Performance and carcass characteristics of guinea fowl fed on dietary Neem (*Azadirachta indica*) leaf powder as a growth promoter

Singh, M. K.[1*]; Singh, S. K.[2]; Sharma, R. K.[2]; Singh, B.[2]; Kumar, Sh.[2]; Joshi, S. K.[3]; Kumar, S.[4] and Sathapathy, S.[5]

[1]Ph.D. Scholar, Department of LPM, G.B.P.U.A & T, Pantnagar-263145 (Uttarakhand), India; [2]Department of LPM, G.B.P.U.A & T, Pantnagar-263145 (Uttarakhand), India; [3]Division of LPM, Ndri, Karnal-132001, Haryana, India; [4]Division of Veterinary Surgery and Radiology, Ivri, Izatnagar, Bareilly-243122, Utter Pradesh, India; [5]Deppartment of Veterinary Anatomy, G.B.P.U.A. & T, Pantnagar-263145 (Uttarakhand), India

[*]***Correspondence:*** *M. K. Singh, Ph.D. Scholar, Department of LPM, G.B.P.U.A & T, Pantnagar-263145 (Uttarakhand), India. E-mail: drmksingh_1@rediffmail.com*

(Received 5 Feb 2014; revised version 14 May 2014; accepted 5 Jul 2014)

Summary

The present work aimed at studying growth pattern and carcass traits in pearl grey guinea fowl fed on dietary Neem (*Azadirachta indica*) leaf powder (NLP) over a period of 12 weeks. Day old guinea fowl keets (n=120) were randomly assigned to four treatment groups, each with 3 replicates. The first treatment was designated as control (T_0) in which no supplement was added to the feed, while in treatments T_1, T_2 and T_3, NLP was provided as 1, 2 and 3 g per kg of feed, respectively. The results revealed a significant increase in body weight at 12 weeks; 1229.7 for T_1, 1249.8 for T_2, and 1266.2 g T_3 compared to 1220.0 g for the control group ($P<0.05$). The results also showed that the supplementation of NLP significantly increased feed intake ($P\leq 0.05$) which might be due to the hypoglycaemic activity of Neem. A significant increase was also found in the feed conversion ratio (FCR) of the treated groups over the control, showing that feeding NLP to the treated groups has lowered their residual feed efficiency. The results of the study demonstrate the beneficial effects of supplementing NLP on body weight gain and dressed yield in the treated groups in guinea fowl. NLP is, therefore, suggested to be used as a feed supplement in guinea fowl for higher profitability.

Key words: Guinea fowl, Growth traits, Neem

Introduction

Today India is the third producer of eggs (63 billion) and 5th producer of poultry (2.8 million tons) in the world (Singh, 2012). Despite its impressive growth, the *per capita* consumption is about 100 eggs and 2250 g chicken meat per annum in urban areas and 15 eggs and 750 g chicken meat in rural areas compared to the recommended level of 180 eggs and 10.25 kg meat (Rama Rao and Rajkumar, 2011). To close this gap and produce quality meat and cheaper animal protein throughout the year, alternate poultry species, namely, turkey and guinea fowl need to be popularized. Turning guinea fowl production into a profitable enterprise will in part, require an understanding of its various performance parameters.

Feed is an important and critical input for the poultry industry as it accounts for 60 to 70% of the production costs. Various feed additives or growth promoters have been developed to improve growth rate, feed efficiency and product quality and to reduce production costs. Recent field trials in India, Greece, the UK and the USA on the subject of herbal formulations as growth promoters have shown encouraging results regarding weight gain, feed efficiency, lowered mortality and increased liveability in poultry (Deepak *et al.*, 2002). Although medicinal plants and herbs have been used for many years in the treatment of various diseases in animals and human beings (Koul *et al.*, 1990), nowadays, they are being used in animal feed as growth promoters. Due to the prohibition of most antimicrobial feed additives in animal feed and their residual effects on animals, plant extracts are becoming more popular. The extract of the *Azadirachta indica* (Neem tree) leaf is reported to possess diverse pharmacological characteristics such as anti-inflammatory, hypo-lipidaemic, immunostimulant, hepatoprotective and hypoglycaemic effects (Khosla *et al.*, 2000).

Being accepted by consumers as natural additives, phytogenic and herbal products have received increased attention in the recent years (Toghyani *et al.*, 2010). The medicinal properties of Neem have been known since time immemorial. Earliest ayurvedic literature refers to the benefits of all parts of this majestic tree-fruit, leaf, bark, flower and root (Subapriya and Nagini, 2005). Neem contains a vast array of biologically active compounds which are chemically diverse and structurally complex (Kaur *et al.*, 2004). Every part of the plant is used as herb. Neem possesses limonoids, protolimonoids, tetranortriterpenoids, pentanortri-terpenoids, hexanortriterpenoids, and some nonterpenoid (Koul *et al.*, 2006). NRC (1992) has reported Neem to contain the chemical, azadirachtin, which has positive effects on pests, and deformental effects on viruses, mites, fungal pathogens, plant parasitic nematodes, intestinal worms, bacteria, molluscs, and protozoan parasites such as coccidian species. The present study was designed to compare the efficacy of different levels of NLP as a commercial growth promoter on growth performance and carcass characteristics of meat-type guinea fowl.

Materials and Methods

Experimental birds and dietary treatments

The present study was undertaken at the Instructional Poultry Farm (IPF), of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar from September to December 2012. The place is located between 28° 53’ 23” to 30° 27’ 50” N and 77° 34’ 27” to 81° 02’ 22” E at 243.84 m MSL (mean sea level) in the Tarai region of Uttarakhand State (India). The climate is humid subtropical. Winters are very severe and summers are hot and humid. Temperatures may rise to a maximum of 43°C in the summer and fall to a minimum of 2°C in the winter. Relative humidity ranges between 15 to 95%.

One hundred twenty day old male and female guinea fowl (pearl variety) were weighed and randomly assigned to four treatment groups with 3 replicates of 10 keets each. The study was conducted for a period of 12 weeks under standard management conditions. Feed and water were provided *ad libitum*, in battery brooders equipped with raised wire floors from hatch to four weeks of age. Initially, the brooder temperature was maintained at 32.2°C for the first week and reduced gradually by 2.8°C every week until 23.9°C, after which no artificial heating was provided. At 3 weeks of age, the keets were transferred to a deep litter in a grower house where they received 23 h of constant lighting from hatch to 12 weeks of age. The first treatment was considered as the control (T_0) in which no supplement was added to the basal feed, while in treatments T_1, T_2 and T_3, NLP was provided as 1, 2 and 3 g per kg of feed, respectively. The nutrient composition of NLP and the experimental feed are given in Tables 1 and 2.

Table 1: Nutrient composition of Neem leaf powder (NLP)

1	Dry matter	90.24%
2	Crude protein	23.40%
3	Ether extract	3.36%
4	Ash	9.90%
5	Crude fibre	7.81%
6	Calcium (g)	1.40
7	Phosphorus total (g)	0.25

Performance and carcass components

Body weights and feed intake were determined at 7, 14, 21, 28, 35, 42, 49, 56, 63, 70, 77 and 84 days, according to which FCR was calculated for each treatment group. At day 84, 2 birds per replicate were randomly chosen and slaughtered by cutting their carotid arteries and partial neck slicing by a manual neck cutter. Carcass yield was calculated by dividing eviscerated weight by live weight. Empty gizzards, livers and hearts were also removed, weighed and calculated as a percentage of live weight.

Table 2: Nutrient composition (on dry matter basis) of basal ration used during experiment

Nutrients (%)	Starter diet (1-4 weeks)	Grower diet (5-8 weeks)	Finisher diet (9-12 weeks)
Moisture	9.85	10.03	10.04
Crude protein	24.00	21.00	18.00
Crude fibre	4.97	4.79	4.36
Ether extract	7.50	9.00	6.15
Total ash	7.27	6.98	6.86
Calcium	1.00	1.00	0.95
Phosphorus	0.72	0.72	0.70

Statistical analysis

All data pertaining to various parameters were analyzed statistically by running ANOVAs using SPSS 19 software. Significant mean differences between the treatments were determined at a 5% significance level ($P<0.05$) using Duncan’s Multiple Range Test (DMRT) as modified by Kramer (1957).

Results

Data on performance indices are summarized in Tables 3 to 7. Mean body weight gains at different intervals in different experimental groups are given in Table 3. The results showed that cumulative body weight gain at 4 weeks of age was at its lowest in the control group (305.6 g) and its highest in the T_1 group (321.9 g), whereas at 8 weeks of age, it was at its lowest in the T_1 (496.5 g) and its highest in the T_2 (530.5 g) groups. At 12 weeks of age, it was again at its lowest in the T_1 (411.3 g) and its highest in the T_3 group (429.00 g). Overall gain was significantly higher (3.8%) and at its maximum in the T_3 group (1266.20 g) and minimum in the control group (1220.00 g).

Means of feed consumption measured at different intervals in different experimental groups are given in Table 4. The results showed that cumulative feed intake at 4 weeks of age was minimum in the control group (490.1 g) and maximum in the T_3 group (578.4 g), whereas it was minimum in T_0 (1,272.3 g) and maximum in T_2 (1,409.3 g) and T_3 (1,409.9 g) at 8 weeks of age. At 12 weeks, feed consumption was again minimum in T_2 (1,941.0 g) and maximum in T_1 (2,022.2 g) and T_3 (2,020.5 g).

Table 5 shows cumulative FCR at 4 weeks of age to be minimum in the control group (1.60) and maximum in the T_3 group (1.76), whereas it was minimum in T_0 (2.54) and maximum in T_1 (2.77) and T_3 (2.68) at 8 weeks of age. At 12 weeks of age, FCR was again minimum in the T_2 (4.78) and T_3 (4.71) and maximum in the T_0 (4.80) and T_1 (4.92) groups. The overall results revealed significant increases in the FCR of treated groups as compared to the control, indicating that feeding NLP to birds of treated groups has decreased their residual feed efficiency.

As Table 6 shows, the dressed yield without giblets of the guinea fowl were found to be significantly affected

Table 3: Body weight gains of guinea fowl (Mean±SE) in different treatment groups (g/bird/week)

Period	Age (wk.)	Dietary treatments			
		T_0	T_1	T_2	T_3
Starter (1-4 weeks)	1	43.7 ± 0.07[a]	42.7 ± 0.07[b]	41.3 ± 0.12[c]	43.7 ± 0.13[a]
	2	63.3 ± 0.20[b]	63.9 ± 0.20[a]	60.9 ± 0.16[c]	60.9 ± 0.17[c]
	3	79.3 ± 0.08[d]	84.7 ± 0.12[c]	92.4 ± 0.07[a]	87.4 ± 0.15[b]
	4	119.3 ± 0.14[c]	130.6 ± 0.13[a]	118.9 ± 0.13[d]	119.6 ± 0.15[b]
	CWBG[A]	305.6 ± 0.15[d]	321.9 ± 0.13[a]	313.5 ± 0.12[b]	311.6 ± 0.14[c]
Grower (5-8 weeks)	5	115.9 ± 0.16[d]	128.6 ± 0.16[c]	136.4 ± 0.14[b]	144.7 ± 0.10[a]
	6	149.2 ± 0.08[a]	115.6 ± 0.11[d]	120.5 ± 0.14[c]	129.8 ± 0.14[b]
	7	116.9 ±0.15[c]	138.6 ± 0.11[b]	140.0 ± 0.15[a]	116.5 ± 0.13[d]
	8	119.2 ± 0.13[c]	113.7 ± 0.12[d]	133.6 ± 0.18[b]	134.6 ± 0.21[a]
	CWBG[A]	501.2 ± 0.16[c]	496.5 ± 0.12[d]	530.5 ± 0.14[a]	525.6 ± 0.13[b]
Finisher (9-12 weeks)	9	122.5 ± 0.55[c]	116.5 ± 0.15[d]	127.8 ± 0.14[b]	130.7 ± 0.13[a]
	10	123.7 ± 0.19[a]	105.5 ± 0.15[c]	94.7 ± 0.14[d]	110.7 ± 0.14[b]
	11	79.2 ± 0.17[c]	86.1 ± 0.10[b]	75.1 ± 0.11[d]	103.0 ± 0.14[a]
	12	87.8 ± 0.18[c]	103.2 ± 0.09[b]	108.2 ± 0.09[a]	84.6 ± 0.12[d]
	CWBG[A]	413.2 ± 0.23[b]	411.3 ± 0.14[c]	405.8 ± 0.11[d]	429.0 ± 0.14[a]
Overall	CWBG[B]	1220.0 ± 0.17[d]	1229.7 ± 0.17[c]	1249.8 ± 0.16[b]	1266.2 ± 0.12[a]

T_0: Control (0 g NLP/kg feed), T_1: (1 g NLP/kg feed), T_2: (2 g NLP/kg feed), and T_3: (3 g NLP/kg feed). Means within rows with different superscript differ significantly (P<0.05). [A] Cumulative body weight gain for the previous 4-wk study period. [B] Cumulative body weight gain for the 12-wk study period

Table 4: Feed intake of guinea fowl (Mean±SE) in different treatment groups (g/bird/week)

Period	Age (wk.)	Dietary treatments			
		T_0	T_1	T_2	T_3
Starter (1-4 weeks)	1	45.8 ± 0.19[d]	62.1 ± 0.69[c]	63.7 ± 0.82[b]	64.9 ± 1.09[a]
	2	96.2 ± 0.24[d]	107.3 ± 0.88[c]	108.1 ± 1.34[b]	108.6 ± 1.32[a]
	3	140.5 ± 1.21[d]	174.9 ± 0.96[a]	164.3 ± 1.69[b]	164.2 ± 1.87[c]
	4	207.6 ± 1.19[d]	221.2 ± 1.22[c]	234.6 ± 0.97[b]	240.7 ± 2.10[a]
	TFC[A]	490.1 ± 3.12[d]	565.5 ± 2.82[c]	570.7 ± 2.89[b]	578.4 ± 4.21[a]
Grower (5-8 weeks)	5	216.8 ± 2.11[d]	287.6 ± 0.98[b]	278.7 ± 1.11[c]	347.3 ± 1.53[a]
	6	335.8 ± 1.82[a]	311.4 ± 1.15[c]	297.0 ± 1.39[d]	320.8 ± 1.34[b]
	7	333.8 ± 1.38[d]	385.1 ± 1.91[b]	407.9 ± 1.69[a]	342.1 ± 1.77[c]
	8	385.9 ± 1.57[d]	392.2 ± 1.67[c]	425.8 ± 1.58[a]	399.7 ± 2.13[b]
	TFC[A]	1,272.3 ± 5.73[d]	1,376.3 ± 3.56[c]	1,409.3 ± 4.33[b]	1,409.9 ± 6.74[a]
Finisher (9-12 weeks)	9	456.2 ± 2.36[c]	469.9 ± 2.25[b]	445.7 ± 1.93[d]	476.4 ± 2.87[a]
	10	479.1 ± 2.82[a]	456.5 ± 1.98[b]	441.3 ± 2.09[d]	451.2 ± 1.73[c]
	11	495.6 ± 2.69[c]	510.8 ± 2.72[b]	461.7 ± 2.18[d]	542.5 ± 2.37[a]
	12	552.1 ± 3.11[c]	585.0 ± 2.19[b]	592.3 ± 3.27[a]	550.4 ± 2.25[d]
	TFC[A]	1,983.0 ± 5.95[c]	2,022.2 ± 4.75[a]	1,941.0 ± 4.83[d]	2020.5 ± 6.96[b]
Overall	TFC[B]	3,745.4 ± 14.75[d]	3,964 ± 12.21[b]	3921.0 ± 13.39[c]	4008.8 ± 15.74[a]

T_0: Control (0 g NLP/kg feed), T_1: (1 g NLP/kg feed), T_2: (2 g NLP/kg feed), and T_3: (3 g NLP/kg feed). Means within rows with no common superscript differ significantly (P<0.05). [A] Total feed consumption for the previous 4-wk study period. [B] Total feed consumption for the 16-wk study period

Table 5: Feed conversion ratio (FCR) (Mean±SE) of guinea fowl in different treatment groups

Period	Age (wk.)	Dietary treatments			
		T_0	T_1	T_2	T_3
Starter (1-4 weeks)	1	1.05 ± 0.02[d]	1.45 ± 0.01[c]	1.54 ± 0.03[a]	1.48 ± 0.02[b]
	2	1.52 ± 0.01[d]	1.68 ± 0.02[c]	1.77 ± 0.00[b]	1.78 ± 0.02[a]
	3	1.77 ± 0.01[d]	2.06 ± 0.03[a]	1.78 ± 0.02[c]	1.89 ± 0.06[b]
	4	1.74 ± 0.00[c]	1.69 ± 0.01[d]	1.97 ± 0.00[b]	2.01 ± 0.01[a]
	AFCR[A]	1.60 ± 0.04[d]	1.76 ± 0.03[c]	1.82 ± 0.03[b]	1.86 ± 0.02[a]
Grower (5-8 weeks)	5	1.87 ± 0.02[d]	2.24 ± 0.04[b]	2.04 ± 0.02[c]	2.40 ± 0.01[a]
	6	2.25 ± 0.01[d]	2.69 ± 0.03[a]	2.46 ± 0.00[c]	2.47 ± 0.02[b]
	7	2.86 ± 0.02[c]	2.78 ± 0.01[d]	2.91 ± 0.04[b]	2.94 ± 0.03[a]
	8	3.24 ± 0.01[b]	3.45 ± 0.03[a]	3.19 ± 0.03[c]	2.97 ± 0.02[d]
	AFCR[A]	2.54 ± 0.03[d]	2.77 ± 0.05[a]	2.66 ± 0.03[c]	2.68 ± 0.01[b]
Finisher (9-12 weeks)	9	3.72 ± 0.01[b]	4.03 ± 0.06[a]	3.49 ± 0.00[d]	3.64 ± 0.01[c]
	10	3.87 ± 0.02[d]	4.33 ± 0.04[b]	4.66 ± 0.02[a]	4.08 ± 0.06[c]
	11	6.26 ± 0.01[a]	5.93 ± 0.00[c]	6.15 ± 0.03[b]	5.27 ± 0.02[d]
	12	6.29 ± 0.03[b]	5.67 ± 0.00[c]	5.47 ± 0.02[c]	6.51 ± 0.00[a]
	AFCR[A]	4.80 ± 0.01[b]	4.92 ± 0.04[a]	4.78 ± 0.00[c]	4.71 ± 0.01[d]
Overall	AFCR[B]	3.07 ± 0.03[d]	3.22 ± 0.02[a]	3.14 ± 0.01[c]	3.17 ± 0.03[b]

T_0: Control (0 g NLP/kg feed), T_1: (1 g NLP/kg feed), T_2: (2 g NLP/kg feed), and T_3: (3 g NLP/kg feed). Means within rows with no common superscript differ (P<0.05). Average feed conversion ratio for the previous 4-wk study period. Average feed conversion ratio for the 16-wk study period

Table 7: Effect of Neem leaf powder (NLP) on cut up parts (% live weight) (Mean±SE) in guinea fowl

Treatments	Cut up parts					
	Thigh	Breast	Drumstick	Back	Neck	Wing
T_0	11.90 ± 0.01^d	23.14 ± 0.02^d	9.63 ± 0.00^d	13.99 ± 0.01^d	4.81 ± 0.02^c	9.64 ± 0.01^b
T_1	12.04 ± 0.00^c	23.30 ± 0.00^c	9.75 ± 0.01^c	14.05 ± 0.00^c	4.81 ± 0.00^c	9.71 ± 0.02^a
T_2	13.40 ± 0.02^b	24.01 ± 0.01^b	9.81 ± 0.00^b	14.29 ± 0.01^b	4.85 ± 0.01^b	9.65 ± 0.00^b
T_3	13.61 ± 0.01^a	24.60 ± 0.00^a	9.87 ± 0.02^a	14.61 ± 0.03^a	4.89 ± 0.01^a	9.70 ± 0.01^a

Values with different superscripts column wise differ significantly (P<0.05)

Table 6: Effect of Neem leaf powder (NLP) on carcass yield (% live weight) in guinea fowl (Mean±SE)

Treatments	Carcass yield	
	Dressed yield without giblet	Dressed yield with giblet
T_0	71.55 ± 0.01^d	76.78 ± 0.03^d
T_1	72.66 ± 0.01^c	77.40 ± 0.02^c
T_2	73.01 ± 0.02^b	77.90 ± 0.01^b
T_3	73.92 ± 0.01^a	78.57 ± 0.01^a

Values with different superscripts column-wise differ significantly (P<0.05)

by NLP supplementation with a maximum yield of 73.92% in T_4 and a minimum yield of 71.55% in the control (P<0.05).

Similarly, the dressed yield with giblets revealed a significant impact of NLP on guinea fowl with the highest value of 78.57% in T_4 and the lowest value of 76.78% in the control group (P<0.05).

Improved dressed yield caused by NLP supplementation could be attributed to the extra muscle mass in the birds.

Results regarding the effect of NLP supplementation on cut-up parts including thighs, breasts, drumsticks, backs, necks and wings are presented in Table 7.

The overall means for thighs and breasts revealed a significant impact of NLP supplementation on cut-up parts (P<0.05). The mean values were 11.90, 12.04, 13.40 and 13.61 percent for thighs and 23.14, 23.30, 24.01 and 24.60 percent for breasts in T_0, T_1, T_2 and T_3, respectively.

The means for drumsticks were found to be 9.63, 9.75, 9.81 and 9.87 percent of the live weight for the T_0, T_1, T_2 and T_3 groups. Mean values were 13.99, 14.05, 14.29 and 14.61 percent for backs, 4.81, 4.81, 4.85 and 4.89 percent for necks and 9.64, 9.71, 9.65 and 9.70 percent for wings for the T_0, T_1, T_2 and T_3 groups, respectively.

The results of the present investigation revealed a significant effect of NLP supplementation on drumstick, back, neck and wing weights of guinea fowl (P<0.05).

Discussion

The higher body weight gains observed in the treated groups in the present study are attributable to the beneficial effects of NLP, possibly due to the better utilization of nutrients. The gains observed in mean body weights in the present study were similar to the findings of Padalwar (1994), Jaykumar *et al*. (2002), Durrani *et al*. (2005), Manwar *et al*. (2005), Ansari *et al*. (2008), and Wankar *et al*. (2009), who reported increased body weights in treated groups of broilers and rats compared to control groups. Contrary to our results, Nidaullah *et al*. (2010) found that weight gain varied insignificantly in groups of broilers treated with aqueous extracts of certain medicinal herbs (garlic bulb, ginger rhizomes, Neem leaves and berberry root barks).

In the present study, overall feed intake was found to be significantly higher (7.0%) and at its maximum in the T_3 group (4,008.8 g), but at its minimum of 3,745.4 g in the control group. This indicates the beneficial effect of NLP on feed intake, possibly due to the hypoglycemic activity of Neem as a biguanide like action resulting in increased cellular uptake and the utilization of glucose (Jayakumar *et al*., 2002). Different from our findings, Nemade *et al*. (1993) reported non-significant increases in feed consumption in the Neem fed groups. Similarly, Nidaullah *et al*. (2010) observed feed intake to be non-significantly varied in groups of broilers treated with aqueous extracts of medicinal herbs.

The results obtained for FCR in the present study were in agreement with those of Nemade *et al*. (1993) who reported an increase in feed efficiency of Neem fed groups. Ansari *et al*. (2008) observed that the FCR of broilers fed with *Azadirachta indica* (Neem) significantly improved compared to other treatments (P≤0.05). However, contrary to our results, Wankar *et al*. (2009) and Nidaullah *et al*. (2010) found that feed efficiency insignificantly improved by dietary NLP supplementation in broilers.

Counter to the results of the present study, Elangovan *et al*. (2000) reported that feeding a diet containing Neem kernel meal to growing Japanese quails did not cause any significant change in carcass characteristics and organoleptic tests for meat. Esonu *et al*. (2007) reported that feeding 5 and 10 percent Neem leaf meal did not show any substantial difference in carcass weight as birds tolerated 5-15 percent Neem leaf meal dietary levels without deleterious effects. In accordance with the present study, Kaushal (2012) reported higher dressing yields in NLP fed Japanese quails. Similarly, Odunsi *et al*. (2009) reported increases in drumstick and back part weights of cockerels fed with a diet including soaked Neem seed cake. In disagreement with the present findings, Kaushal (2012) reported an insignificant effect of NLP supplementation on drumstick, back, neck and wing weights of Japanese quails.

The results of the present study indicated that the supplementation of NLP significantly improved body weight gain, FCR and dressed yield in treated groups, demonstrating the beneficial effect of NLP through improved feed efficiency and more edible yield. It is suggested, therefore that NLP be used as a feed supplement in guinea fowl to obtain higher profitability.

Acknowledgements

Authors are thankful to the Director of the Experiment Station, G. B. Pant University of Agriculture and Technology, Pantnagar and the Dean of the College of Veterinary and Animal Sciences, Pantnagar for providing necessary facilities to conduct the experiment. Assistance provided by the Department of Livestock Products Technology of G. B. Pant University of Agricultural and Technology for this work is also thankfully acknowledged.

References

Ansari, JZ; Haq, A; Yousa, M; Ahmad, T and Khan, S (2008). Evaluation of different medicinal plants as growth promoters for broiler chicks. Sarhad J. Agri., 24: 323-329.

Deepak, G; Jogi, S; Kumar, A; Bais, R and Vikas, KS (2002). Effect of herbal liver stimulants on efficacy of feed utilization in commercial broiler chicken. Ind. J. Anim. Res., 36: 43-45.

Durrani, FR; Chand, N; Jan, M; Sultan, A; Durrani, Z and Akhtar, S (2005). Immunomodulatory and growth promoting effects of Neem leaves infusion in broiler chicks. Sarhad J. Agri., 24: 655-659.

Elangovan, AV; Verma, SVS; Sastry, VRB and Singh, SD (2000). Effect of feeding Neem (*Azadirachta indica*) kernel meal on growth, nutrient utilization and physiology of Japanese quails (*Coturnix cotrnix japonica*). Asian Aust. J. Anim. Sci., 13: 1272-1277.

Jayakumar, K; Srinivasan, MR; Ramesh, N; Sachan, A; Umesh, MH; Honnegowda and Narayana, K (2002). Effect of Neem leaf extract on feed intake and body weights in rats. Indian Vet. J., 79: 735-736.

Kaur, G; Alam, MS and Athar, M (2004). Nimbidin suppresses functions of macrophages and neutrophils: relevance to its antiinflammatory mechanisms. Phytotherapy Res., 18: 419-424.

Kaushal, S (2012). Effect of Neem (*Azadirachta indica*) leaf powder supplementation on production performance, haemato-biochemical and immunological parameters in Japanese quails. Thesis, MVSc. G. B. Pant University of Agriculture and Technology.

Khosla, P; Bhanwara, S; Sing, J; Sethi, S and Srivastava, RK (2000). A study of hypoglycaemic effects of *Azadirachta indica* (Neem) in normaland alloxan diabetic rabbits. Indian J. Physiol. Pharmacol., 44: 69-74.

Koul, A; Ghara, AR and Gangar, SC (2006). Chemomodulatory effects of *Azadirachta indica* on the hepatic status of skin tumor bearing mice. J. Int. Sci., 20: 169-177.

Koul, O; Isman, MB and Ketkar, CM (1990). Properties and uses of Neem (*Azadirachta indica*). Can. J. Bot., 68: 1-11.

Kramer, CY (1957). Extension of multiple range tests to group correlated adjusted means. Biometrics. 13: 13-17.

Nemade, PP and Kukde, RJ (1993). Effect of Neem leaf extract on broiler performance. Indian Poult. Rev., 24: 30-32.

Nidaullah, H; Durrani, FR; Ahmad, S; Jan, IU and Gul, S (2010). Aqueous extract from different medicinal plants as anticoccidial, growth promotive and immunostimulant in broilers. ARPN J. Agric. Bio. Sci., 5: 153-159.

NRC (1992). *Neem: a tree for solving global problems*. Washington, D.C., National Academic Press.

Odunsi, AA; Adegbile, SA; Akande, TO and Olayeni, TB (2009). Neem (*Azadirachta indica*) seed cake in the diet of cockerel chickens. Int. J. Poult. Sci., 8: 47-51.

Rama Rao, SV and Rajkumar, U (2011). Current status and prospectus of poultry production in India. In: International Symposium of Indian Poultry Science Association, (IPSACON-2011). Bihar Veterinary College. PP: 200-204.

Singh, RP (2012). Present status and prospects of egg and poultry processing in India. In: 29th Annual Conference and National Symposium of Indian Poultry Science Association (IPSACON 2012). Project Directorate on Poultry & Sri Venkateswara Veterinary University Rajendranagar, Hyderabad, India. PP: 111-115.

Subapriya, R and Nagini, S (2005). Medicinal properties of Neem leaves: a review. Curr. Med. Chem. Anticancer Agents. 5: 149-156.

Toghyani, M; Toghyani, M; Gheisari, AA; Ghalamkari, GH and Mohammadrezaei, M (2010). Growth performance, serum biochemistry, and blood hematology of broiler chicks fed different levels of black seed (*Nigella sativa*) and peppermint (*Mentha piperita*). Livest. Sci., 129: 173-178.

Wankar, AK; Shirbhate, RN; Bahiram, KB; Dhenge, SA and Jasutkar, RA (2009). Effect of Neem (*Azadirachta indica*) leaf powder supplementation on growth in broilers. Vet. World. 2: 396-397.