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Aditi Digarse
Department of Animal Husbandry and Dairying, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Neeraj
Department of Animal Husbandry and Dairying, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Ramesh Pandey
Department of Animal Husbandry and Dairying, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Sana DV Satyanarayana
Livestock Expert (Program Officer), WASSAN India, Bhubaneswar, Odisha, India

Corresponding Author:
Aditi Digarse
Department of Animal Husbandry and Dairying, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Impact of pumpkin seed powder supplementation on growth performance of caged broiler chicks

Aditi Digarse, Neeraj, Ramesh Pandey and Sana DV Satyanarayana

Abstract
The study investigated the effect of dietary supplementation with pumpkin seed powder (*Cucurbita maxima*) at levels of 0%, 0.5%, 0.75%, and 1% on the growth performance of caged broiler chicks over a four-week period. A total of 48 day-old chicks were randomly assigned to four treatment groups (T_0: control, T_1: 0.5%, T_2: 0.75%, T_3: 1%), each with four replicates of three chicks. Weekly body weight and weight gain were measured, and data were analyzed using Analysis of Variance (ANOVA) in a Randomized Block Design (RBD). Results showed no significant differences in body weight and weight gain among treatments in the first three weeks ($p>0.05$). However, by the fourth week, T_3 (1% supplementation) exhibited significantly higher mean body weight (1309.49 g) and weight gain (630.37 g) compared to T_0 (1202.58 g, 506.66 g), T_1 (1116.25 g, 404.49 g), and T_2 (1232.00 g, 587.83 g) ($p<0.05$). These findings suggest that 1% pumpkin seed powder supplementation enhances growth performance in broiler chicks, particularly in the later stages of rearing, offering a potential natural feed additive for poultry production.

Keywords: Pumpkin seed powder, *Cucurbita maxima*, broiler chicks, growth performance, body weight, weight gain, natural feed additive

1. Introduction

The poultry industry in India has seen significant growth, driven by increasing demand for protein-rich products such as chicken and eggs. India ranks third in egg production and eighth in poultry meat production globally, with egg production rising from 78.48 billion in 2014-15 to 122.11 billion in 2020-21 (Digarse, 2023) [8]. To meet this demand, feed additives are commonly used to enhance growth performance and feed efficiency in broilers. However, concerns over antibiotic growth promoters (AGPs) due to microbial resistance and public health risks have prompted exploration of natural alternatives (Botsoglou *et al.*, 2002; Windisch *et al.*, 2008) [7, 15].

Pumpkin seeds (*Cucurbita maxima*) are rich in crude protein (30.6%), antioxidants, minerals (zinc, magnesium, iron), and bioactive compounds such as cucurbitin, which have antiparasitic and anti-inflammatory properties (Wafar *et al.*, 2017; Mathewos *et al.*, 2019) [14, 12]. These nutritional attributes make pumpkin seeds a promising natural feed additive for poultry. Previous studies have reported that pumpkin seed meal at 10% inclusion does not adversely affect broiler performance (Martínez *et al.*, 2010) [11], while supplementation with pumpkin seed oil reduces plasma cholesterol and triglycerides (Hajati *et al.*, 2011) [9]. However, limited research exists on the effects of lower supplementation levels of pumpkin seed powder on broiler growth.

This study aimed to evaluate the impact of dietary pumpkin seed powder supplementation at 0%, 0.5%, 0.75%, and 1% on weekly body weight and weight gain in caged broiler chicks over four weeks. The objectives were to assess weekly body weight and weight gain, with a focus on significant differences observed in the fourth week, using data from the experimental trial (Tables 1-22) conducted at Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, India.

2. Materials and Methods

The experiment was conducted at the Small Animals' Laboratory, Department of Animal Husbandry and Dairying, Sam Higginbottom University of Agriculture, Technology and

Sciences, Prayagraj, India. A total of 48 day-old broiler chicks of the same hatch were randomly assigned to four treatment groups (T_0: control, T_1: 0.5% pumpkin seed powder, T_2: 0.75% pumpkin seed powder, T_3: 1% pumpkin seed powder) in a Randomized Block Design (RBD). Each treatment group consisted of 12 chicks, divided into four replicates of three chicks each, housed in battery-type metal cages under standard management practices.

The basal diet was formulated to meet the nutritional requirements of broilers, with a starter ration (22% crude protein, 2900 kcal/kg metabolizable energy) fed up to three weeks and a finisher ration (19% crude protein, 3000 kcal/kg metabolizable energy) fed in the fourth week. Pumpkin seed powder was supplemented at 0 g/kg (T_0), 5 g/kg (T_1), 7.5 g/kg (T_2), and 10 g/kg (T_3) of feed. Feed and water were provided ad libitum throughout the experiment.

Body weight was recorded individually for each chick at weekly intervals (day-old, first, second, third, and fourth weeks) using an electronic weighing machine in the morning before feeding. Weekly weight gain was calculated by subtracting the previous week's body weight from the current week's body weight. Data were compiled from Tables 1-22 of the experimental records (Digarse, 2023) [8].

Data on body weight and weight gain were analyzed using Analysis of Variance (ANOVA) in an RBD, as described by Snedecor and Cochran (1994). The critical difference (CD) was calculated to determine significant differences between treatment means at a 5% significance level ($p<0.05$). The ANOVA structure included degrees of freedom, sum of squares, mean sum of squares, and F-calculated values, as presented in Tables 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, and 22.

3. Results and Discussion
3.1 Body Weight
The mean body weight of day-old chicks across treatments ranged from 42.00-49.33 g, with no significant differences ($p>0.05$) among T_0 (43.83 g), T_1 (47.66 g), T_2 (45.33 g), and T_3 (44.00 g) (Table 1, 2). This ensured random and unbiased distribution of chicks across treatments.

Table 1: Average body weight (g) of day old broiler chicks in different treatments.

Treatments	T_0	T_1	T_2	T_3	Mean
R_1	45.33	49.33	47.33	44.66	46.66
R_2	38.66	49.33	40.66	42	42.66
R_3	45.33	47.33	47.33	46	46.49
R_4	46	44.66	46	43.33	44.99
Mean	43.83	47.66	45.33	44	43.83

Table 2: Analysis of variances (ANOVA) for the data on body weight of day-old broiler chicks contained in Table 1.

Source of Variation	SS	DF	MSS	F-Cal	F-tab	Result
Rows	47.33	3	15.78	2.75	3.86	NS
Columns	46.37	3	15.46	2.70	3.86	NS
Error	51.62	9	5.74			
Total	145.31	15				

At the first week, body weight ranged from 118-156 g, with mean values of 135.16 g (T_0), 147.50 g (T_1), 129.50 g (T_2), and 141.16 g (T_3) (Table 3). The highest mean body weight was observed in T_1, but differences were non-significant ($p>0.05$) (Table 4). In the second week, body weight ranged from 287.33-354.66 g, with mean values of 327.50 g (T_0), 354.33 g (T_1), 317.16 g (T_2), and 331.58 g (T_3) (Table 5). T_1

again recorded the highest mean, but differences remained non-significant ($p>0.05$) (Table 6).

Table 3: Average body weight (g) of broiler chicks at one week of age in different treatments.

Treatments	T_0	T_1	T_2	T_3	Mean
R_1	127.33	152	118	143.33	135.16
R_2	130.66	145.33	135.33	139.33	137.66
R_3	155.33	156	138	140.66	147.49
R_4	127.33	136.66	126.66	141.33	132.99
Mean	135.16	147.5	129.5	141.16	138.33

Table 4: Analysis of variances (ANOVA) for the data on body weight of broiler chicks at first week of age contained in Table 4.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	491.78	3	163.93	2.80	3.86	NS
Columns	720.55	3	240.18	4.10	3.86	S
Error	527.36	9	58.60			
Total	1739.69	15				

Table 5: Average body weight (g) of broiler chicks at second week of age in different treatments.

Treatments	T_0	T_1	T_2	T_3	Mean
R_1	346.66	372	287.33	321.66	331.91
R_2	319.33	362.66	313.33	343.33	334.66
R_3	310.66	354.66	328.66	309.33	325.83
R_4	333.33	328	339.33	352	338.16
Mean	327.5	354.33	317.16	331.58	332.64

Table 6: Analysis of variances (ANOVA) for the data on body weight of broiler chicks at second week contained in Table 5.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	326.02	3	108.67	0.23	3.86	NS
Columns	2950.24	3	983.41	2.12	3.86	NS
Error	4177.17	9	464.13			
Total	7453.44	15				

By the third week, body weight ranged from 600-738.66 g, with mean values of 696.33 g (T_0), 711.83 g (T_1), 644.33 g (T_2), and 658.83 g (T_3) (Table 7). T1 had the highest mean body weight, but no significant differences were observed ($p>0.05$) (Table 8). In the fourth week, body weight ranged from 1073-1507.33 g, with mean values of 1202.58 g (T_0), 1116.25 g (T_1), 1232.00 g (T_2), and 1309.49 g (T_3) (Table 9). T_3 exhibited significantly higher body weight compared to other treatments ($p<0.05$) (Table 10).

Table 7: Average body weight (g) of broiler chicks at third week of age in different treatments.

Treatments	T_0	T_1	T_2	T^3	Mean
R_1	738	737.33	637.33	678.66	697.83
R_2	662.66	734.66	600	660.66	664.50
R_3	738.66	692	660.66	611.33	675.66
R_4	646	683.33	679.33	684.66	673.33
Mean	696.3333	711.83	644.33	658.83	677.83

Table 8: Analysis of variances (ANOVA) for the data on body weight of broiler chicks at third week contained in Table 7.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	2410.89	3	803.63	0.52	3.49	NS
Columns	11926.38	3	3975.33	2.56	3.26	NS
Error	13988.69	9	1554.22			
Total	28324.89	15				

Table 9: Average body weight (g) of broiler chicks at fourth week of age in different treatments.

Treatments	T_0	T_1	T_2	T_3	Mean
R_1	1194	1122.67	1235.33	1507.33	1264.83
R_2	1119.33	1160	1206.67	1074	1140
R_3	1327	1109.33	1240	1266	1235.58
R_4	1170	1073	1246	1390.66	1219.91
Mean	1202.58	1116.25	1232	1309.49	1215.08

Table 10: Analysis of variances (ANOVA) for the data on body weight of broiler chicks at fourth week contained in Table 9.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	34224.19	3	11408.06	1.056472	3.49	NS
Columns	76498.03	3	25499.34	2.36143	3.26	NS
Error	97184.36	9	10798.26			
Total	207906.6	15				

The overall weekly mean body weight across treatments was 590.49 g (T_0), 582.49 g (T_1), 580.78 g (T_2), and 610.26 g (T_3), with T_3 showing a significant effect ($p<0.05$) (Table 11, 12). These results indicate that 1% pumpkin seed powder supplementation significantly enhanced body weight by the fourth week.

Table 11: Average weekly mean body weight of broiler in different treatments.

Treatments	T_0	T_1	T_2	T_3	Mean
W_1	135.16	147.5	129.5	141.16	138.33
W_2	327.5	354.33	317.16	331.58	332.64
W_3	696.33	711.83	644.33	658.83	677.83
W_4	1203	1116.32	1232.16	1309.5	1215.24
Mean	590.49	582.49	580.78	610.26	

Table 12: Analysis of variance (ANOVA) for the data on weekly body weight of broiler contained in Table above.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	2675520	3	891840	385.6515	3.86	S
Columns	2192.475	3	730.8249	0.316025	3.86	NS
Error	20812.99	9	2312.554			
Total	2698525	15				

1.1. Weight Gain

Weekly weight gain data showed no significant differences in the first three weeks ($p>0.05$). In the first week, weight gain ranged from 70.67-108.67 g, with mean values of 91.33 g (T_0), 99.83 g (T_1), 84.16 g (T_2), and 97.16 g (T_3) (Table 13, 14). In the second week, weight gain ranged from 155.33-220 g, with mean values of 192.33 g (T_0), 206.83 g (T_1), 187.66 g (T_2), and 192.83 g (T_3) (Table 15, 16). In the third week, weight gain ranged from 284.67-428.01 g, with mean values of 368.83 g (T_0), 357.57 g (T_1), 326.67 g (T_2), and 327.29 g (T_3) (Table 17, 18).

Table 13: Average gain in weight (g) of broiler chicks at first week of age in different treatments.

Treatments	T_0	T_1	T_2	T_3	Mean
R_1	82	102.67	70.67	98.66	88.5
R_2	92	96	94.67	97.33	95
R_3	110	108.67	90.67	94.66	101
R_4	81.33	92	80.66	98	87.99
Mean	91.33	99.83	84.16	97.16	

Table 14: Analysis of Variance (ANOVA) for the data on gain weight (g) of broiler Chicks at first week of age contained in table.

Source of Variation	SS	DF	MS	F-Cal	F-Tab	Result
Rows	452.85	3	150.95	2.26	3.86	NS
Columns	579.10	3	193.03	2.89	3.86	NS
Error	601.71	9	66.86			
Total	1633.66	15				

Table 15: Average gain in weight (g) of broiler chicks at second week of age in different treatments.

Treatments	T_0	T_1	T_2	T_3	Mean
R_1	219.33	220	169.33	186.5	198.79
R_2	188.67	217.33	178	204	197
R_3	155.33	198.66	190.66	161.84	176.62
R_4	206	191.34	212.67	219.01	207.26
Mean	192.33	206.83	187.66	192.83	

Table 16: Analysis of variance (ANOVA) for the data on gain weight (g) of broiler chicks at second week of age contained in table.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	2025.02	3	675.01	1.63	3.86	NS
Columns	822.30	3	274.10	0.66	3.86	NS
Error	3738.05	9	415.34			
Total	6585.37	15				

Table 17: Average gains in weight (g) of broiler chicks at third week of age in different treatments.

Treatments	T_0	T_1	T_2	T_3	Mean
R_1	391.34	365.33	350	357.17	365.96
R_2	343.33	372.3	284.67	317.33	329.40
R_3	428.01	337.33	332.01	302	349.83
R_4	312.67	355.33	340	332.66	335.16
Mean	368.83	357.57	326.67	327.29	

Table 18: Analysis of variance (ANOVA) for the data on gain weight (g) of broiler chicks at third week of age contained in Table 19.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	3210.17	3	1070.06	1.07	3.86	NS
Columns	5503.57	3	1834.52	1.74	3.86	NS
Error	9469.80	9	1052.20			
Total	18183.54	15				

In the fourth week, weight gain ranged from 385.33-828.67 g, with mean values of 506.66 g (T_0), 404.49 g (T_1), 587.83 g (T_2), and 630.37 g (T_3) (Table 19). T_3 showed significantly higher weight gain compared to other treatments ($p<0.05$) (Table 20). The overall weekly mean weight gain across treatments was 289.78 g (T_0), 267.18 g (T_1), 296.58 g (T_2), and 311.91 g (T_3), with significant differences ($p<0.05$) (Table 21, 22).

Table 19: Average gain in weight (g) of broilers at fourth week of age in different treatments.

Treatment	T_0	T_1	T_2	T_3	Mean
R_1	456	385.33	598	828.67	567
R_2	456.67	425.33	606.67	413.33	475.5
R_3	589.99	417.3	580.01	654.67	560.49
R_4	524	390	566.67	624.84	526.37
Mean	506.66	404.49	587.83	630.37	

Table 20: Analysis of Variance (ANOVA) for the data on gain weight (g) of broilers at fourth week of age contained in Table 19.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	21040.86	3	7013.62	0.78	3.86	NS
Columns	118784.6	3	39594.87	4.43	3.86	S
Error	80462.2	9	8940.24			
Total	220287.7	15				

Table 21: Average weekly gain in weight (g) of broilers in different treatments

Treatments	T_0	T_1	T_2	T_3	Mean
W_1	91.33	99.83	84.16	97.16	93.12
W_2	192.33	206.83	187.66	192.83	194.91
W_3	368.83	357.57	326.67	327.29	345.09
W_4	506.66	404.49	587.83	630.37	532.33
Mean	289.78	267.18	296.58	311.91	

Table 22: Analysis of Variance (ANOVA) for the data on weekly gain in Weight (g) of broilers contained in Table 21.

Source of Variation	SS	DF	MSS	F-Cal	F-Tab	Result
Rows	438233.10	3	146077.70	48.21	3.86	S
Columns	4147.20	3	1382.40	0.46	3.86	NS
Error	27272.85	9	3030.32			
Total	469653.20	15				

The significant increase in body weight (1309.49 g) and weight gain (630.37 g) in T_3 (1% pumpkin seed powder) by the fourth week aligns with previous findings on the nutritional benefits of pumpkin seeds. Wafar *et al.* (2017) [14] reported that pumpkin seed meal, with 30.6% crude protein and high mineral content, supports growth performance in broilers. The high zinc and magnesium content in pumpkin seeds may enhance metabolic processes and nutrient absorption, contributing to improved growth (O'Dell *et al.*, 1990) [13]. The lack of significant differences in the first three weeks suggests that the benefits of pumpkin seed supplementation become more pronounced as chicks mature, possibly due to cumulative effects of bioactive compounds like cu*c*urbitin and antioxidants (Bauri *et al.*, 2015) [6].

The non-significant differences in early weeks are consistent with Martínez *et al.* (2010) [11], who found no adverse effects of 10% pumpkin seed meal on broiler performance. However, the significant effect of 1% supplementation in the fourth week indicates an optimal inclusion level for growth enhancement without negatively impacting feed palatability, as noted by Windisch *et al.* (2008) [15]. The improved growth in T_3 may also be attributed to the antiparasitic properties of cucurbitin, which could reduce gut stress and enhance nutrient utilization. Compared to other phytogenic additives, such as neem seed powder, pumpkin seeds offer similar growth-promoting effects at lower inclusion levels (Mathewos *et al.*, 2019) [12]. The significant effect of T_3 on body weight and weight gain supports the potential of pumpkin seed powder as a natural alternative to AGPs, addressing consumer concerns about antibiotic residues (Botsoglou *et al.*, 2002) [7].

3. Conclusion
Dietary supplementation with 1% pumpkin seed powder (*Cucurbita maxima*) significantly improved body weight (1309.49 g) and weight gain (630.37 g) in caged broiler chicks by the fourth week, compared to the control and lower supplementation levels. These findings highlight the potential of pumpkin seed powder as a natural feed additive to enhance broiler growth performance, particularly in the later stages of rearing. Further research is needed to explore optimal inclusion levels beyond 1% and long-term effects on carcass quality and health parameters.

4. Acknowledgments

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