Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(3): 658-663

Received: 08-03-2019
Accepted: 12-04-2019

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Effect of dietary supplementation of Neem (*Azadirachta indica*) leaf powder on the performance of commercial broiler chicken

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Abstract
The present experiment was conducted to study the effect of supplementation of Neem (*Azadirachta indica*) leaf powder (NLP) on the performance of commercial broiler chicken. A total of 144 day-old commercial broiler chicks (Cobb 400) were randomly divided into four groups *viz.* T_0 (only basal diet as control), T_1 (basal diet +0.1 % NLP), T_2 (basal diet +0.2 % NLP) and T_3 (basal diet +0.3 % NLP) consisting of 36 birds per group and further subdivided into 3 replicates of 12 chicks each. Supplementation of 0.3% Neem leaf powder improved the total feed consumption, significantly ($P<0.05$) improved final body weight and body weight gain. The final body weight per broiler was highest in T_3 group (2048.61 ± 24.27 g) followed by T_2 group (1939.64 ± 20.63 g), T_1 (1744.12 ± 45.71 g) and T_0 (1710.29 ± 38.32 g). At the end of the experimental period best FCR (1.75), highest BPEI (117.06) and higher gross profit was obtained in T_3 group among the different experimental groups.

Keywords: Supplementation, Neem leaf powder, broiler, basal diet

Introduction
Indian Broiler Industry has witnessed a phenomenal growth since the last two decades and have become one of the most popular and profitable enterprise for the educated unemployed youths of India. Chicken meat production increased significantly in the past few years because of many research and education programmes that have helped enhanced feed intake and growth rate [28]. Majot portion of the production cost accounts for the feed cost and India being a developing country there have been irregular supply for quality and economic feed. A steady supply of low cost feed is essential to improve the overall productivity of the poultry birds [31]. Continuous efforts are being made to find out alternative economic feed ingredients to quest the need of the farmers. The researchers have now-a-days focused on locally available natural feed resources which can be used as feed additives to improve the performance of broilers. Moreover, indiscriminate use of antimicrobials and other drugs for enhancing growth rate tend to various ill effects both on the health of birds as well on the consumers [20]. Therefore poultry scientists are again concentrating on the use of our ancient medicinal system to find beneficial herbs and plants, which can be safely used to increase the production [7, 13]. Use of herbs and other medicinal plants and their extracts in poultry feeding could be more beneficial as growth enhancer and prevention against many common poultry diseases. Moreover these herbs would be readily available, commonly known to lay men and effectively can be used in poultry diet. One of such plant is neem or Mahaneem (*Azadirachta indica*). The various biologically active principles present in different parts of the Neem plant includes Azadirachtin, Meliacin, Nimbin, Nimbidin, Nimbidol, Gedunin, Salannin, Valassin and many other derivatives [25]. Neem leaf yields mainly quercetin (flavonoid) and nimbosterol (beta sibosterol) as well as number of liminoids [12]. Neem is an indigenous plant of Asian subcontinent known for its utmost medicinal properties since ancient time. The extract of the neem leaf was reported to possess diverse pharmacological characteristics such as anti-inflammatory, antifungal, antibacterial, antiviral, antiulcer, antioxidant, antimalarial, ant mutagenic, anticarcinogenic, hypolipidaemic, immunostimulant, hepatoprotective and hypoglycaemic effects [17, 30]. Considering the above facts in view, the present study was undertaken to evaluate the performance of broiler chicken supplemented with Neem Leaf Powder (NLP) in the basal diet of broiler chicken at different levels.

2. Materials and Methods

The present work was conducted in the experimental poultry shed of Instructional Poultry Farm, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati taking 144 number of day old commercial broiler chicks (Cobb 400) having similar body weight and from a single hatch. The chicks were wing banded and weighed and were distributed at random into four Groups *viz*. T_0, T_1, T_2 and T_3 containing 36 chicks in each group. Each group was further subdivided into 3 replicates of 12 chicks. Birds were maintained following standard feeding and uniform managemental practices under deep litter system of rearing. Fresh Neem leaves were harvested from middle aged green trees and were sundried for 8 to 10 days on polythene sheets until they become crispy while retaining the greenish colouration. The dried leaves were then pulverized and stored in cellophane bags until preparation of feed. Diet T_0 served as control (with no Neem leaf powder supplementation) while diet T_1, T_2 and T_3 contained 0.1, 0.2 and 0.3% of Neem leaf powder respectively. The chicks were fed broiler starter (1-28 days) and finisher (29-42 days) diets as per BIS (1992) as described in Table 01. The ingredient and nutrient composition for mash feed for starter and finisher basal diet is presented in Table 01. All the biosecurity measures were adopted during the experimental period. Chicks were vaccinated against Ranikhet Disease (RD) and Infectious Bursal Disease (IBD) as per standard schedule. The performance of broiler in respect of weekly feed intake, weekly body weight and body weight gain, Feed Conversion Ratio (FCR), Broiler Performance Efficiency Index (BPEI), livability and economics of production were calculated as per standard methods. Completely Randomized Design (CRD), the mean, SE (Standard Error) and One Way Analysis of Variance were performed by the software SAS system (Local, X64_7PRO).

Table 1: Ingredients and nutrient composition of basal diet (broiler starter and broiler finisher) as per bis (1992)

Ingredients (Kg.)	Starter (0-28 days)	Finisher (29-42 days)
Maize	50.0	52.5
Rice polish	7.0	7.0
Ground nut cake	17.0	12.0
Soya bean meal	22.5	24.0
Vegetable oil	1.0	2.0
Mineral mixture	2.0	2.0
Common salt	0.5	0.5
Nutrient composition		
Dry matter (%)	88.4	86.6
Crude protein (%)	22.04	20.99
Ether extract (%)	3.5	5.0
Crude fibre (%)	4.0	3.5
Nitrogen free extract (%)	63.16	64.51
Total ash (%)	7.3	6.0
Metabolizable energy (Kcal/Kg.)*	2803.11	2901.53

*Calculated values.

(N.B. Vitamin premix (Vitablend vit A, B2, D3, K) was added @ 20 g per quintal of diet in both starter and finisher diet. Mineral mixture contained calcium 25%, Phosphorus 5%, Sodium chloride 23%, Iodine 10 ppm, Copper 100 ppm, Manganese 2000 ppm and Cobalt 10 ppm).

3. Results and Discussion

3.1 Weekly feed consumption

On perusal of the mean weekly feed intake of the present study (Table 02), it could be seen that during the first week of age the feed intake was lowest in T_0 group and highest in T_3 group. During the second week, feed intake was highest in T_2 group and lowest in T_1 group. Similar trend was seen in third week of age, except that feed intake was lowest in T_0 group. During the fourth week, feed intake was highest in T_3 group and lowest in T_1 group, where as in the fifth week the highest feed intake was recorded in the T_0 group and lowest in the T_3 group. At the end of the sixth week of age highest feed intake was found in T_3 group (994.40 g) and the lowest in T_2 group (839.24 g). Thus it was found from all the weeks that supplementation of neem leaf powder at 0.2 and 0.3% level improved feed intake except fifth week of age as compared to control group (0.0%).The increased feed intake might be due to its appetite and digestion stimulating, antibacterial and hepatoprotective properties (Wanker *et al*., 2009) [32]. which help to reduce the microbial load of birds and improved the feed consumption. Moreover neem leaves act as carminative and aid in digestion (Durrani *et al*., 2008) [11]. Similar findings with respect to improvement in feed intake were observed by several workers (Onyimonyi *et al*., 2009) [27]. Khatun *et al*., 2013 [16]. Nodu *et al*., 2016 and Shihab *et al*., 2017) [24, 29]. The finding of the present study was contradictory to the findings of Wanker *et al.* (2009) [32]. Zanu *et al.* (2011) [33]. Adeyemo and Akanmu (2012), Bonsu *et al.* (2012) [8]. Nnenna and Okey, (2013) [23]. And Ali *et al.* (2015) [2]. Who reported no significant difference in feed intake between the control and neem leaf fed groups of broiler chicken. The total feed consumption per broiler under different experimental groups was found to be highest in T_3 group (3593.86 g) followed by T_2 (3504.96 g), T_0 (3247.58 g) and T_1 (3222.67 g) group. Thus it indicated that supplementation of NLP at the levels of 0.2 and 0.3% increased total feed consumption by 8.05 and 9.63% respectively, as compared to control. Contrary to the present finding Shihab *et al.* (2017) [29]. Found highest total feed consumption in 0.2% NLP supplemented group (3281.6 g) and lowest in control group (2592.6 g) during a period of five weeks. However, supplementation of high level of NLP at the dose of 0.5% and above significantly reduced feed intake in broiler chicken (Onyimonyi *et al*., 2009) [27]. Adeyemo and Akanmu, 2012 and Bonsu *et al*., 2012) [8].

3.2 Weekly body weight and body weight gain

The mean (±SE) weekly body weight (Table 03) of different treatment groups did not differ significantly (P>0.05) during the first week of age. During the second, third, fourth, fifth and sixth week of age, the body weight of broiler chicken differed significantly ($P \leq 0.01$). The T_3 and T_2 group gained significantly ($P \leq 0.01$) higher body weights as compared to control (T_0) and T_1 group during the second, third, fourth, fifth and sixth week of age. Similar observations were made by Manwar *et al*. (2005), Onyimonyi *et al*. (2009) [27]. Zanu *et al*. (2011) [33]. Ansari *et al*. (2012) [5] and Shihab *et al*. (2017) [5, 29]. Who reported that supplementation of neem leaf powder in the basal diet of broiler chicken improved final body weight of the broiler chicken. Contrary to the present findings, Landy *et al*. (2011) [18], Bonsu *et al*. (2012) [8] and Nayaka *et al*. (2013) [8, 21]. Reported that body weight was not affected by the dietary supplementation of neem leaf powder in broiler chicken.

The mean (±SE) weekly body weight gain (Table 04) of different experimental groups showed no significant (P>0.05) difference in the first week of age. On the second, third and fourth week of age, the mean (±SE) weekly body weight gain

differed significantly (P≤0.01) among the different treatment groups. The body weight gain of T_2 and T_3 groups was significantly (P≤0.05) higher as compared to T_0 and T_1 group during the second, third and fourth week of age. During the fifth week, the mean (±SE) weekly body weight gain differed significantly (*P*≤0.05) among the different treatment groups. However during this fifth week the T_3 group achieved significantly (*P*≤ 0.05) lower body weight gain as compared to other groups, whereas in the sixth week only T_3 group showed significantly (*P*≤ 0.05) higher body weight gain as compared to other experimental groups. Similar findings with respect to higher weight gain due to dietary supplementation of NLP in broiler chicken were also observed by several workers (Chakravarty and Prasad, 1991; Onyimonyi *et al*., 2009) [27]. Khatun *et al*., 2013 [16]. Kharde and Soujanya, 2014 and Nodu *et al*., 2016) [24]. The improvement in body weight and body weight gain of the broiler chicken due to supplementation of NLP in the diets might be due to the diversified effect of neem leaves on intestinal microflora, thereby avoiding stressful condition (Durrani *et al.* 2008) [11]. Moreover the active ingredients present in neem leaves *viz.* Nimbin, Nimbidin and
Azadirachtin (Brahmachari, 2004) [9] inhibit activities of host pathogens (Amandioha, 2000) [4] and can thus be used as antibacterial in broiler production. Thus, the present study revealed that inclusion of dietary supplementation of neem leaf powder in the broiler ration at the dose of 0.2 and 0.3% improved the body weight and body weight gain compared to broilers fed basal diet without neem leaf powder. This finding corroborated well with the reports of Manwar *et al*. (2005) [19], Ansari *et al*. (2012) [5]. Ali *et al*. (2015) [2]. And Alam *et al*. (2015).

3.3 Weekly and overall Feed conversion ratio (FCR)

Among the different experimental groups, the mean weekly feed conversion ratio (Table 05) of T_3 group showed the best FCR values during the first (1.81) and second (1.72) week of age. On the third week, T_2 and T_3 showed the best result (1.83) as compared to T_1 (1.96) and T_0 group (1.89). At the end of the fourth, fifth and sixth week, T_3 group showed best FCR values (1.75, 1.76 and 1.76) as compared to other groups.

The overall FCR of the entire period of experiment was best in T_3 group (1.75) followed by T_2 (1.80), T_1 (1.84) and T_0 (1.89) group. The feed conversion ratio of the broiler chicken improved gradually due to dietary supplementation of NLP in the basal diets compared to the control group. The best feed conversion ratio was obtained in the T_3 group supplemented with NLP at the rate of 0.3% in the basal diet.

The better feed conversion ratio can be attributed to the antimicrobial and antiprotozoal properties of neem leaves, which helped to reduce the microbial load of birds and improved the feed conversion ratio (Kale *et al*., 2003). Neem leaves had its appetite and digestion stimulating as well as hepatoprotective properties (Wanker *et al*., 2009) [32] which lead to better feed utilization reflected by improved feed conversion ratio. Similar observations were reported in broiler chicken by several workers (Chakravarty and Prasad, 1991; Ansari *et al*., 2012 [5]. Kharde and Soujanya, 2014 and Nodu *et al*., 2016) [24] who found improved FCR due to dietary inclusion of neem leaf powder in the basal diet of broiler chicken at levels 0.3% and less. On the other hand, addition of neem leaf powder in the broiler ration did not show significant differences in feed conversion ratio according to findings of several workers (Nidaullah *et al*., 2010; Zanu *et al*., 2011 [33]. Bonsu *et al*., 2012 [8]. Nayaka *et al*., 2013 and Ali *et al*., 2015) [21, 2]. The poor FCR values recorded in several experimental trials supplemented with neem leaf powder at higher levels (0.5% and above) were due to bitter and astringent taste of the NLP (Bonsu *et al*., 2012) [8]. The high level of neem leaf (0.5%) implied a reduction in FCR in broilers could be attributed to the presence of antinutritional factors contained in the leaf meal (Ansari *et al*., 2012) [5].

3.4 Broiler Performance Efficiency Index and Livability

In the present findings, it was observed that among the different treatment groups, T_3 group showed the highest BPEI (117.06) followed by T_2 (107.74), T_1 (94.78) and T_0 (90.49) group (Table 06). The highest value of BPEI in T_3 group was due to higher average body weight, better feed conversion ratio and cent per cent livability in broiler chicken during the entire experimental trial. The efficiency index of broiler chicken improved gradually as the level of supplementation of neem leaf powder increased from 0.1% to 0.3% as compared to control group.

The livability of T_3 and T_2 group was found to be cent per cent (100) as compared to control (97.22%) and T_1 group (94.44%). Similar findings were reported by Durrani *et al*. (2008), Nayaka *et al*. (2013) [21]. And Nodu *et al*. (2016) [24] in broiler chicken supplemented with leaf powder or extract as phytogenic growth promoter. This might be due to the antioxidant and antimicrobial activities of neem which suppressed the pathogenic bacteria and enhance immune status (Nayaka *et al*., 2013) [21]. Moreover Durrani *et al*. (2008) [11]. Opined that higher livability in treated group was due to efficient use of neem leaves in preventing mortality and eliminating stress. Contrary to the present findings Ansari *et al*. (2012) [5]. And Nnenna and Okey (2013) [23] reported no significant (P>0.05) effect on livability of broiler chicken supplemented with NLP or NLE at different levels.

3.5 Economics of production

The cost of production per broiler was found to be (Rs.) 155.48, 154.36, 163.91 and 167.28 for T_0, T_1, T_2 and T_3 groups, respectively (Table 07). The cost of production per broiler in T_3 and T_2 was numerically higher by about (Rs.) 11.80 and 8.43 as compared to T_0 group. However, gross profit per broiler was found to be highest in T_3 group (Rs. 37.58) followed by T_2 (Rs. 30.05), T_1 (Rs. 20.04) and T_0 (Rs. 15.52) group. Thus, among the four experimental groups, the T_3 group showed best result in respect of higher gross profit per broiler. The gross profit per broiler was higher by Rs. 22.06 in T_3 group as compared to T_0 group. The better gross profit per broiler in T_3 and T_2 group could be attributed to the better growth performance and improved FCR of broilers due to addition of neem leaf powder in the ration. These findings corroborated with the findings of Onyimonyi *et al*. (2009) [27]. And Bonsu *et al*. (2012) [8]. Who found reduction in production cost per bird, increased live weight, better FCR and higher gross profit in NLP treated groups as compared to control group.

Table 2: Mean weekly feed intake (g/bird) and total feed consumption (g/bird) of broiler chicken under different treatment groups

Group / Week	T_0 (Control)	T_1 (NLP-0.1%)	T_2 (NLP-0.2%)	T_3 (NLP-0.3%)
1st	173.86	178.61	178.17	185.99
2nd	234.89	226.06	316.68	292.40
3rd	354.24	382.59	548.68	529.05
4th	625.47	612.52	755.32	851.20
5th	929.76	902.22	866.85	740.81
6th	929.34	920.65	839.24	994.40
Total	**3247.58**	**3222.67**	**3504.96**	**3593.86**

Table 3: Mean ± se weekly body weight (g) of broiler chicken under different treatment groups

Group / Week	T_0 (Control)	T_1 (NLP-0.1%)	T_2 (NLP-0.2%)	T_3 (NLP-0.3%)
1st	138.25^{a}±2.75	139.56^{a}±2.06	140.94^{a}±1.72	143.61^{a}±2.42
2nd	262.89^{a}±6.69	264.44^{a}±4.03	320.25^{b}±6.99	311.28^{b}±5.63
3rd	444.29^{a}±11.43	457.20^{a}±10.13	602.33^{b}±18.93	588.68^{b}±9.37
4th	779.06^{a}±20.90	764.12^{a}±20.58	1008.19^{b}±25.42	1077.19^{b}±13.37
5th	1240.00^{a} ± 33.86	1251.47^{a}±31.77	1483.53^{b}±27.44	1484.72^{b}±20.30
6th	1710.29^{a}±38.32	1744.12^{a}±45.71	1939.64^{b}±20.63	2048.61^{c}±24.27

Means bearing different superscripts in a row differ significantly ($P \leq 0.01$).

Table 4: Mean ± se weekly body weight gain (g/bird) of broiler chicken under different treatment groups

Group / Week	T_0 (Control)	T_1 (NLP-0.1%)	T_2 (NLP-0.2%)	T_3 (NLP-0.3%)
1st	94.49^{a} ± 2.41	96.03^{a} ± 1.98	97.90^{a} ± 1.69	102.76^{a} ± 3.26
2nd	126.97^{a} ± 7.18	124.21^{a} ± 2.65	182.00^{b} ± 6.69	170.00^{b} ± 6.52
3rd	187.43^{a} ± 13.84	195.20^{a} ± 10.10	299.83^{b} ± 12.30	289.10^{b} ± 10.11
4th	330.94^{a} ± 14.00	320.26^{a} ± 14.68	421.97^{b}± 12.02	486.40^{c}± 11.80
5th	476.80^{a} ± 19.46	469.91^{a} ± 17.64	473.69^{a}± 14.38	420.92^{b}± 13.75
6th	486.57^{a}± 15.38	489.71^{a} ± 21.71	456.11^{a} ±21.03	565.00^{b}± 15.38

Means bearing different superscripts in a row differ significantly ($P \leq 0.01$).

Table 5: Mean weekly feed conversion ratio of broiler chicken under different treatment groups

Group / Week	T_0 (Control)	T_1 (NLP-0.1%)	T_2 (NLP-0.2%)	T_3 (NLP-0.3%)
1st	1.84	1.86	1.82	1.81
2nd	1.85	1.82	1.74	1.72
3rd	1.89	1.96	1.83	1.83
4th	1.89	1.91	1.79	1.75
5th	1.95	1.92	1.83	1.76
6th	1.91	1.88	1.84	1.76
Overall	**1.89**	**1.84**	**1.80**	**1.75**

Table 6: Broiler performance efficiency index (bpei) and per cent livability of broiler chicken under different treatment groups

Parameters	Groups			
	T_0 (Control)	T_1 (NLP-0.1%)	T_2 (NLP-0.2%)	T_3 (NLP-0.3%)
BPEI	90.49	94.78	107.74	117.06
Livability (%)	97.22	94.44	100	100

Table 7: Cost of production and gross profit (rs.) per broiler under different treatment groups

Parameters / Groups	T_0 (Control)	T_1 (NLP-0.1%)	T_2 (NLP-0.2%)	T_3 (NLP-0.3%)
I. Expenditure				
1) Chick cost (A) = 1.05 x cost of one day-old chick (Rs.)	36.75	36.75	36.75	36.75
2) Feed cost (B) = Live weight in Kg x FCR x Cost per Kg of feed***** (Rs.)	98.41	97.48	105.78	108.71
3) Miscellaneous expenditure (C) = Add 15% of (A+B) (Rs.)	20.32	20.13	21.38	21.82
4) Additional cost of Neem Leaf Powder (D)	Nil	Nil	Nil	Nil
5) Production cost per broiler (A+B+C+D) (Rs.)	155.48	154.36	163.91	167.28
II. Return				
Sale of one live broiler @ Rs. 100 per Kg	171.00	174.40	193.96	204.86
III. Gross profit per broiler (Rs.**)**	15.52	20.04	30.05	37.58

4. Conclusion

Thus, it can be recommended that neem leaf powder can be used economically as a natural feed additive in broiler chicken diet at the level of 0.3% to improve the overall performance of commercial broiler chicken. Further in depth studies may be required using different levels of NLP as feed additive in broiler chicken to validate the present results.

5. Acknowledgement

The authors express sincere gratitude and thankfulness to the Dean, Faculty of Veterinary Science, AAU, Khanapara, Guwahati - 22 for providing the necessary facilities and financial aid to carry out the research programme at the Instructional Poultry Farm of the college.

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