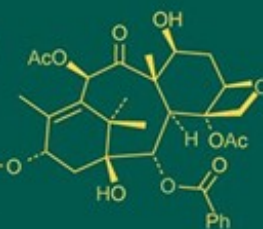
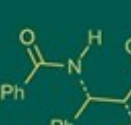
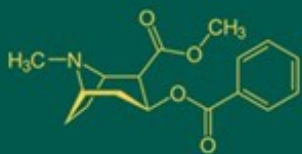


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Effect of addition of ginger (*Zingiber officinale*), and black cumin (*Nigella sativa* L.) on feed conversion ratio of Kaveri layer

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ABSTRACT

The experiment was conducted to study Effect of Addition of Ginger (*Zingiber officinale*), and Black Cumin (*Nigella Sativa* L.) on Growth Performance of Kaveri Layer. A total one hundred fifty 28-week old 150 Kaveri laying hens were randomly divided into three replication and ten treatments, and fed a basal diet with T₀- Control I.G. 0% GP+0% BCP, T₁- 1% GP + 3% BCP, T₂- 1% GP + 4% BCP, T₃- 1% GP + 5% BCP, T₄- 2% GP + 3% BCP, T₅- 2% GP + 4% BCP, T₆- 2% GP + 5% BCP, T₇- 3% GP + 3% BCP, T₈- 3% GP + 4% BCP and T₉- 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 Kaveri 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 poultry industry has considerable potential for future expansion. During 2018–19, Maharashtra produced 59,649 lakh eggs and ranked seventh among Indian states, contributing approximately 5.77% of the country's total egg production of 10,33,176 lakh eggs. It followed Andhra Pradesh (1,97,545 lakh), Tamil Nadu (1,88,422 lakh), Telangana (1,36,868 lakh), West Bengal (85,999 lakh), Haryana (60,577 lakh), and Karnataka (59,994 lakh), according to the Department of Animal Husbandry and Dairying, Government of India (2019).

The increasing demand for poultry products has encouraged researchers to investigate different genetic, nutritional, environmental, and managerial factors that can enhance egg production and maintain the productivity of laying hens. Modern layer strains possess considerable genetic potential for high egg production, which has been achieved primarily through systematic selection and breeding of commercial layer populations.

In recent decades, substantial changes have occurred in human lifestyles and dietary patterns compared with those of earlier generations. These changes have contributed to the increasing prevalence of lifestyle-associated diseases, including coronary heart disease, hypertension, and diabetes. Furthermore, the growing levels of stress associated with modern living may contribute to diseases related to free-radical generation (Sen and Chakraborty, 2011) [22, 23]. Oxidative stress-related health risks are also associated with unhealthy lifestyle practices and exposure to chemicals, environmental pollution, drugs, and cigarette smoke.

Urbanization in India increased from 27.81% in 2001 to 31.16% in 2011 (Bhagat, 2011) [8, 9]. The rapid growth of urbanization and industrialization has substantially influenced the lifestyle, dietary practices, and nutritional status of the Indian population. In addition, modern occupations have become increasingly technology-oriented and demanding, often involving reduced physical activity and irregular working schedules (Ayyagari et al., 2011) [7, 8]. Particularly in urban regions, Indian lifestyles are becoming increasingly westernized, which has been associated with a rising incidence of lifestyle-related health problems (Garg and Sharma, 2013) [16, 17]. Contemporary dietary practices are also frequently characterized by inadequate or nutritionally imbalanced diets.

Besides genetic improvement and appropriate management practices, nutrition plays a major role in determining the productive performance of poultry. Feed represents one of the largest expenses in layer production and accounts for approximately 70% of variable production costs. Consequently, considerable efforts have been directed toward reducing production costs through efficient utilization of feed and the incorpora

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tion of suitable feed additives. Feed additives are important tools for improving feed conversion efficiency, growth performance, and disease resistance. Commonly used poultry feed additives include antibiotics, coccidiostats, antioxidants, enzymes, hormones, probiotics, buffers, organic acids, mould inhibitors, herbal products, and synthetic micronutrients.

Herbal feed additives may promote animal growth through several mechanisms. These include stimulation of the endocrine system and intermediary nutrient metabolism, structural and histological changes in the gastrointestinal tract, improved digestion and nutrient absorption, enhanced nitrogen utilization, antioxidant effects, modification of intestinal microbial populations, and improved immune responses. Herbs may also contribute to meeting the nutritional requirements of animals to a certain extent.

Black cumin (*Nigella sativa* L.), commonly referred to as black caraway, is an annual herbaceous flowering plant belonging to the family Ranunculaceae and is native to Southwest Asia. In India, it is known by several names, including karunjiragan, kalonji, mangarail, and kolonkire. Black cumin is cultivated mainly in Gujarat, West Bengal, and Rajasthan. Its reported production in India was 4,86,000 MT, with Gujarat contributing the highest production of approximately 2,84,000 MT (Anonymous, 2018b) [5]. The plant has numerous medicinal applications (Datta et al., 2012) [11, 12] and has been traditionally used in the management of ailments such as cough, asthma, and fever.

Ginger is primarily cultivated in Central Asia, China, India, and Pakistan and is exported to several countries worldwide. India is one of the leading ginger-producing countries and contributes approximately one-third of global production. In 2020, India exported nearly 19,000 MT of ginger and ranked fourth globally in fresh ginger exports and second in exports of crushed or ground ginger. The reported ginger production in India was approximately 10,81,000 MT. Major ginger-producing states include Kerala, Sikkim, Meghalaya, West Bengal, Odisha, Tamil Nadu, Karnataka, Andhra Pradesh, Maharashtra, and Himachal Pradesh. Assam recorded the highest production, with approximately 1,66,000 MT (Anonymous, 2018b) [5]. Ginger rhizomes contain several biologically active compounds that

possess antioxidant, antimicrobial, and pharmacological properties (Akoachere et al., 2002; Ali et al., 2008) [4].

Material and Methodology

A total of 150 commercial White Leghorn layer birds, aged 28 weeks, were randomly assigned to nine dietary treatments, with 30 birds allocated to each treatment and three replications per treatment. A 3² factorial experimental design was employed for the feeding trial. Ginger root powder and black cumin seed powder were incorporated into the diets individually and in different combinations to formulate the nine dietary treatments.

The chemical composition of the basal diet, ginger root powder, and black cumin seed powder is presented in Table 1. Birds in the control group (T₀) received only the basal diet. The remaining treatment groups received different combinations of ginger root powder and black cumin seed powder as follows:

- **T0:** Basal diet only
- **T1:** 1% ginger root powder + 3% black cumin seed powder
- **T2:** 1% ginger root powder + 4% black cumin seed powder
- **T3:** 1% ginger root powder + 5% black cumin seed powder
- **T4:** 2% ginger root powder + 3% black cumin seed powder
- **T5:** 2% ginger root powder + 4% black cumin seed powder
- **T6:** 2% ginger root powder + 5% black cumin seed powder
- **T7:** 3% ginger root powder + 3% black cumin seed powder
- **T8:** 3% ginger root powder + 4% black cumin seed powder
- **T9:** 3% ginger root powder + 5% black cumin seed powder

The feeding experiment was conducted for 70 days. Feed was supplied to the birds daily on an ad-libitum basis. Feed refusals were recorded at two-week intervals separately for each replicate, and actual feed intake was determined by subtracting the quantity of feed refused from the total quantity offered during each bi-weekly period. Feed conversion ratio (FCR) was determined on the basis of feed required per dozen eggs as well as per kilogram of egg mass. The FCR was calculated at bi-weekly intervals for each experimental unit using the formulae described by Singh and Kumar (1994).

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

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

The data obtained in the present study were statistically analyzed using appropriate analysis of variance (ANOVA) procedures as outlined by Snedecor and Cochran (2004). When the calculated variance ratios (F-values) showed statistical significance at the 5% or 1% probability levels, the differences among treatment means were further evaluated using Duncan's New Multiple Range Test (DMRT), 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 root 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

Parameter	Basal	Ginger root powder	Black cumin root powder
Phosphorous	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 (FCR), expressed as kg feed consumed per kg of egg mass, at different experimental periods for all treatment groups is presented in Table 2.

The bi-weekly mean FCR recorded during the experimental period was 2.41, 2.34, 2.34, 2.37, 2.30, 2.35, 2.39, 2.37, 2.36, and 2.37 for treatment groups T₀, T₁, T₂, T₃, T₄, T₅, T₆, T₇, T₈, and T₉, respectively.

Comparison of FCR among the treatment groups during different bi-weekly periods indicated that the differences were statistically non-significant during the first and second bi-weekly periods. However, significant differences ($P < 0.05$) were observed from the third to the fifth bi-weekly periods. The highest overall mean FCR was recorded

in the T_0 (control) group, whereas the lowest FCR was observed in T_4 . The FCR values of T_0 , T_3 , T_6 , T_7 , and T_9 were statistically comparable with one another. Similarly, T_1 , T_2 , and T_5 did not differ significantly from each other.

The findings of the present investigation indicate that dietary supplementation with ginger root powder, either alone or in combination with black cumin seed powder, influenced feed utilization efficiency in laying hens. The present results are in agreement with the findings

of Dwivedi *et al.* (1986) [13, 14], Nasiroleslami and Torki (2010) [21, 22], Elmakki *et al.* (2013) [14, 15], El-Shaikh *et al.* (1998) [15, 16], Ajuwon *et al.* (2002) [2], Akhtar *et al.* (2003) [3], Khan *et al.* (2013) [18, 19], and Boka *et al.* (2014) [9, 10]. These studies reported that dietary inclusion of ginger powder and black cumin (Kalonji) seeds could improve feed efficiency, particularly when feed utilization is expressed per kilogram of egg mass in laying hens.

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)					Overall Average
	I	II	III	IV	V	
T_0	2.42	2.41	2.48 ^a	2.41 ^a	2.35 ^a	2.41 ^a
T_1	2.41	2.41	2.38 ^c	2.27 ^d	2.25 ^b	2.34 ^b
T_2	2.39	2.39	2.40 ^{bc}	2.28 ^d	2.23 ^b	2.34 ^b
T_3	2.42	2.37	2.48 ^a	2.29 ^d	2.29 ^a	2.37 ^a
T_4	2.42	2.40	2.32 ^d	2.21 ^e	2.14 ^c	2.30 ^c
T_5	2.42	2.40	2.38 ^c	2.28 ^d	2.29 ^a	2.35 ^b
T_6	2.41	2.42	2.44 ^{ab}	2.34 ^c	2.34 ^a	2.39 ^a
T_7	2.41	2.41	2.41 ^b	2.33 ^c	2.31 ^a	2.37 ^a
T_8	2.40	2.41	2.39 ^c	2.32 ^c	2.30 ^a	2.36 ^{ab}
T_9	2.42	2.40	2.32 ^d	2.38 ^b	2.33 ^a	2.37 ^a
SE	0.039	0.015	0.011	0.019	0.027	0.023
CD @ 5 %	NS	NS	0.032	0.055	0.079	0.070

The improvement in feed efficiency observed in the present investigation is consistent with the findings of earlier studies examining the effects of black cumin (Kalonji) and ginger supplementation. Denli *et al.* (2004) [12, 13] and Mohammed and Al-Hameed (2021) [20, 21], in studies involving black seed extracts, also reported improved feed efficiency when expressed in terms of feed required per kilogram of egg mass. The similarity of these findings across different investigations indicates the potential role of these herbal supplements in improving the utilization of feed for egg production.

However, contrasting results have also been reported. Aydin *et al.* (2006) [5, 6], Aydin *et al.* (2008) [7], and Bolukbasi *et al.* (2009) [10, 11] observed no significant effect of black seed supplementation on feed efficiency. Such variation among studies may be attributed to differences in supplementation levels, experimental duration, bird characteristics, dietary composition, or other experimental conditions. The present study further examined the combined supplementation of ginger root powder and black cumin seed powder, which was associated with improved body weight gain and, consequently, better feed utilization in laying hens. The observed response may indicate a possible complementary or synergistic interaction between the two herbal supplements. The beneficial effects may also be related to their nutritional composition, particularly their vitamin and mineral contents, including calcium and iron.

The present findings are also supported by Shokrollahi and Sharifi (2018) [23, 24], who evaluated different levels of *Nigella sativa* seed powder in Japanese quail diets and reported significant differences in feed conversion ratio, expressed as kilograms of feed per kilogram of

egg mass, among the dietary treatments. These findings further demonstrate the potential value of black cumin seed powder as a dietary supplement for improving feed utilization. Similarly, Yatoo *et al.* (2012) [27] reported satisfactory feed conversion following the incorporation of different feed additives, including fenugreek and black cumin, into poultry diets. This observation suggests that the combined use of plant-derived feed additives may have potential for improving feed efficiency in poultry production.

Overall, the findings of the present study add to the existing evidence regarding the potential benefits of ginger root powder and black cumin seed powder supplementation in laying hens, particularly with respect to feed utilization and production efficiency.

Feed conversion ratio (kg feed/dozen eggs)

The observations pertaining to feed conversion ratio based on feed consumption per dozen eggs during the period from 28 to 38 weeks of age are presented in Table 3.

The bi-weekly mean feed conversion ratio recorded during the experimental period was 1.61, 1.59, 1.60, 1.60, 1.57, 1.61, 1.60, 1.58, 1.61, and 1.60 for treatment groups T_0 , T_1 , T_2 , T_3 , T_4 , T_5 , T_6 , T_7 , T_8 , and T_9 , respectively.

The lowest FCR of 1.57 was recorded in the T_4 treatment group, whereas the highest value of 1.61 was observed in the T_0 control group. Although minor numerical differences were observed among the treatment groups, dietary supplementation did not significantly influence the average feed conversion ratio. Statistical analysis indicated that the differences among treatments were non-significant during the experimental period.

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)					Overall Average
	I	II	III	IV	V	
T_0	1.56	1.60	1.65	1.65	1.62	1.61
T_1	1.59	1.60	1.63	1.59	1.57	1.59
T_2	1.59	1.60	1.62	1.60	1.59	1.60

(continued on next page)

Treatment	Period (bi- weekly)					Overall Average
	I	II	III	IV	V	
T ₃	1.60	1.62	1.62	1.60	1.58	1.60
T ₄	1.55	1.56	1.60	1.58	1.57	1.57
T ₅	1.61	1.62	1.62	1.60	1.58	1.61
T ₆	1.59	1.61	1.64	1.60	1.58	1.60
T ₇	1.56	1.57	1.61	1.59	1.57	1.58
T ₈	1.61	1.62	1.62	1.60	1.59	1.61
T ₉	1.61	1.63	1.62	1.59	1.59	1.60
SE	0.037	0.032	0.020	0.020	0.019	0.016
CD @ 5 %	NS	NS	NS	NS	NS	NS

The results obtained in the present investigation on the dietary supplementation of ginger root powder and black cumin seed powder in laying hens were generally consistent with findings reported in previous studies on poultry nutrition. The response to ginger root powder supplementation observed in the present study agrees with the findings of Incharoen and Yamauchi (2009) [17, 18], Zhao *et al.* (2011) [28], and Malekizadeh *et al.* (2012) [19, 20], who reported an improvement in feed conversion ratio in laying hens following the incorporation of ginger root powder into the diet. Similarly, Abd El-Galil and Henda (2015) [1] observed a significantly improved feed conversion ratio in hens receiving dietary ginger root powder.

The findings concerning black cumin seed powder supplementation were also comparable with the results reported by Yalcin *et al.* (2012) [24, 26] and Boka *et al.* (2014) [9, 10], who documented improved feed conversion efficiency in laying birds supplemented with black cumin seed powder. Khan *et al.* (2013) [18, 19] and Bolukbasi *et al.* (2009) [10, 11] likewise reported significantly improved feed conversion ratios in laying birds supplemented with black cumin seed powder and *Nigella sativa* oil, respectively.

Nevertheless, the response to supplementation may vary according to the level included in the diet. Bolukbasi *et al.* (2009) [10, 11] observed that higher levels of *Nigella sativa* oil supplementation were associated with a deterioration in feed conversion ratio, suggesting that the response may be dependent on the dosage. In contrast, Aydin *et al.* (2008) [6, 7] reported improved feed conversion at a 3% level of black cumin supplementation, whereas relatively poorer feed conversion ratios were observed at lower inclusion levels of 1% and 2%. These variations emphasize the importance of determining an appropriate supplementation level when incorporating black cumin products into layer diets.

The absence of a significant effect on feed intake, together with the improvement in egg production observed in the present study, may indicate that the beneficial effects of black cumin seed powder are associated with enhanced digestive processes and nutrient utilization. Its reported effects on gastric secretion, digestive enzyme activity, and antioxidant mechanisms may contribute to more efficient utilization of dietary nutrients. The bioactive constituents present in black cumin seed powder may therefore have a favorable influence on digestion and nutrient availability, ultimately supporting more efficient conversion of feed into egg production.

Conclusion

Based on the findings of the present investigation, dietary supplementation with 2% ginger root powder combined with 3% black cumin seed powder in the Kaveri layer diet was beneficial for improving live body weight, body weight gain, feed consumption, and feed conversion ratio. The observed beneficial effects of black cumin seed powder, particularly its potential antioxidant properties, indicate that herbal feed supplementation may have potential for improving productive performance and feed utilization in laying hens. Further investigations may be undertaken to determine the optimum combination and inclusion levels of ginger and black cumin for maximizing the productive efficiency of commercial layers.

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