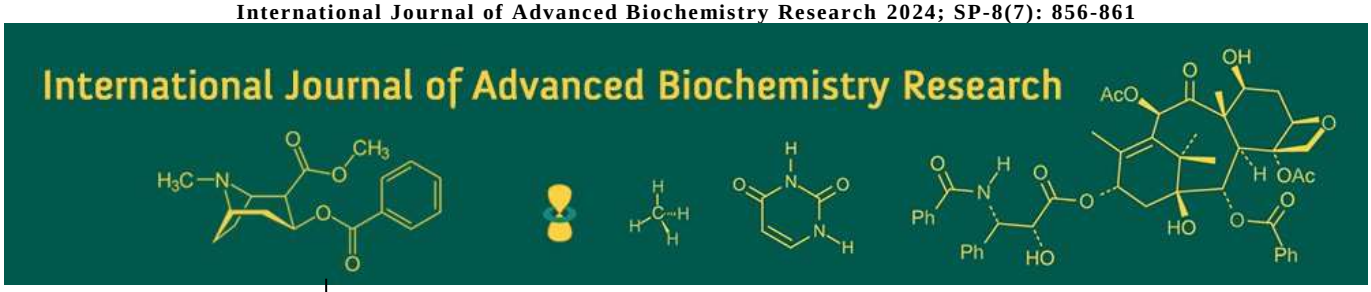

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; SP-8(7): 856-861
www.biochemjournal.com
Received: 17-06-2024
Accepted: 19-07-2024

AK Parade
Ph.D., Scholar, Department of Animal Husbandry and Dairy Science, PGI, MPKV, Rahuri, Ahmednagar, Maharashtra, India

DK Deokar
Senior Scientist, RCDP on Cattle, Department of Animal Husbandry and Dairy Science, MPKV, Rahuri, Ahmednagar, Maharashtra, India

PB Meshram
Ph.D., Scholar, Department of Animal Husbandry and Dairy Science, PGI, MPKV, Rahuri, Ahmednagar, Maharashtra, India

SB Adangle
Assistant Professor, Department of Animal Husbandry and Dairy Science, COA Karad, Maharashtra, India

DK Kambale
Head, Department of Animal Husbandry and Dairy Science, MPKV, Rahuri, Ahmednagar, Maharashtra, India

Corresponding Author:
AK Parade
Ph.D., Scholar, Department of Animal Husbandry and Dairy Science, PGI, MPKV, Rahuri, Ahmednagar, Maharashtra, India

Effect of addition of ginger (*Zingiber officinale*), and black cumin (*Nigella Sativa* L.) on feed conversion ratio of white leghorn layer

AK Parade, DK Deokar, PB Meshram, SB Adangle and DK Kambale

DOI: https://doi.org/10.33545/26174693.2024.v8.i7Sk.1660

Abstract
The experiment was conducted to study Effect of Addition of Ginger (*Zingiber officinale*), and Black Cumin (*Nigella Sativa L.*) on Growth Performance of White Leghorn Layer. A total one hundred fifty 28- week old 150 white leghorn laying hens were randomly divided into three replication and ten treatments, and fed a basal diet with T_0- Control I.G. 0% GP+0% BCP, T_1- 1% GP + 3% BCP, T_2-1% GP + 4% BCP, T_3-1% GP + 5% BCP, T_4-2% GP+ 3% BCP, T_5-2% GP+ 4% BCP, T_6-2% GP+ 5% BCP, T_7- 3% GP+ 3% BCP, T_8-3% GP+ 4% BCP and T_9-3% GP+ 5% BCP, respectively. The experiment lasted 70 days. While feed intake and feed conversion ratio (FCR) showed no significant differences between treatments, there were statistically significant variations in FCR across the groups. These findings suggest that ginger and black cumin supplementation at the tested levels may not significantly affect feed intake or overall efficiency in converting feed to production in White Leghorn layers. Further research might be needed to explore the potential benefits of these supplements on other aspects of laying hen performance or to determine optimal inclusion levels for improved FCR.

Keywords: Ginger root powder, black cumin seed powder, feed conversion ratio

Introduction
The Indian layer industry has tremendous scope for growth in the future. Egg production in Maharashtra is 59649 lakh number during 2018-19 and ranks seventh in India (5.77% of total egg production of 1033176 lakh number in India) next to AP (197545 lakh number), TN (188422 lakh number), Telangana (136868 lakh number), WB (85999 lakh number), Haryana (60577 lakh number) and Karnataka (59994 lakh number) as per statistics of Department of Animal Husbandry and Dairying, GOI, 2019. The higher demand of poultry products inspired many researchers to study the effects of various genetic, nutritional, environmental and managerial aspects to scale up egg production and to sustain high hen production. The modern layer strains have achieved great potential in egg production. This was possible due to the genetic improvement through selection and breeding of the commercial layers.

In the present modern life, people's life style and food habits are changed compared to previous generations and the consequences of these changes induced several lifestyle diseases (coronary heart disease, hypertension and diabetes, etc.). Also, in the current competitive world, people are prone to more stress which caused for free radical associated diseases (Sen and Chakraborty, 2011) [23]. The risk of diseases due to oxidative stress is also associated with unhealthy lifestyle, like exposure to chemicals, pollution, drugs, cigarette smoking, etc. Specially, in India, urbanization has been increased from 27.81 percent in 2001 to 31.16 percent in 2011 (Bhagat, 2011) [9]. This increased urbanization and industrialization had a strong impact on Indian lifestyles and diets and the nutritional status of the population. Moreover, in recent times, the work has become more technological, strenuous, involves limited physical activity and odd working hours (Ayyagari *et al.*, 2011) [8]. The lifestyle in India, particularly in urban areas is westernizing rapidly and has been associated to alarming increase in the incidence of lifestyle related health problems (Garg and Sharma, 2013) [17]. Moreover, in modern food habits, people are mostly consuming either deficient or imbalance diet. Specially, in India, urbanization has been increased from 27.81 percent in 2001 to 31.16 percent in 2011 (Bhagat, 2011) [9]. This increased urbanization and industrialization had a

strong impact on Indian lifestyles and diets and the nutritional status of the population. Moreover, in recent times, the work has become more technological, strenuous, involves limited physical activity and odd working hours (Ayyagari *et al*., 2011) [8]. The lifestyle in India, particularly in urban areas is westernizing rapidly and has been associated to alarming increase in the incidence of lifestyle related health problems (Sharma and Garg, 2013) [17]. Moreover, in modern food habits, people are mostly consuming either deficient or imbalance diet.

Apart from better genetics and management, feed plays an equally important role in improving the performance of the birds. Feed is a major input as it accounts for about 70 percent of the variable costs in layer production. Over a period of time, extensive efforts have been taken to lower down the cost of production by lowering the expenses on feed *viz*. by use of feed additives. Feed additives are one of the important tools used for improving feed conversion ratio, growth rate and disease resistance. The additives those hold great promise in the feeding of poultry comprise of antibiotics, coccidiostats, antioxidants, enzymes, hormones, probiotics, buffers, organic acids, mold inhibitors, herbal products, synthetic micronutrients etc. The possible mechanisms of action of herbs in the animal for growth promotion include stimulation of the endocrine system and intermediate nutrient metabolism, morphological and histological modifications of the gastrointestinal tract, increased digestibility and absorption of nutrient, enhanced nitrogen absorption, antioxidant activity, changes in the intestinal microbial population and improvement of the immune response. Herbs can fulfill the nutrient requirements of the animals to certain extent.

Black cumin (*Nigella sativa* L.) also known as black caraway is an annual herbaceous flowering plant and belongs to the family Ranunculaceae and native to southwest Asia. It is called as karunjiragan, kalonji, mangarail, kolonkire etc. In India, black cumin was cultivated in Gujarat, West Bengal and Rajasthan. Its productivity in India is 486000 MT with the maximum production of 284000 MT in Gujarat (Anonymus, 2018b) [5]. It has a wide range of medicinal uses (Datta *et al*., 2012) [12]. It is used for the treatment of cough, asthma and fever.

Ginger primarily grown in Central Asia, China, India and Pakistan and exported worldwide. At present, India is the largest producer and accounting for 3 about one-third of the total world output. India exports around 19,000 MT of ginger in 2020 and ranks 4th globally in the export of fresh ginger, while second in crushed/ground ginger. Its productivity in India is 1081000 MT. Major ginger growing states are Kerala, Sikkim, Meghalaya, West Bengal, Odisha, Tamil Nadu, Karnataka andhra Pradesh, Maharashtra and Himachal Pradesh, with production of 166000 MT Assam holds first rank (Anonymus, 2018b) [5]. Ginger root contains several compounds which have biological activities such as antioxidation, antimicrobial and pharmacological effects (Akoachere *et al*., 2002; Ali *et al*., 2008) [4].

Material and Methodology

A total of 150 birds, 28 weeks old of commercial egg type strain White Leghorn layer were randomly allotted to one of the nine treatments with 30 layers in each treatment with three replications. The factorial design (32) was adopted for the present feeding trial. Herbal feed additive, ginger root powder and black cumin seed powder were supplemented either in combination to prepare nine different treatment diets for the feeding of birds under different dietary groups. The chemical composition of basal diet, ginger root powder and black cumin seed powder was presented in (table 1). The T_0 i.e. control group was fed on basal diet while T_1 supplemented with 1% ginger root powder + 3% black cumin seed powder, T_2- supplemented with 1% ginger root powder + 4% black cumin seed powder, T_3 supplemented with 1% ginger root powder + 5% black cumin seed powder, T_4- supplemented with 2% ginger root powder + 3% black cumin seed powder, T_5- supplemented with 2% ginger root powder + 4% black cumin seed powder, T_6- supplemented with 2% ginger root powder + 5% black cumin seed powder, T_7- supplemented with 3% ginger root powder + 3% black cumin seed powder, T_8- supplemented with 3% ginger root powder + 4% black cumin seed powder and T_9- supplemented with 3% ginger root powder + 5% black cumin seed powder, respectively. A feeding trial of 70 days was carried out. Birds were offered feed daily ad-libitum and refusal was recorded after every bi-week separately for each replicate and actual feed intake of each replicate was calculated. It was calculated by subtracting the amount of feed refused from the total amount of feed offered during the bi-week. Birds were offered feed daily ad-libitum and refusal was recorded after every week separately for each replicate. Feed conversion ratio was calculated on the basis of per dozen of eggs as well as per Kg mass of eggs on bi-weekly basis for each experimental unit, by using the following formulae as described by Singh and Kumar (1994).

$$\text{FCR/dozen eggs} = \frac{\text{Total feed consumed (kg) during the period}}{\text{Total number of eggs produced during the period}} \times 12$$

$$\text{FCR/Kg egg mass} = \frac{\text{Total feed consumed during the period (kg)}}{\text{Total egg mass produced during the period (kg)}}$$

Data collected during the present investigation were subjected to statistical analysis by adopting appropriate methods of analysis of variance as described by Snedecor and Cochran (2004). Wherever the variance ratio (F-values) were found significant at 5 percent and 1 percent levels of probability, the significance of mean differences were tested by Duncan's New Multiple Range Test (Duncan's Range Test) as modified by Kramer.

Table 1: Chemical composition of basal diet, ginger root powder and black cumin seed powder (%DM basis)

Parameter	Basal	Ginger root powder	Black cumin Seed Powder
DM	91.45	91.2	95.4
CP	18.00	8.85	10.16
EE	5.14	2.8	6.6
CF	4.80	5.3	7.8
Ash	4.0	1.5	3.7
Calcium	1.04	1.5	1.8
Phosphorus	0.90	1.2	0.05
ME (kcal/kg)	2800.00	2830.00	2850.00

Results and Discussion

Feed conversion ratio (kg Feed/kg Egg Mass)

The feed conversion ratio (kg Feed/kg Egg Mass) at different periods in various treatment groups have been presented in Table 2. The pattern of feed conversion ratio (kg Feed/kg Egg Mass) depicted in Fig. 1.

The bi-weekly average feed conversion ratio of various treatment groups in study period were found to be 2.42, 2.26, 2.34, 2.36, 2.33, 2.34, 2.39, 2.35, 2.38 and 2.38 in T_0, T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9 treatment groups, respectively.

The comparison of feed conversion ratio at different bi-weeks revealed that all treatments were non-significant during up to second bi-week's period, Statistically the significant (p<0.05%) FCR was observed in third to six bi-weeks period. The overall average feed conversion ratio for treatment statistically significant higher FCR was recorded in T_0 treatment as compared to other treatment groups and lower FCR was recorded in T_1 group. However, treatment T_0, T_3, T_6, T_8 and T_9 were at par with each other, also treatment T_2, T_3, T_5, T_6, T_7, T_8 and T_9 were at par with each other as well as treatment T_2, T_3, T_4, T_5, T_7, T_8 and T_9 were at par with each other.

The results of the present study, which investigated the supplementation of ginger powder and its combination with black cumin seed powder, offer insights into the impact on feed efficiency in layers. The findings presented here align with several studies, such as Dwivedi *et al.* (1986) [14], Nasiroleslami and Torki (2010) [22], Elmakki *et al.* (2013) [15], EL-Shaikh *et al.* (1998) [16], Ajuwon *et al.* (2002) [2], Akhtar *et al.* (2003) [3], Khan *et al.* (2013) [19] and Boka *et al.* (2014) [10], which collectively suggest that the inclusion of ginger powder and Kolongi seeds in layer diets significantly improves feed efficiency per kilogram of eggs.

Table 2: Effect of ginger powder and black cumin seed powder on feed conversion ratio (kg feed/kg egg mass) of White Leghorn layers in different treatment groups and periods

Treatment	Period (Bi-Weekly)					
	I	II	III	IV	V	Overall Average
T_0	2.44	2.48	2.48 ^{a}	2.41 ^{a}	2.33 ^{a}	2.42 ^{a}
T_1	2.30	2.32	2.32 ^{d}	2.21 ^{f}	2.15 ^{c}	2.26 ^{d}
T_2	2.43	2.41	2.40 ^{abcd}	2.27 ^{de}	2.21 ^{bc}	2.34 ^{bc}
T_3	2.38	2.42	2.47 ^{ab}	2.29 ^{cde}	2.29 ^{ab}	2.36 ^{abc}
T_4	2.41	2.41	2.38 ^{bcd}	2.27 ^{ef}	2.21 ^{bc}	2.33 ^{c}
T_5	2.38	2.46	2.37 ^{cd}	2.28 ^{cde}	2.24 ^{ab}	2.34 ^{bc}
T_6	2.42	2.47	2.47 ^{ab}	2.34 ^{bc}	2.30 ^{a}	2.39 ^{ab}
T_7	2.36	2.39	2.42 ^{abc}	2.33 ^{bcd}	2.27 ^{ab}	2.35 ^{bc}
T_8	2.38	2.48	2.49 ^{a}	2.32 ^{cde}	2.28 ^{ab}	2.38 ^{abc}
T_9	2.43	2.46	2.44 ^{abc}	2.38 ^{ab}	2.25 ^{ab}	2.38 ^{abc}
SE	0.057	0.049	0.031	0.021	0.029	0.022
CD @ 5%	NS	NS	0.091	0.063	0.086	0.064

(Means under each treatment in the same period with different superscripts differ significantly)

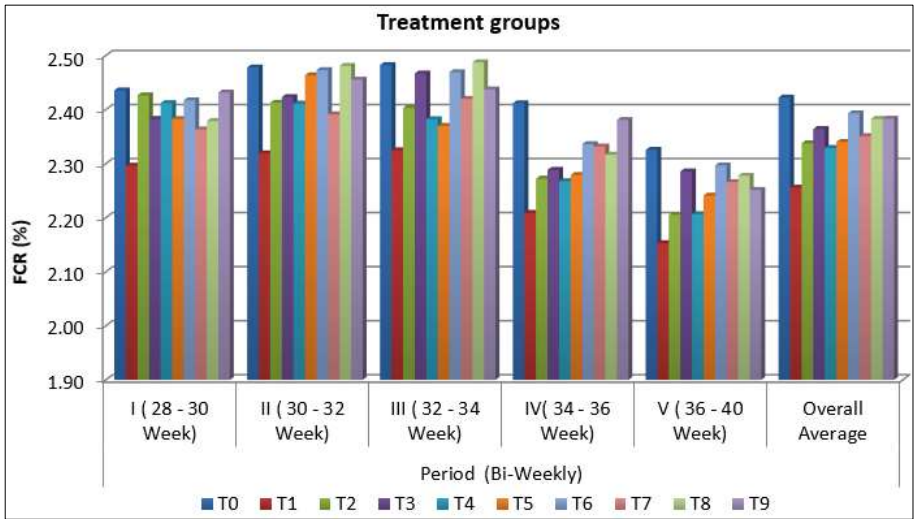

Fig 1: Feed conversion ratio of laying hens (Kg feed/Kg egg mass)

The positive effects on feed efficiency observed in this study were in line with research that had explored the benefits of Kolongi seeds and ginger supplementation. Denli *et al.* (2004) [13] and Mohammed and AL-Hameed (2021) [21], investigating black seed extracts, effect also noted higher feed efficiency in terms of kilograms of egg mass. These consistent findings across different studies reinforce the potential of these supplements to enhance the utilization of feed resources for egg production.

On the other hand, there are studies, as mentioned by Aydin *et al.* (2006) [6], Aydin *et al.* (2008) [7] and Bolukbasi *et al.* (2009) [11], that reported non-significant effect on feed efficiency with black seed supplementation. The contrasting results suggest that the impact of black seed supplementation on feed efficiency may be influenced by various factors, including dosage, duration of supplementation and potentially the specific conditions of the study. The study also introduces the combination of ginger powder and black cumin seed powder, which

demonstrated improved body weight gain and, as inferred, enhanced feed efficiency in layers. This synergistic effect is particularly intriguing and underscores the potential for complementary interactions between these two supplements. The study postulates that the rich vitamin and mineral content, including calcium and iron, in these plant-based supplements may contribute to the observed positive outcomes.

Furthermore, the findings were consistent with research by Shokrollahi and Sharifi (2018) [24], who investigated the effects of different levels of Nigella Sativa seed powder in Japanese quail rations and reported significant differences in feed conversion ratio (kilograms of egg mass) among treatments. This aligns with the present study's emphasis on the potential benefits of black cumin seed powder.

Yatoo's (2012) [27] report on the addition of different feed additives, including fenugreek and black cumin, resulting in good feed conversion ratio, further supports the notion that a combination of various plant-based supplements may contribute to improved feed efficiency in poultry.

In conclusion, the findings of the present study contribute to the existing body of knowledge by highlighting the positive impact of ginger powder and black cumin seed powder supplementation on feed efficiency in layers.

Feed conversion ratio (kg feed/dozens of eggs)

The observations on average egg weight of different treatments from 39 to 47 weeks period are given in Table 3. The pattern of feed conversion ratio (kg feed/ dozens of eggs) depicted in Fig. 2.

The bi-weekly average feed conversion ratio of various treatment groups in study period were found to be 1.63, 1.57, 1.62, 1.61, 1.62, 1.62, 1.63, 1.61, 1.62 and 1.62 in T_0, T_1, T_2, T_3, T_4, T_5, T_6, T_7, T_8 and T_9 treatment groups, respectively.

The minimum feed conversion ratio (1.57) was observed in T_1 treatment group and the maximum feed conversion ratio (1.63) recorded in T_0 (Control) treatment. The average feed conversion ratio was unaffected by the dietary treatments, though slight numerical difference occurred among the treatment groups. The statistical analysis revealed that there is no significant difference in eggs weight during experimental period in different treatment group.

Table 3: Effect of ginger powder and black cumin seed powder on feed conversion ratio (Kg feed/dozen of eggs) of White Leghorn layers in different treatment groups

Treatment	Period (Bi-Weekly)					
	I	II	III	IV	V	Overall Average
T_0	1.61	1.64	1.66	1.65	1.61	1.63
T_1	1.54	1.58	1.62	1.57	1.55	1.57
T_2	1.61	1.63	1.67	1.60	1.58	1.62
T_3	1.59	1.62	1.67	1.59	1.59	1.61
T_4	1.62	1.63	1.65	1.60	1.59	1.62
T_5	1.59	1.67	1.64	1.61	1.59	1.62
T_6	1.62	1.66	1.66	1.62	1.61	1.63
T_7	1.58	1.61	1.64	1.62	1.58	1.61
T_8	1.59	1.67	1.67	1.62	1.58	1.62
T_9	1.62	1.64	1.64	1.64	1.58	1.62
SE	0.036	0.033	0.018	0.020	0.017	0.014
CD @ 5%	NS	NS	NS	NS	NS	NS

(Means under each treatment in the same period with different superscripts differ significantly)

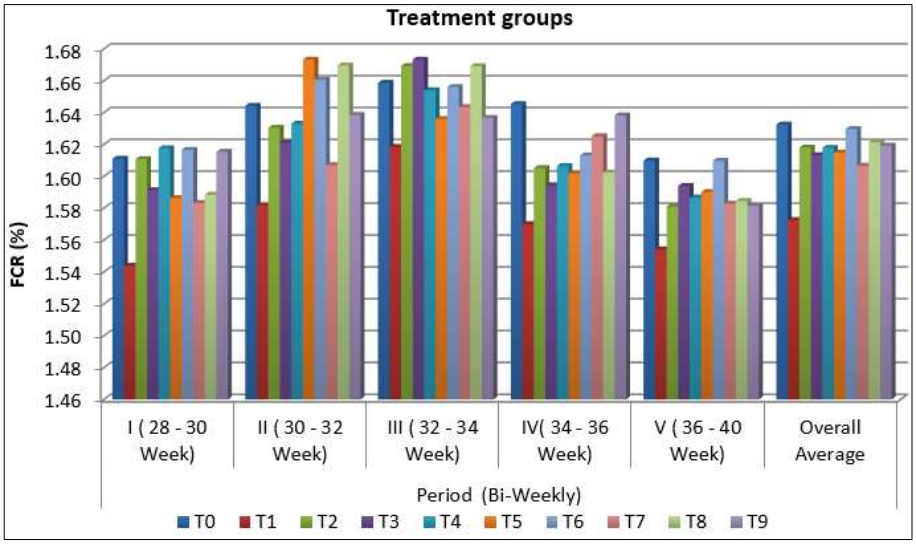

Fig 2: Feed conversion ratio laying hens (Kg feed/dozens of egg)

The findings of the present study, which investigated the supplementation of ginger root powder and black cumin seed powder in laying hens, were consistent with and supported by several existing studies in the field of poultry nutrition. The results related to ginger root powder supplementation align with the research conducted by Incharoen and Yamauchi (2009) [18], Zhao *et al.* (2011) [28] and Malekizadeh *et al.* (2012) [20], all of which reported an

improvement in feed conversion ratio in laying hens due to the inclusion of ginger root powder in their diets. Additionally, Abd El-galil and Henda (2015) [1] also reported a significantly better feed conversion ratio as a result of ginger root powder supplementation in the diet of hens.

Similarly, the present study's findings on black cumin seed powder supplementation were in accordance with the research by Yalcin *et al*. (2012) [26] and Boka *et al*. (2014) [10], both of which demonstrated improved feed conversion in laying birds when supplemented with black cumin seed powder. Khan *et al*. (2013) [19] and Bolukbasi *et al*. (2009) [11] also reported significantly better feed conversion ratios in laying birds supplemented with black cumin seed powder and Nigella sativa oil, respectively. However, Bolukbasi *et al*. (2009) [11] noted that at higher levels of Nigella sativa oil supplementation, a poorer feed conversion ratio was observed, highlighting the potential for dosage-dependent effects.

Contrastingly, Aydin *et al*. (2008) [7] reported a better feed conversion ratio at the 3% level of black cumin supplementation, whereas poorer ratios were observed at lower levels (1 and 2%). This discrepancy underscores the importance of dosage considerations in the efficacy of black cumin seed powder as a supplement in laying hen diets.

The non-significant difference observed in feed intake, coupled with an increase in egg production, suggests that the positive effects of black cumin seed powder on gastric secretion, digestive enzyme activities and antioxidant properties contribute to the overall improvement in feed conversion ratio. This aligns with the notion that certain bioactive compounds in black cumin seed powder may positively influence the digestive processes in laying hens, leading to enhanced nutrient utilization and improved efficiency in converting feed into egg production.

Conclusion

The inclusion of 1% Ginger powder and 3% Black cumin powder in white leghorn layers diet is beneficial in improving the live weight, weight gain, feed consumption and feed conversion ratio. In conclusion the positive influence on antioxidant properties associated with black cumin seed powder supplementation provides a promising avenue for further exploration in the quest for optimizing feed efficiency in laying hens.

References

1. Abd El-Galil K, Mahmoud HA. Effect of ginger roots meal as feed additives in laying Japanese quail diets. Journal of American Science. 2015;11(2):164-173.
2. Ajuwon KM, Matamni O, Daniyan OC. Effect of water sources and ascorbic acid supplementation on egg quality and egg production parameter of laying hens. Livestock Research for Rural Development. 2002;14(6):1-5.
3. Nasir A, Abid. Effect of feeding powdered *Nigella sativa* L. seeds on poultry egg production and their suitability for human consumption. Veterinarski Arhiv. 2003;73(3):180-190.
4. Akoachere JT, Ndip RN, Chenwi EB, Ndip LM, Njock TE, Anong DN, *et al*. Antibacterial effects of *Zingiber officinale* and *Garcinia kola* on respiratory tract pathogens. East African Medical Journal. 2002;79(11):588-592.
5. Anonymus. Business case for spice production and processing, 2018 spice report; c2018.
6. Aydin R, Bal MA, Ozugur AK, Toprak HHC, Kamalak A, Karaman M, *et al*. Effects of black seed (*Nigella sativa* L.) supplementation on feed efficiency, egg yield parameters and shell quality in chickens. Pakistan Journal of Biological Sciences. 2006;9(2):243-247.
7. Aydin R, Karaman M, Cicek T, Yardibi H. Black cumin (*Nigella sativa* L.) supplementation into the diet of the laying hen positively influences egg yield parameters, shell quality and decreases egg cholesterol. Poultry Science. 2008;87(1):2590-2595.
8. Ayyagari R, Grover V, Purvis R. Technostress: Technological antecedents and implications. MIS Quarterly. 2011;35(4):831-858.
9. Bhagat RB. Emerging pattern of urbanisation in India. Economic and Political Weekly. 2011;46(34):10-12.
10. Boka J, Mahdavi AH, Samie AH, Jahanian R. Effect of different levels of black cumin (*Nigella sativa* L.) on performance, intestinal *Escherichia coli* colonization and jejunal morphology in laying hens. Journal of Animal Physiology and Animal Nutrition. 2014;98(2):373-383.
11. Bolukbasi SC, Kaynar O, Erhan MK, Urupan H. Effect of feeding *Nigella sativa* oil on laying hen performance, cholesterol and some proteins ratio of egg yolk and *Escherichia coli* count in feces. Archiv. fur Geflugelkunde. 2009;73(3):167-172.
12. Datta AK, Saha A, Bhattacharya A, Mandal A, Paul R, Sengupta S, *et al*. Black cumin (*Nigella sativa* L.) – A review. Journal of Plant Development Sciences. 2012;4(1):1-43.
13. Denli M, Okan F, Uluocak AN. Effect of dietary black seed (*Nigella sativa* L.) extract supplementation on laying performance and egg quality of quail (*Coturnix coturnix japonica*). Journal of Applied Animal Research. 2004;26(2):73-76.
14. Dwivedi HB, Singh C, Kushwaha NS. Study on mortality and feed conversion efficiency in inbreds and their crosses. Poultry Guide. 1986;23(4):44-47.
15. Elmakki AM, AbdelAtti KA, Dousa BM, Elagib HAA, Malik HEE, Elamin KM, *et al*. Effects of dietary ground ginger (*Zingiber officinale*) root additive on broiler performance. Global Journal of Animal Science and Research. 2013;2(1):76-83.
16. El-Shaikh AMA, Amin AE, Khadiga AA. The effect of feeding different levels of *Nigella sativa* seeds on layer performance and egg quality characteristics. Sudan Journal of Veterinary Science and Animal Husbandry. 1998;37(4):121-128.
17. Garg H, Sharma SP. Multi-objective reliability-redundancy allocation problem using particle swarm optimization. Computers & Industrial Engineering. 2013;64(1):247-255.
18. Incharoen T, Yamauchi K. Production performance, egg quality and intestinal histology in laying hens fed dietary dried fermented ginger. International Journal of Poultry Science. 2009;8(11):1078-1085.
19. Khan SH, Anjum MA, Parveen A, Khawaja T, Ashraf NM. Effects of black cumin seed (*Nigella sativa* L.) on performance and immune system in newly evolved crossbred laying hens. Veterinary Quarterly. 2013;33(1):13-19.

20. Malekizadeh M, Moeini MM, Ghazi S. The effects of different levels of ginger (*Zingiber officinale* Rosc) and turmeric (*Curcuma longa* Linn) rhizomes powder on some blood metabolites and production performance characteristics of laying hens. International Journal of Advanced Research in Science and Engineering. 2012;1(2):127-134.
21. Mohammed HA, Al-Hameed SA. Effect of dietary black cumin seeds (*Nigella sativa*), garlic (*Allium sativum*) and lettuce leaves (*Lactuca sativa*) on performance and egg quality traits of native layer hens. In: IOP Conference Series: Earth and Environmental Science. 2021;910(1):012001.
22. Nasiroleslami M, Torki M. Including essential oils of fennel (*Foeniculum vulgare*) and ginger (*Zingiber officinale*) to diet and evaluating performance of laying hens, white blood cell count and egg quality characteristics. Advances in Environmental Biology. 2010;4(3):341-346.
23. Sen S, Chakraborty R. The role of antioxidants in human health. In: Oxidative stress: diagnostics, prevention and therapy. American Chemical Society. 2011;1083:1-37.
24. Shokrollahi B, Sharifi B. Effect of *Nigella sativa* seeds on growth performance, blood parameters, carcass quality and antibody production in Japanese quails. Journal of Livestock Science. 2018;9(2):120-128.
25. Singh V, Tyagi PK, Tyagi P, Mandal AB, Singh S. Reducing egg cholesterol through dietary addition of ginger and garlic in quails. Indian Journal of Poultry Science. 2013;48(3):306-312.
26. Yalcin S, Uzunoglu K, Duyum HM, Eltan O. Effects of dietary yeast autolysate (*Saccharomyces cerevisiae*) and black cumin seed (*Nigella sativa* L.) on performance, egg traits, some blood characteristics and antibody production of laying hens. Livestock Science. 2012;145(1):13-20.
27. Yatoo MA, Sharma RK, Khan N, Rastogi A, Pathak AK. Effect of fenugreek and black cumin seeds as feed additives on blood biochemical profile and performance of broilers. Indian Journal of Animal Nutrition. 2012;29(2):174-178.
28. Zhao X, Yang ZB, Yang WR, Wang Y, Jiang SZ, Zhang GG, *et al*. Effects of ginger root (*Zingiber officinale*) on laying performance and antioxidant status of laying hens and on dietary oxidation stability. Poultry Science. 2011;90(8):1720-1727.