Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(6): 478-482

Received: 08-07-2020
Accepted: 19-08-2020

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Effect of dietary supplementation of herbal feed additives (black cumin, garlic and turmeric) in combination with linseed oil on production performance of white leghorn laying chickens

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Abstract
The study was carried out to discern the effects of dietary incorporation of black cumin (*Nigella sativa*), garlic (*Allium sativum*), and turmeric (*Curcuma longa*) in combination with linseed oil on production performance in White Leghorn laying hens. A feeding trial of 12 weeks duration was conducted on 28 week old 120 hens. Hens were randomly distributed into four treatment groups with 30 hens per treatment having three replicates in each. Four treatments includes control (T_1): basal diet; Treatment 2 (T_2): incorporation of 1% herbal feed additives (black cumin, garlic and turmeric powder; 1:1:1 ratio) and 1.5% linseed oil in basal diet; Treatment 3 (T_3): incorporation of 1% herbal feed additives (as in T_2) and 2% linseed oil in basal diet and Treatment 4 (T_4): incorporation of 1% herbal feed additives (as in T_2) and 2.5% linseed oil in basal diet. Results showed significant ($P< 0.05$) increase on egg production (71.53%), feed intake (113.32 g) and egg weight (57.64 g) in T_2 group compared to T_3 and T_4 groups in laying chickens. There was no significant effect on FCR and body weight gain among treatment groups. From the results it can be concluded that dietary supplementation of 1% feed additive mixture of black cumin, garlic and turmeric powder in equal proportion in combination with 1.5% linseed oil in basal diet ameliorate egg production, feed intake and egg weight and is cost effective for improving production performance in White Leghorn laying chickens.

Keywords: Egg production, white leghorn layers, linseed oil, black cumin, garlic, turmeric

1. Introduction
Poultry production has emerged as the most dynamic, quickest growing and profitable segment within the animal husbandry sector in India. India accounts for about 5.65 percent of global egg production, 3rd in world total egg production (95.2 billion). However, per capita availability of eggs is 74 eggs/year, which is much lesser than the ICMR recommendation of 182 eggs/year. Therefore, there is a huge scope for the development of poultry industries in India. Black cumin (*Nigella sativa)* seeds having anti-bacterial properties [1], analgesic, antioxidant, antidiabetic, antiparasitic, and appetite stimulant properties [2], as well as presence of several bioactive molecules like thymoquinone, thymol, thymohydroquinone, nigellicine and nigelledine [3]. Feeding of black cumin seeds has been shown to increase egg production in laying hens [4]. Garlic (*Allium sativum)* has antibacterial, antifungal, antiparasitic, hypocholesterolemic and antioxidant activities as it have alliin, ajoene, allicin, diallyl polysulfides, s-allylcysteine and di-allylsulfide [5]. Turmeric *(Curcuma longa)* rhizome powder has antioxidant, antibacterial, anti-inflammatory, antihypertensive, and hypocholesterolemic properties [6]. Linseed oil contains palmitic acid (6.0%), stearic acid (2.5%), arachidonic acid (0.5%), oleic acid (19.0%), linoleic acid (24.1%), alpha-linolenic acid (47.4%), and other (0.5%). Flaxseed is one of the most concentrated PUFA sources available for poultry in natural feedstuff, because it contains high levels of linolenic acid [7]. Thus realizing the importance of herbal feed additive mixture (black cumin, garlic and turmeric) in combination with linseed oil, the present research study was carried out to study the effect of dietary supplementation of black cumin, garlic and turmeric in combination with linseed oil on egg production, feed intake, FCR, body weight gain and economics of egg production in laying chickens.

2. Materials and Methods

The experiment was carried out on 120 White Leghorn laying hens at Instructional Poultry Farm of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar. All the birds were individually weighed and randomly allocated in four treatments groups of three replicates having 10 birds in each.

2.1 Experimental design and treatments

Feeding trial of 12 weeks duration was conducted where laying hens were randomly distributed into four treatments groups with 30 hens per treatment having three replicates in each. Four treatments includes control (T_1): basal diet; Treatment 2 (T_2): incorporation of 1% herbal feed additives (black cumin, garlic and turmeric powder; 1:1:1 ratio) and 1.5% linseed oil in basal diet; Treatment 3 (T_3): incorporation of 1% herbal feed additives (black cumin, garlic and turmeric powder; 1:1:1 ratio) and 2% linseed oil in basal diet and Treatment 4 (T_4): incorporation of 1% herbal feed additives (black cumin, garlic and turmeric powder; 1:1:1 ratio) and 2.5% linseed oil in basal diet. The experiment was conducted strictly in accordance with the guidelines of 'Institutional Animal Ethics Committee (IAEC)', GBPUAT, Pantnagar, India.

2.2 Housing and Management

Layer birds were reared in California battery cages fitted with feeder and waterers. Lighting was provided for 18 hours. Experimental diets and fresh water were given *ad libitum* throughout the experimental period. Proper ventilation free from dust was maintained throughout the experimental feeding trial. The birds were weighed individually before allocating to each treatment groups. The management conditions were similar for different treatment groups. Weekly feed intake, weekly egg weight, feed conversion ratio, and daily egg production was recorded.

2.3 Experimental diet

Ingredient of basal diets used for experimental White Leghorn laying hens are presented in Table 1 as per BIS (2007) specification and proximate analysis were performed as per standard methods.

Table 1: Composition of basal layer diet (kg/100kg)

Ingredients	Amounts
Maize	50 kg
De-oiled rice bran	09 kg
Rice polish	4.5 kg
G.N.C	09 kg
Soybean meal	18 kg
Marble Powder	03 kg
Common Salt	400 gm
Marble Chips	4.5 kg
Choline Chloride	100 gm
DL Methionine	150 gm
Trace Min. mix.	100 gm
Vitamin BV 250	100 gm
Hepatocare	100 gm
DCP	01 kg
Toxin binder	50 gm
Total	100 kg

2.4 Production parameters

2.4.1 Egg production

Daily egg production was recorded treatment group and replicate wise for the period of 12 weeks. The egg production percentage for every treatment groups was calculated replicate wise in three phase. Eggs were collected twice a day in the morning and in the evening.

$$\text{Egg Production}(\%) = \frac{\text{Total No. of egg produce per replicate}}{\text{Total No. of hen per replicate} \times \text{Total No. of days}} \times 100$$

2.4.2 Feed intake

Daily record of feed given to different groups was maintained. Left over feed was weighed and recorded weekly. The feed intake in different groups was calculated by subtracting the weight of left-over feed from the weight of total feed offered in every week, during the experimental feeding period.

2.4.3 Egg weight

Individual egg weight was measured by using an electronic balance. Average egg weight from each replicate was calculated and recorded.

2.4.4 Feed conversion ratio (FCR)

FCR is feed consumed by hens against dozen eggs produced by the hens. Higher the ratio, lower the efficiency with which the feed is converted to the eggs. It was calculated weekly.

$$\text{Feed conversion ratio} = \frac{\text{Feed consumed in Kg}}{\text{Dozen eggs}}$$

2.4.5 Body weight gain

Body weight of individual bird from each treatment group was recorded at the beginning of trial period and final body weight was recorded at the end of trial period. The average body weight gain of each treatment group was recorded.

2.5 Economics of egg production

The cost of feed was calculated considering the actual purchase prices of the feed ingredients and feed additives used in the preparation of the experimental feed. The average dozen egg production was calculated as per the observation recorded in daily basis. The economics of the dozen egg production was worked out by calculating the cost of total feed consumed divided by dozen egg production as given below.

$$\text{Feed cost/dozen egg production (Rs.)} = \frac{\text{Feed consumed in Kg} \times \text{Feed cost (Rs./kg)}}{\text{Dozen egg production}}$$

2.6 Statistical methods

The experimental data obtained in this study were analysed statistically described by Snedecor and Cochran, 1994 by using general linear model procedure SPSS package [8]. Difference between treatments means were compared using Duncan's Multiple Range Test by Kramer, 1957 [9].

3. Results and Discussion

3.1 Phase 1 (28-32 weeks)

The average egg production, feed intake and feed conversion ratio in White Leghorn laying chicken during phase 1 of feeding trial are presented in Table 2. The layers did not showed any significant (P>0.05) difference on average egg production. The average daily feed intake was significantly ($P< 0.05$) higher in treatment group T_2 (112.20 g) compared

to other treatment groups T_1 (104.75g), T_3 (102.4 g) and T_4 (101.28 g). The average FCR (kg feed/ dozen eggs) did not show any significant (P>0.05) difference among treatment groups.

3.2 Phase 2 (32-36 weeks)

The average egg production, feed intake and feed conversion ratio in White Leghorn laying chicken during phase 2 of feeding trial are presented in Table 3. Significantly (P<0.05) higher egg production was observed in T_2 group (75.20%) compared to T_4 (62.00%) group among the treatment groups of dietary supplementation of black cumin, garlic, turmeric and linseed oil. The average feed intake was significantly (*P*< 0.05) improved in T_2 (114.50 g) group compared with T_3 (102.95 g) and T_4 (102.25 g) groups. The average FCR (kg feed/ dozen eggs) did not differ significantly (P>0.05) among different treatments groups.

3.3 Phase 3 (36-40 weeks)

The average egg production, feed intake and feed conversion ratio in White Leghorn layers during phase 3 of feeding trial are presented in Table 4. The average egg production did not show any significant difference among different treatment groups. The average feed intake was significantly (P<0.05) higher in T_2 (113.26 g) group, compared to T_1 (107.34), T_3 (104.66 g) and T_4 (103.61 g). The average FCR (kg feed/dozen eggs) did not differ significantly among treatment groups.

Table 2: Average production performance of White Leghorn layers from 28-32 weeks (phase 1) fed diet supplemented with black cumin, garlic and turmeric mixture in combination with linseed oil

Parameters	Treatments/Groups				SE_m	P-value	CD at 5%
	T1	T2	T3	T4			
Egg production (%)	55.52 ± 3.16	62.88 ± 1.06	54.85 ± 4.52	50.21 ± 2.06	2.99	0.092	ns
Feed intake* (gm)	104.75^{a} ± 1.69	112.20^{b} ± 2.38	102.40^{a} ± 1.74	101.28^{a} ± 0.48	1.72	0.008	5.61
FCR (kg feed/ dozen eggs)	2.27 ± 0.097	2.14 ± 0.028	2.26 ± 0.137	2.42 ± 0.086	0.096	0.287	ns

^{a,b} Mean values bearing different superscripts within a row differ significantly from each other, $^{*}P$< 0.05

Table 3: Average production performances of White Leghorn layers from 32-36 weeks (phase 2) fed diet supplemented with black cumin, garlic and turmeric mixture in combination with linseed oil

Parameters	Treatments/Groups				SE_m	P-value	CD at 5%
	T1	T2	T3	T4			
Egg production* (%)	68.04^{ab} ± 1.50	75.20^{b} ± 2.41	66.99^{ab} ± 3.00	62.00^{a} ± 2.89	2.52	0.037	8.24
Feed intake* (gm)	107.24^{ab} ± 2.09	114.50^{b} ± 3.64	102.95^{a} ±0.97	102.25^{a} ± 1.67	2.31	0.020	7.55
FCR (kg feed/ dozen eggs)	1.89 ± 0.005	1.82 ± 0.002	1.85 ± 0.067	1.98 ± 0.060	0.04	0.148	ns

^{a,b} Mean values bearing different superscripts within a row differ significantly from each other, $^{*}P$< 0.05

Table 4: Average production performances of White Leghorn layers from 36-40 weeks (phase 3) fed diet supplemented with black cumin, garlic and turmeric mixture in combination with linseed oil

Parameters	Treatments/Groups				SE_m	P-value	CD at 5%
	T1	T2	T3	T4			
Egg production (%)	70.63 ± 1.88	76.52 ± 3.24	70.80 ± 3.15	65.09 ± 1.91	2.63	0.086	ns
Feed intake* (gm)	107.34^{a} ± 1.85	113.26^{b} ± 2.21	104.66^{a} ± 1.28	103.61^{a} ± 1.66	1.78	0.021	5.83
FCR(kg feed/ dozen eggs)	1.82 ± 0.017	1.78 ± 0.043	1.77 ± 0.057	1.91 ± 0.025	0.04	0.131	ns

^{a,b} Mean values bearing different superscripts within a row differ significantly from each other, $^{*}P$< 0.05

3.4 Overall period (28-40 weeks)

The overall average production performance of White Leghorn layers in terms of egg production, feed intake, feed conversion ratio, egg weight and body weight gain of different groups during 28-40 weeks of feeding trial are presented in Table 5. Egg production was Significantly (*P*< 0.05) higher in the layers of T_2 group (71.53%) compared to T_4 (59.10%) group. Significantly (*P*< 0.05) higher feed intake was observed in T_2 (113.32 g) group compared to T_1 (106.44 g), T_3 (103.34 g) and T_4 (102.38 g) groups. Similarly, significant (P<0.05) higher egg weight was observed in T_2 (57.64 g) group compared to other treatment groups. The average FCR (kg feed/dozen eggs and kg feed/kg eggs) for overall period did not differ significantly among treatment groups. The average body weight gain for overall trial period was 1.45, 1.86, 1.89 and 1.51 g/day/hen of the treatment T_1, T_2, T_3 and T_4, respectively and did not differ significantly among different treatment groups.

The results showed that dietary supplementation of the herbal feed additive mixture of black cumin, garlic, turmeric (1:1:1 ratio) at the rate of 1% and linseed oil at the rate of 1.5% (T_2) has significantly improved the production percentage in terms of egg production and egg weight. Also, it was observed that with the increasing level of linseed oil percentage, the production performance decreased gradually. These results are in agreement with the findings of Singh (2016) who reported that the combined effect of black cumin, garlic, and turmeric at 1% on production performance that is in terms of egg production percentage and egg weight [10]. These results are in corroboration with the findings of Yalcin *et al.* (2012) and Hassan and Alaqil (2014) who reported significant effect of black cumin supplementation on egg production and egg weight in laying hens [11, 12]. Chongtham *et al.* (2015) and Hossain *et al* (2016) reported no significant effect on feed conversion ratio in laying hens [13, 14]. Significant effect on egg production due to garlic powder supplementation has been reported by Aswal *et al.* (2017) and Omer *et al.* (2019) [15, 16]. Canogullari *et al.* (2010) and Aswal *et al.* (2017) reported significant effect on feed intake due to garlic supplementation in layer ration [17, 15]. The results of body weight gain are in agreement with the findings of Asrat *et al.* (2018), and Ayed *et al.* (2018) who reported no significant effect of garlic supplementation on body weight gain in laying hens [18, 19]. Phuoc *et al.* (2019) reported that supplementation of turmeric

powder in the layer ration has significant effect on egg production which is in agreement to the findings of present study [20]. These results are in corroboration with the findings of Promila *et al.* (2016) who reported that dietary supplementation of linseed oil had significant ($P< 0.05$) effect on egg production and average egg weight in White Leghorn layers [21].

3.5 Economics of egg production

The average values of economics of egg production in terms of feed cost per kg egg mass from 28-40 weeks of feeding trial fed diet supplemented with black cumin, garlic, turmeric powder mixture in combination with linseed oil are presented in Table 6. Significantly ($P< 0.05$) higher average dozen egg production was recorded in T_2 (5.00) followed by T_1 (4.53) and T_3 (4.49) whereas lowest average dozen egg production was recorded in T_4 (4.13). Average feed intake for treatment groups T_1, T_2, T_3 and T_4 was 8.94, 9.51, 8.68, 8.59 kg, respectively. Total feed cost also differed significantly ($P< 0.05$) among these groups. Significantly ($P< 0.05$) lower feed cost/ dozen egg was recorded in T_1 (69.13) followed by T_2 (75.11) and T_3 (78.51) and significantly ($P< 0.05$) highest feed cost/ dozen egg was recorded in T_4 (86.44).

Table 5: Average production performance of White Leghorn layers from 28-40 weeks (overall period) fed diet supplemented with black cumin, garlic and turmeric mixture in combination with linseed oil

Parameters	Treatments/Groups				SE_m	P-value	CD at 5%
	T1	T2	T3	T4			
Egg production* (%)	$64.73^{ab} \pm 2.16$	$71.53^{b} \pm 1.81$	$64.21^{ab} \pm 3.26$	$59.10^{a} \pm 2.27$	2.44	0.042	7.95
Feed intake* (gm/bird/day)	$106.44^{a} \pm 1.80$	$113.32^{b} \pm 2.35$	$103.34^{a} \pm 1.09$	$102.38^{a} \pm 1.23$	1.69	0.007	5.53
Egg weight* (gm)	$56.82^{b} \pm 0.26$	$57.64^{c} \pm 0.32$	$56.53^{ab} \pm 0.14$	$56.07^{a} \pm 0.03$	0.22	0.006	0.71
FCR (kg feed/ dozen eggs)	1.97 ± 0.033	1.90 ± 0.009	1.93 ± 0.074	2.08 ± 0.054	0.04	0.131	Ns
FCR (kg feed/ kg eggs)	2.89 ± 0.042	2.74 ± 0.024	2.85 ± 0.111	3.09 ± 0.082	0.07	0.055	Ns
Body weight gain (gm/ day)	1.45 ± 0.13	1.86 ± 0.12	1.89 ± 0.13	1.51 ± 0.08	0.11	0.058	Ns

[a,b,c] Mean values bearing different superscripts within a row differ significantly from each other, [*]$P< 0.05$

Table 6: Average values of economics of egg production (feed cost/ dozen egg) of White Leghorn layers from 28-40 weeks fed diet supplemented with black cumin, garlic and turmeric mixture in combination with linseed oil

Parameters	Treatments/Groups				SE_m	P-value	CD at 5%
	T1	T2	T3	T4			
Average dozen egg*	$4.53^{ab} \pm 0.15$	$5.00^{b} \pm 0.12$	$4.49^{ab} \pm 0.39$	$4.13^{a} \pm 0.16$	0.171	0.042	0.558
Average feed intake (kg)*	$8.94^{a} \pm 0.15$	$9.51^{b} \pm 0.19$	$8.68^{a} \pm 0.09$	$8.59^{a} \pm 0.10$	0.142	0.007	0.465
Total feed cost (Rs.)*	$312.94^{a} \pm 5.29$	$375.97^{c} \pm 6.94$	$351.50^{b} \pm 3.21$	$356.85^{bc} \pm 3.61$	4.992	0.001	16.282
Feed cost/ dozen egg (Rs.)*	$69.13^{a} \pm 1.16$	$75.11^{ab} \pm 0.53$	$78.51^{b} \pm 3.12$	$86.44^{c} \pm 2.42$	2.079	0.002	6.782

[a,b,c] Mean values bearing different superscripts within a row differ significantly from each other, [*]$P< 0.05$

4. Conclusion

From the results of the present study, it can be concluded that dietary supplementation of 1% herbal feed additive mixture of black cumin, garlic and turmeric powder in equal proportion in combination with 1.5% linseed oil in basal diet ameliorate egg production, feed intake and egg weight with lower FCR and is cost effective for improving production performance in White Leghorn laying chickens.

5. Acknowledgements

We gratefully acknowledge Govind Ballabh Pant University of Agriculture and Technology, Pantnagar for providing all the required facilities.

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