight gain, feed intake and FCR during different phases

The growth performance of layer pullet fed chia seed @ 1.0 % and 2.0 % for starter phase (0-8 week) is presented in Table 4. During the starter phase, chia seed had no significant effect on initial body weight, final body weight, body weight gain (BWG), average daily feed intake (ADFI), or feed conversion ratio (FCR), but it had a significant effect on growth parameters during the grower phase (Table 4), with chia seed supplementation significantly improving final body weight at the 2% level. Furthermore, chia supplemented groups gained more body weight and had a better FCR than the control group. Feed intake was considerably lower in the T2 group compared to T1 and T3. However, no significant difference was seen between the chia supplemented groups in terms of body weight gain and FCR, which were equivalent but still better than the control group. Supplementation with chia seeds not only enhanced the feed conversion ratio (FCR), as confirmed by Rasul et al. (2019), who indicated 4.74% improvement in FCR, but also decreased feed consumption (T2), which aligns with the results of Mendonca et al. (2020), who also observed a decrease in feed intake after chia supplementation.

Table 4. Effect of feeding different levels of chia seeds on the growth performance of layer pullets during starter and grower phase.

Treatment	T1	T2	T3	SEM	P Value
Starter Phase (0-8 weeks)					
Initial body weight (g)	38.58	38.36	38.38	0.040	0.056
Final body weight (g)	533.03	517.20	536.00	4.349	0.168
BWG (g)	494.45	478.84	497.63	4.346	0.171
ADFI (g)	30.48	29.68	30.43	0.235	0.326
FCR	3.45	3.47	3.43	0.014	0.437
Cost of feed/100g gain (Rs)	12.70	13.37	14.13	-	-
Grower Phase (9-16 weeks)					
Initial body weight (g)	533.03	517.20	536.00	4.349	0.168
Final body weight (g)	1003.05^{a}	1001.67^{a}	1032.04^{b}	5.160	0.007
BWG (g)	470.02^{a}	484.47^{b}	496.04^{b}	3.974	0.009
ADFI (g)	47.15^{b}	46.68^{a}	47.48^{b}	0.121	0.007
FCR	5.62^{b}	5.40^{a}	5.36^{a}	0.044	0.013
Cost of feed/100g gain (Rs)	20.29	20.49	21.59	-	-

^{ab}Means bearing different superscripts in a row differ significantly ($P < 0.05$).

Nutrient retention

The digestibility coefficients of nutrients in starter pullets fed various level of chia seed is presented in Table 5. Dry matter, crude protein, crude fiber, and organic matter digestibility were not significantly affected by chia seed supplementation at the 1% and 2% level in the starter pullet diet. However, the chia seeds supplemented treatment (T2 & T3) consistently showed (P<0.05) a much greater EED compared to the control (T1). Chia supplementation had a pronounced impact on the apparent use of minerals. Specifically, the T3 group, which received chia seed supplementation at a concentration of 2%, exhibited increased (P<0.05) retention of calcium. Silva et al. (2019) showed that administering chia seeds soluble extracts intra-amniotically was associated with a significant increase (P < 0.05) in villus surface area, villus length, villus width, and the number of goblet cells. The enhanced nutrient retention seen in the chia supplemented group may be attributed to this factor.

Table 5. Effect of supplementation of chia seeds on nutrient retention in layer pullet

Treatment	T1	T2	T3	SEM	P Value
DMD (%)	70.0	71.4	71.2	0.42	0.42
CPD (%)	65.5	65.2	65.7	0.12	0.20
CFD (%)	35.6	36.2	37.9	0.49	0.12
EED (%)	85.2^{a}	87.7^{b}	88.2^{b}	0.63	0.04
OMD (%)	76.9	76.9	76.3	0.27	0.69
Ca (%)	41.0^{a}	42.3^{ab}	42.9^{b}	0.37	0.05
P (%)	40.3	39.3	39.8	0.39	0.67

^{ab}Means bearing different superscripts in a row differ significantly (P <0.05).

Economics

The economic analysis was conducted for different phases, calculating the cost per 100 grams of weight gain (Table 4). During the starter phase, the costs for T1, T2, and T3 were Rs 12.70, Rs 13.37, and Rs 14.13, respectively. In the grower phase, the costs increased to Rs 20.29, Rs 20.49, and Rs 21.59, respectively. It's important to note that incorporating premium ingredients, such as chia seed (@ Rs 290 per kg), does raise the overall diet cost. However, these ingredients are intended for value addition, so the increased cost is anticipated.

CONCLUSION

Supplementation of chia enhanced the growth performance of layer pullets during the trial. Additionally, the chia supplemented groups shown improved nutrient retention. So, chia seed can be supplemented up to 2% in the diet of layer pullets during growth phase. Although chia seeds effectively improved body weight gain and feed conversion ratio (FCR), their inclusion in layer pullets diets can lead to increased cost.

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