



Effect of black cumin (*nigella sativa*) and garlic (*allium sativum*) as natural feed additive on growth performance of kaveri chicken

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ABSTRACT

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The present experimental trial was conducted to study the effect of black cumin (*Nigella sativa*) and garlic (*Allium sativum*) as natural feed additive on growth performance of Kaveri chicken a backyard poultry variety. Three experimental trials were carried out in three distinct seasons for the experiment. The first trial took place in the winter, from 22 October 2020 to 31 December 2020; the second trial took place in the summer, from 27 February 2021 to 8 May 2021; and the third trial took place in the rainy season, from 5 June 2022 to 14 August 2022. The experimental trials were conducted using two hundred-day old Kaveri chicks for a period of ten weeks. The chicks were split up into five treatments of 40 chicks in each treatment with four replications of ten chicks. The basal diet was given to the control (T₁) group, while the feed was supplemented with Neodox @ 250g/tonne of feed, 1% black cumin seed, 1% garlic mash and 0.5% black cumin seed + 0.5% garlic mash for the T₂, T₃, T₄ and T₅ groups. The results of the present experiments indicated that basal diet supplemented with combination of black cumin seed and garlic mash (0.5+0.5%) increased body weight, weight gain, feed consumption, water intake and improved feed conversion significantly (P<0.05). The significantly higher body weight, weight gain, feed consumption and better feed efficiency was recorded in T₂ group followed by T₅, T₄, T₃ and lowest in T₁ control group in each trial. It was concluded that 0.5+0.5% black cumin seed and garlic mash in Kaveri chicken diets can be used as natural feed additive by replacing antibiotic and enhancing growth performance, feed conversion of Kaveri birds.

Keywords: Growth performance, Feed intake, Feed conversion ratio, Water intake, Kaveri, Herbal feed additives

INTRODUCTION

Poultry industry is a fast-growing segment of the agriculture sector in the world. Feed additives are important materials that can improve the efficiency of feed utilization, animal performance and enhance immune responses. Potential of birds is fully utilized by such feed formulation and feeding practices. At present, number of feed additives are used to feed poultry birds for increasing in body weight gain and improving feed efficiency (FCR). However, availability of quality feed at the reasonable cost is key to successful poultry operation (Basak *et al.*, 2002). Given this, using feed additives as growth promoters is crucial to resolving issues with quality feed. Nonetheless, certain additives that are intended to boost feed efficiency, such as probiotics, hormones, antibiotics, and others, have side effects. Eggs and meat have residue from them. Herbal feed additives are the most effective among all of these when it comes to increasing poultry weight, feed efficiency and feed intake. There are no negative impacts on the health of birds from these herbal feed additives. The dietary use of herbal growth promoters increases the performance of poultry by increasing live weight gain and FCR (Prasad and Sen, 1993, Samarth *et al.*, 2002). Black cumin seed have been used in traditional medicine

as diuretic and antihypertensive, digestive and appetite stimulant; also have antibacterial, antioxidant, antidiabetic, anticancer, antiparasitic, analgesic, renal protective and anti-inflammatory properties due to the presence of pharmacologically active compound like thymoquinone, dithymoquinone, thymohydro-quinone and thymol (Guler *et al.*, 2006). Black cumin is also essential source of fatty acids (mainly linoleic acid and oleic acid), minerals (iron, calcium, sodium, phosphorus, zinc and copper) and vitamins like thiamine, ascorbic acid, niacin, pyridoxine and folic acid. Black cumin seed has feed growth promoter effect and may be promising in improving broiler performance (AI-Beitawi *et al.*, 2009). Garlic (*Allium sativum*) which belongs to the family *Alliaceae* and the genus *Allium* is widely distributed and used all over the world as a spice and herbal remedy for the prevention and treatment of a variety of diseases (Javandel *et al.*, 2008). Garlic (*Allium sativum*) is well known as a spice and herbal medicine for the prevention and treatment of a variety of diseases, namely respiratory infections, ulcers, diarrhea, and skin infections. The key active ingredient in garlic is a powerful plant chemical called allicin which rapidly decomposes to several volatile organosulphur compounds and it also contains organic sulphurous compounds such as allin, ajoene, Allyl propyl disulfide, diallyl trisulfide (Mansoub, 2011) which may be responsible for the

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various properties of garlic. It has been shown to exhibit antibiotic, antimicrobial, antioxidant, anticancer, immunomodulatory, anti-inflammatory, hypoglycemic and cardiovascular protecting effects. The Sulphur compounds of garlic are responsible for garlic's pungent odor and many of its medicinal effect like lowering cholesterol level (Chowdhury *et al.*, 2002).

A number of experiments conducted to find alternative to antibiotics revealed that no single alternative exists with the effects comparable to antibiotics (Nasir and Grashorn, 2010). There is need to find more efficient alternatives or combinations of different alternatives for maintaining health and improving performance of poultry and other livestock species. A number of studies have been conducted to examine the effect of black cumin and garlic at different dietary levels on the performance of broiler and laying chicken however, the result has not been consistent. Brenes and Rourna (2010) suggested that certain interactions of botanicals need to be examined because of the complexity regarding the number and variability of bioactive compounds. Data about a comparative assessment of the effects of garlic and black cumin, either given separately or in combination, on Kaveri performance are not currently available. The present research was undertaken to study the effect of black cumin and garlic as natural feed additives on growth performance of Kaveri chicken.

MATERIALS AND METHODS

In the present study, three experimental trials on Kaveri chicken first in winter, second in the summer season and third in the rainy season were carried out to discern the season effect and effect of black cumin and garlic as a natural feed additive on the growth performance of Kaveri chicken. The poultry unit of the Department of Animal Husbandry and Dairy Science at the College of Agriculture, VNMKV, Parbhani, Maharashtra state, was the site of the current study. Two hundred day old Kaveri backyard poultry chicks were obtained from a local commercial hatchery. Each experimental chick had its weight recorded and its wings banded. After that, the chicks were divided into five treatments at random, each consisting of 40 chicks and four replications of 10 chicks each. This was done to ensure that the average body weight of each treatment

group was similar. Ten weeks were allocated for the conduct of each trial. All the experimental chicks were reared on deep litter system of rearing with paddy husk as a litter material in a well-ventilated shed with identical management and environmental conditions. Proper brooding of chicks was done by providing sufficient heat and light by using electric bulbs in each treatment for the first three weeks of age. Afterwards sufficient artificial light was provided during night hours throughout the experimental period.

Treatments:

T₁ - Basal diet (Control)

T₂ - Basal diet + Antibiotic (BMD @ 250g/Tonne of feed) Neodox forte

T₃ - Basal diet +1% Black cumin seed

T₄ - Basal diet + 1% Garlic mash

T₅ - Basal diet + 0.5% Black cumin seed + 0.5% Garlic mash

Fresh, clean and cool drinking water was provided to birds *ad-libitum*. All the precautionary measures against diseases were taken throughout the experimental period. All the Kaveri chicks were fed with ground maize for the first two days of age. The pre-starter, starter and finisher diets were offered from 2-14 days, 15-28 days and 28-70 days, respectively. The diets were fed *ad-libitum* to experimental groups by adding the required amount of black cumin seed and garlic mash as per treatment. The required quantities of Black cumin seed (*Nigella sativa*) and Garlic (*Allium sativum*) were purchased from the local market in Parbhani district (Maharashtra), India. The Black cumin seed (*Nigella sativa*) was mixed in basal diet as per treatments. The garlic (*Allium sativum*) mash was prepared from the garlic cloves. Garlic was separated and descaled manually to get the pure garlic bulbs. Garlic bulbs were crushed and mashed with the help of a grinder. The weighed quantity of mashed garlic was kept in hot air oven for drying at 50°C for 8 hours. The per cent ingredient composition of the experimental ration for pre-starter, starter and finisher is presented in Table 1.

The weekly body weights were determined by weighing the birds weekly and weight gain was calculated by subtracting the weight of the previous week from that of the current week. The feed conversion ratio was computed by dividing the average feed intake by the

Table 1: Per cent chemical composition of experimental standard ration on dry matter basis

S.N.	Nutrients	Per cent in ration		
		Pre-starter	Starter	Finisher
1	Crude Protein	22.00	20.00	18.00
2	Crude fiber	6.00	6.00	5.50
3	Ether Extract	4.20	4.50	4.36
4	Total ash	6.50	6.00	5.00
5	Acid insoluble ash	1.50	2.00	2.00
6	Metabolizable energy (kcal/kg)	2600	2700	2800

average weight gain and the feed intake was obtained by deducting the leftover feed from the feed that was provided. The treatment wise data on cumulative body weight, body weight gain, feed consumption and feed conversion ratio were subjected to analysis of variance of complete randomized design (Panse and Sukhatme 1967).

RESULTS AND DISCUSSION

Growth performance of Kaveri chicken

Cumulative body weights

Table 2 provides information on the cumulative body weights of experimental Kaveri birds under various experimental treatments that were recorded at ten-week intervals over the winter, summer, and rainy seasons. The statistical analysis of the weekly body weight of Kaveri birds in the experimental trial- I (winter season) during each week revealed a significant ($P<0.05$) difference among the treatment groups. At the end of the tenth week, the average cumulative body weights of Kaveri birds in the treatment group T_2 were significantly ($P<0.05$) higher as compared to T_1 , T_3 and T_4 and at par with T_5 group. The average body weight of (1575.15 g) obtained in T_2 group was superior over T_1 (1382.46 g), T_3 (1466.26 g), T_4 (1485.44 g) and at par with T_5 (1525.50 g) group. The statistical analysis on the weekly body weight of Kaveri birds in the experimental trial- II (summer season) during each week revealed significant ($P<0.05$) difference among the treatment groups. At the end of tenth week it may be seen from Table 2 that the average cumulative body weights of Kaveri birds in the treatment group T_2 was significantly ($P<0.05$) higher as compared to T_1 , T_3 , T_4 and T_5 group whereas treatment T_3 and T_4 at par with each other. The average body weight of (1480.82g) obtained in T_2 group was superior over T_1 (1318g), T_3 (1391.30g), T_4 (1412.47g) and those in T_5 (1450.38g) groups. Body weight by birds in T_3 group (1391.30g) did not differ statistically from T_4 (1412.47g).

The statistical analysis on the weekly body weight of Kaveri birds in the experimental trial- III (rainy season) during each week revealed significant ($P<0.05$)

difference among the treatment groups. At the end of tenth week the average cumulative body weights of Kaveri birds in the treatment group T_2 was significantly ($P<0.05$) higher as compared to T_1 , T_3 , T_4 and T_5 groups whereas treatment T_3 and T_4 were at par with each other. The average body weight of (1565.33g) obtained in T_2 group was superior over T_1 (1382.12g), T_3 (1465.31g), T_4 (1477.83g) and those in T_5 (1529.00g) groups. Body weight by birds in T_3 group (1465.31g) did not differ statistically from T_4 (1477.83g). The pooled analysis on the weekly body weight of Kaveri birds in the experimental trial-I, II and III during each week revealed significant ($P<0.05$) difference among the treatment groups. At the end of tenth week the average cumulative body weights of Kaveri birds in the treatment group T_2 was significantly ($P<0.05$) higher as compared to T_1 , T_3 , T_4 and T_5 groups whereas treatments T_3 and T_4 were at par with each other. The average body weight of (1540.40g) obtained in T_2 group was superior over T_1 (1360.90g), T_3 (1441g), T_4 (1458.60g) and those in T_5 (1501.60g) groups. Body weight gain by birds in T_3 group did not differ statistically from T_4 group.

The results obtained in experimental trial-I, II and III i.e. in winter, summer and rainy seasons, respectively indicated that the highest body weights were obtained in winter as compared to summer and rainy seasons. It may be due to temperature effects. The comfort zone temperature for poultry birds is between 12-28°C. In experimental trial-I, II and III Kaveri chickens supplemented with Neodox as antibiotic growth promoter gained significantly ($P<0.05$) higher body weights than that of control. The present findings are in accordance with Miles *et al.* (2006), Abudabos (2012), and Ramiah *et al.* (2014). Abudabos (2012) used Enramycin (0.1g/kg feed) as feed additive in broiler chicken diet and observed a reduction in the number of *Clostridium perfringens* and an improvement in growth performance. The results observed due to dietary supplementation of black cumin on body weight were strongly supported by the findings of Singh *et al.* (2018), Durrani *et al.* (2007), Khan *et al.* (2012), Choudhary *et al.* (2014), and Guler

Table 2: Average weekly cumulative body weight (g) per bird

Experimental trial	Experimental						Pooled analysis	
	I		II		III		(I, II and III)	
	Initial	10 th	Initial	10 th	Initial	10 th	Initial	10 th
Treatments	Body wt.	Week	Body wt.	Week	Body wt.	Week	Body wt.	Week
T_1	31.75	1382.46 ^d	32.70	1318.0 ^d	34.50	1382.12 ^d	32.98	1360.90 ^d
T_2	32.05	1575.15 ^a	32.90	1480.82 ^a	34.53	1565.33 ^a	33.15	1540.40 ^a
T_3	32.10	1466.26 ^c	32.80	1391.30 ^c	35.0	1465.31 ^c	33.30	1441.00 ^c
T_4	32.15	1485.44 ^{bc}	33.0	1412.47 ^c	34.80	1477.83 ^c	33.31	1458.60 ^c
T_5	31.20	1525.50 ^{ab}	33.10	1450.38 ^b	35.20	1529.00 ^b	33.16	1501.60 ^b
SE±	1.63	16.72	1.26	7.91	0.42	11.69	0.66	11.49
C.D. at 5%	N.S.	50.40	N.S.	23.84	N.S.	35.24	N.S.	31.80

(Interpretation: Means bearing different superscripts within a column differ significantly ($P<0.05$))

et al. (2006), who reported that effect ($P<0.05$) of 1% black cumin seeds and also antibiotic additive on average daily weight gain in broiler chicken. The results obtained with the dietary supplementation of garlic powder on body weight were in accordance with the findings of Singh *et al.* (2015) and Bajad (2017) who showed that the value for weekly gain in body weight of Giriraja birds receiving 0.8 per cent garlic powder had significantly ($P<0.05$) increased live body weights as compared to control. Allicin (an antibiotic compound present in garlic) may be the cause of this improvement in weight gain. It inhibits the growth of pathogenic bacteria and aflatoxin-producing fungi, facilitating a higher absorption of nutrients from the intestinal mucosa and ultimately improving the body weights of the birds.

In the investigation Kaveri birds supplemented with the combination of black cumin and garlic powder had exhibited significantly higher live body weights as compared to sole feeding groups and body weights were at par with that of antibiotic supplemented group. The results of the present study are in agreement with Saeid *et al.* (2013) who observed that the dietary supplementation with plant premix (GP and BS) and BS positively influenced BW, BWG and FC as compared to the control group. A similar trend was also observed by Mahmood *et al.* (2009) reported that the addition of herbal growth promoters, both garlic and kalongi improved the weight gain of the broilers. The improvement in performance due to the incorporation of the black cumin and garlic combination in Kaveri might be due to the synergistic action of the active principles present in black cumin and garlic which has a beneficial effect in improving the gut health and thereby resulting in maximum absorption of the nutrients.

Live body weight gain

Table 3 presents the data on the live body weight gain of experimental Kaveri birds under different experimental treatments at ten-week ages in the winter, summer, and rainy seasons. The statistical analysis of experimental trial-I (summer season) on the average gain in weight of Kaveri birds under five different treatments

revealed significant differences ($P<0.05$) from 5th week. After the 10th week the total gain in body weight of Kaveri birds in the treatment group T₂ was significantly higher ($P<0.05$) as compared to T₁, T₃, T₄ and T₅ groups. The treatment T₁ control (1350.71 g) is significantly lower as compared to all the treatments i.e. T₂ (1543.10 g), T₃ (1434.16 g), T₄ (1453.29 g) and T₅ (1494.30 g).

The statistical analysis of experimental trial-II (winter season) on the average gain in weight of Kaveri birds under five different treatments revealed significant differences ($P<0.05$) from 5th week. After the tenth week the total gain in body weight of bird among treatment groups T₂ was significantly higher ($P<0.05$) as compared to T₁, T₃, T₄ and T₅ group. Average gain in body weight in T₃ did not differ significantly with T₄ group. The treatment T₁ control (1285.30g) is significantly lower in body weight gain compared to all the treatments i.e. T₂ (1447.92g), T₃ (1358.50g), T₄ (1379.47g) and T₅ (1417.58 g).

The statistical analysis of experimental trial-III (rainy season) on the average gain in weight of Kaveri birds under five different treatments revealed significant differences ($P<0.05$) from 5th week. After the tenth week the total gain in body weight of bird among treatment groups T₂ was significantly higher ($P<0.05$) as compared to T₁, T₃, T₄ and T₅ groups. Average gain in body weight in T₃ did not differ significantly with T₄ groups. The treatment T₁ control (1347.62g) is significantly lower as compared to all the treatments i.e. T₂ (1530.81g), T₃ (1430.31g), T₄ (1447.03g) and T₅ (1493.80 g).

The pooled analysis of experimental trial-I, II and III (winter, summer and rainy season) on the average gain in weight of Kaveri birds under five different treatments revealed significant differences ($P<0.05$) from 6th week. After the 10th week the total gain in body weight of bird among treatment groups T₂ was significantly higher ($P<0.05$) as compared to T₁, T₃, T₄ and T₅ groups. The treatment T₁ control (1327.90g) is significantly lower as compared to all the treatments i.e. T₂ (1507.30g), T₃ (1407.70g), T₄ (1426.60g) and T₅ (1468.60 g).

The results obtained in experimental trial-I, II and

Table 3: Average weekly gain in body weight (g) per bird

Experimental trial							Pooled analysis	
	I		II		III		(I, II and III)	
	Initial	10 th	Initial	10 th	Initial	10 th	Initial	10 th
Treatments	Body wt.	Week	Body wt.	Week	Body wt.	Week	Body wt.	Week
T ₁	45.70	1350.71 ^e	44.30	1285.30 ^d	44.0	1347.62 ^d	44.66	1327.90 ^e
T ₂	48.25	1543.10 ^a	44.80	1447.92 ^a	45.60	1530.81 ^a	46.21	1507.30 ^a
T ₃	47.30	1434.16 ^d	43.90	1358.50 ^c	44.45	1430.31 ^c	45.21	1407.70 ^d
T ₄	48.30	1453.29 ^c	46.60	1379.47 ^c	45.25	1447.03 ^c	46.71	1426.60 ^c
T ₅	48.50	1494.30 ^b	45.35	1417.58 ^b	45.38	1493.80 ^b	46.40	1468.60 ^b
SE±	3.64	3.54	2.89	7.31	3.28	5.96	3.50	5.16
C.D. at 5%	N.S.	10.67	N.S.	22.04	N.S.	17.99	N.S.	14.29

(Interpretation: Means bearing different superscripts within a column significantly ($P<0.05$))

III (winter, summer and rainy season) indicate that the highest gain in body weight was obtained in rainy season as compared to summer and winter season. In each trial Kaveri chickens fed Neodox as antibiotic growth promoter gained significantly ($P<0.05$) higher body weight gain than the control. The finding of present investigation is in agreement with the reports of Guler *et al.* (2006), who reported significant effect ($P<0.05$) of 1% black cumin seeds along with antibiotic additive on average daily gain. The results regarding effect of dietary black cumin on body weight gain are in accordance with the findings of Ahmad Shafiq (2018) who reported that the feeding Vanaraja birds with diet supplemented with black cumin seed powder had increased the average body weight gain as compared to control. The results regarding effect of garlic on body weight gain similar with the finding of Ashyerizadeh *et al.* (2009) and Onyimonyi *et al.* (2012) also reported that the body weight gain was found to be better with garlic supplementation. The Kaveri birds supplemented with the combination of black cumin and garlic powder attained significantly higher live body weight gain than sole feeding group. However, the findings are at par with antibiotic-supplemented group. The results of the present study are in accordance with Saeid *et al.* (2013) who observed that the birds offered the diet containing 0.5% plant premix (GP and BS) feed increased ($P<0.05$) BW, BWG and improved feed efficiency as compared with control group ($P<0.05$).

Feed consumption

Throughout the trial period in the winter, summer and rainy seasons, the feed consumption of experimental Kaveri birds under various experimental treatments was recorded at weekly intervals. The findings are shown in Table 4. The average weekly feed intake in g of the Kaveri birds in experimental trial-I (winter season) revealed that there was a significant difference among all treatment group whereas, a significant difference was recorded after fifth week up to the end of experiment. At the end of the experiment the total feed consumed by different treatment groups i.e. T_1 group consumed significantly ($P<0.05$) lower quantity of feed (3688.66 g) as compared to T_2

(3982.79 g), T_3 (3844.59 g), T_4 (3879.37 g) and T_5 (3931.07 g). At end of the experiment, the average feed consumption of birds among different treatments T_2 group were significantly higher ($P<0.05$) as compared to T_1 , T_3 , T_4 and T_5 groups.

The average weekly feed intake (g) of the Kaveri birds in experimental trial-II (summer season) has revealed that there was a significant difference among all treatment groups whereas, a significant difference was recorded after sixth week up to the end of the experiment. The Kaveri chicks in T_1 group consumed significantly ($P<0.05$) lower quantity of total feed as compared to T_2 , T_3 , T_4 and T_5 . At the end of the experiment, the average feed consumption of birds among treatment groups T_2 and T_5 were statistically ($P>0.05$) similar but significantly higher ($P<0.05$) as compared to T_1 , T_3 , and T_4 groups. Whereas, T_3 and T_4 were at are par with each other.

The average weekly feed intake (g) of the Kaveri birds in experimental trial-III (rainy season) has revealed that there was a significant difference among all treatment groups whereas, a significant difference was recorded after fifth week up to the end of experiment. The Kaveri chicks in T_1 group consumed significantly ($P<0.05$) lower quantity of total feed as compared to T_2 , T_3 , T_4 and T_5 . At the end of experiment, the average feed consumption of birds among different treatments T_2 group were significantly higher ($P<0.05$) as compared to T_1 , T_3 , T_4 and T_5 groups.

The pooled analysis of experimental trial-I, II and III (winter, summer and rainy seasons) on the average weekly feed intake (g) has indicated that there was significant difference among all treatment groups whereas, a significant difference was recorded after fifth week up to end of experiment. The Kaveri chicks in T_1 group consumed significantly ($P<0.05$) lower quantity of total feed as compared to T_2 , T_3 , T_4 and T_5 . At the end of experiment, the average feed consumption of birds among treatment groups T_2 and T_5 were statistically ($P>0.05$) similar but significantly higher ($P<0.05$) as compared to T_1 , T_3 , and T_4 groups. Whereas, T_3 and T_4 are at par with each other.

Table 4: Average weekly feed consumption (g) per bird

Experimental trial							Pooled analysis	
	I		II		III		(I, II and III)	
	Initial	10 th	Initial	10 th	Initial	10 th	Initial	10 th
Treatments	Body wt.	Week	Body wt.	Week	Body wt.	Week	Body wt.	Week
T_1	84.88	3688.66 ^e	78.23	3473.24 ^c	82.95	3664.31 ^e	82.01	3608.70 ^d
T_2	86.41	3982.79 ^a	79.54	3659.72 ^a	84.33	3962.43 ^a	83.42	3868.30 ^a
T_3	86.29	3844.59 ^d	78.43	3568.39 ^b	83.88	3796.85 ^d	82.86	3736.60 ^c
T_4	87.17	3879.37 ^c	78.81	3585.53 ^b	84.65	3879.46 ^c	83.54	3764.80 ^{bc}
T_5	87.53	3931.07 ^b	79.09	3635.61 ^a	84.80	3907.37 ^b	83.80	3823.40 ^a
SE±	4.32	7.00	5.53	8.03	4.58	9.77	5.15	14.06
C.D. at 5%	N.S.	21.11	N.S.	24.22	N.S.	29.46	N.S.	45.78

(Interpretation: Means bearing different superscripts within a column significantly ($P<0.05$))

The results obtained in experimental trial I, II and III i.e. in winter, summer and rainy seasons indicated that the feed consumption was improved in winter season as compared to rainy and summer seasons. In each trial, the Kaveri birds supplemented with antibiotic growth promoters showed increased feed intake of birds over other treatment groups and control groups. The results of the present investigation are in agreement with Singh *et al.* (2018) reported that the feed intake and performance index improved significantly ($P<0.05$) in broilers fed diets with antibiotic growth promoter, and BCS at 1.0% (BC10) and 1.5% (BC15) compared to the birds fed BCS at 0.5% (BC5) or the control diet. The results revealed in present experiment with supplementation of black cumin seed on feed intake are in agreement with the finding of Durrani *et al.* (2007), Shokrollahi and Sharifi (2018), Naula (2018), who reported that the birds fed with 1% black cumin seed powder consumed significantly ($P<0.05$) higher quantity of feed as compared to control. The results obtained with supplementation of garlic powder are well supported with the finding of Elagib *et al.* (2013) reported the highest feed consumption by the birds fed diet containing 3 % garlic powder. Mohamed *et al.* (2016) also reported that Allicin supplementation increased feed intake of broiler chicken as compared to control.

The Kaveri birds fed with combination of black cumin and garlic powder consumed significantly higher quantity of feed than sole fed groups. However, feed intake was at par with that of antibiotic group. The results of present study are in line with Saeid *et al.* (2013) who used the combination of 0.5% garlic and black cumin premix for 42 days in commercial strain (Hubbard) broilers and found that the premix and black cumin positively influenced feed intake compared to the control group.

Feed conversion ratio (FCR)

Table 5 presents the findings of experimental trials I, II, and III. The weekly feed conversion ratios for 0–10 weeks were calculated by using data on average weekly body weight gain and weekly feed consumption. In the

experimental trial-I (summer season) the average feed conversion ratio from first to tenth week ranged from 2.58 to 2.73. A significant difference was observed from 4th week onwards till the 10th week. The cumulative average feed conversion ratio at the end of experiment revealed significant difference between treatment group T₂ (2.58) over T₁ control (2.73), T₃ (2.68), T₄ (2.66) and T₅ (2.63) group, whereas treatment group T₄ and T₅ were similar. The feed conversion ratio in treatment T₁ was observed significantly ($P<0.05$) poor as compared to other treatment groups. The better feed conversion ratio of 2.58 was obtained in T₂ group receiving antibiotic (BMD @ 250g/Tonne of feed), followed by 2.63 with 0.5%+0.5% black cumin and garlic in T₅, 2.66 with 1% garlic in T₄, 2.68 with 1% black cumin in T₃ and poor feed conversion ratio i.e. 2.73 in T₁ control at the end of 10th week.

In the experimental trial-II (winter season) the average feed conversion ratio from first to tenth week ranged from 2.52 to 2.70. A significant differences were observed from 5th week to 10th week. The cumulative average feed conversion ratio at the end of the experiment indicated a significant difference between treatment group T₂ (2.52) over T₁ control (2.70). However, the treatment group T₃ (2.62), T₄ (2.59) and T₅ (2.56) were at par. The better feed conversion ratio of 2.52 was obtained in T₂ group receiving antibiotic (BMD @ 250g/tonne of feed), followed by 2.56 with 0.5%+0.5% black cumin and garlic in T₅, 2.59 with 1% garlic in T₄, 2.62 with 1% black cumin in T₃ and poor feed conversion ratio i.e. 2.70 in T₁ control at the end of 10th week.

In the experimental trial-III (rainy season) the average feed conversion ratio from first to tenth week ranged from 2.58 to 2.71. A significant difference was observed from 4th week onwards till the 10th week. The cumulative average feed conversion ratio at the end of experiment indicated a significant difference between treatment group T₂ (2.58) over T₁ control (2.71), T₃ (2.65), T₄ (2.64) and T₅ (2.61) groups, whereas treatment group T₄ and T₅ were similar. The feed conversion ratio in treatment T₁ was observed a significantly ($P<0.05$) poor

Table 5: Average feed conversion ratio (FCR)

Experimental trial	I		II		III		Pooled analysis (I, II and III)	
	Initial	10 th	Initial	10 th	Initial	10 th	Initial	10 th
Treatments	Body wt.	Week	Body wt.	Week	Body wt.	Week	Body wt.	Week
T ₁	1.85	2.73 ^a	1.76	2.70 ^a	1.88	2.71 ^a	1.82	2.71 ^a
T ₂	1.79	2.58 ^c	1.77	2.52 ^c	1.84	2.58 ^c	1.79	2.56 ^c
T ₃	1.82	2.68 ^{ab}	1.78	2.62 ^{ab}	1.88	2.65 ^{ab}	1.82	2.65 ^{ab}
T ₄	1.80	2.66 ^b	1.69	2.59 ^{bc}	1.87	2.64 ^{bc}	1.79	2.63 ^{bc}
T ₅	1.80	2.63 ^b	1.74	2.56 ^{bc}	1.86	2.61 ^{bc}	1.79	2.60 ^{bc}
SE±	0.11	0.01	0.04	0.026	0.08	0.02	0.03	0.023
C.D. at 5%	N.S.	0.052	N.S.	0.079	N.S.	0.06	N.S.	0.066

(Interpretation: Means bearing different superscripts within a column significantly ($P<0.05$))

as compared to other treatment groups. It was revealed from Table 4, that the better feed conversion ratio of 2.58 was obtained in T₂ group receiving antibiotic (BMD @ 250g/tonne of feed), followed by 2.61 with 0.5%+0.5% black cumin and garlic in T₅, 2.64 with 1% garlic in T₄, 2.65 with 1% black cumin in T₃ and poor feed conversion ratio i.e. 2.71 in T₁ control at the end of 10th week.

The pooled analysis of three trials showed that the average feed conversion ratio from first to tenth week ranged from 2.56 to 2.71. A significant difference was observed from 3rd week onwards till the 10th week. The cumulative average feed conversion ratio at the end of experiment indicated a significant difference between treatment group T₂ (2.56) over T₁ control (2.71), T₃ (2.65), T₄ (2.63) and T₅ (2.60) groups, whereas treatment group T₄ and T₅ were similar and at par with T₂ group. The feed conversion ratio in treatment T₁ was observed a significantly ($P<0.05$) poor as compared to other treatment groups. It was revealed from Table 4, that the better feed conversion ratio of 2.56 was obtained in T₂ group receiving antibiotic (BMD @ 250g/tonne of feed), followed by 2.60 with 0.5%+0.5% black cumin and garlic in T₅, 2.63 with 1% garlic in T₄, 2.65 with 1% black cumin in T₃ and poor feed conversion ratio i.e. 2.71 in T₁ control at the end of 10th week.

The results obtained in experimental trial-I, II and III i.e. in winter, summer and rainy seasons indicated the improve the feed conversion ratios in summer season as compared to winter and rainy seasons. In each trial, the Kaveri birds supplemented with antibiotic growth promoter improved feed conversion ratio of birds over other treatment groups and control group. The results of the present investigation are in agreement with Guler *et al.* (2006), who reported that the feed conversion ratios were significantly improved by the supplementation of 1% black cumin seed and antibiotic in the diet of broiler birds. Singh *et al.* (2018) also reported that the feed efficiency and performance index improved significantly ($p<0.05$) in broilers fed with antibiotic growth promoter and black cumin seed at 1% and 1.5% compared to the birds fed BCS at 0.5% or the control diet. Findings of

the present investigation regarding the effect of black cumin are in accordance with the findings of Naula (2018), Ali *et al.* (2014), Shokrollahi and Sharifi (2018), Jahan *et al.* (2015) Who reported that supplementing different percentage of black cumin had significantly ($P<0.05$) improved the feed conversion ratio. Ahmad *et al.* (2018) reported that the cumulative feed conversion ratio for the supplementation of black cumin was significantly improved as compared with that of control group in Vanaraja poultry bird. The results regarding the effect of garlic powder on feed conversion ratio were similar with the finding of Bajad (2017) who reported that the cumulative feed conversion ratio for the supplementation of garlic powder was significantly improved than the control group in Giriraja chicken. Findings of the present investigation regarding the combined effect of black cumin and garlic powder were encouraging as compared with the combination sole feeding group and were at par with antibiotic-supplemented group. The results of present study are in accordance with Saeid *et al.* (2013) who observed significant improvement in the feed conversion ratio with the addition of 0.5% garlic and black cumin powder its combination to the ration.

Water intake

Throughout the trial, the experimental chicks' water consumption was noted once every week and the results of experimental trial-I, II and III are presented in Table 6. In the experimental trial-I (winter season) there was significant difference among the treatment group T₅ over T₁, T₂, T₃ and T₄. The Kaveri chicks in T₅ group consumed significantly ($P<0.05$) higher average weekly quantity of water (10863 ml) as compared to T₁ (9570 ml), T₂ (9760 ml), T₃ (9683 ml) and T₄ (9688 ml). whereas average weekly water intake among treatment T₃ and T₄ were at par with each other. It has been observed that highest water intake of 10863 ml was noted in T₅ group Kaveri receiving 0.5% Black cumin seed and 0.5 % Garlic mash followed by 9760 ml with antibiotic in T₂, 9688 ml with 1% Garlic in T₄, 9683 ml with 1% Black cumin seed in T₃ and lowest water intake i.e. 9570 ml in T₁ control at

Table 6: Average weekly water intake (ml) per bird

Experimental trial							Pooled analysis (I, II and III)	
	I		II		III		Initial	10 th
	Initial	10 th	Initial	10 th	Initial	10 th		
Treatments	Body wt.	Week	Body wt.	Week	Body wt.	Week	Body wt.	Week
T ₁	190	9570 ^d	183	12218 ^e	185.2	9478.84 ^d	186.07	10422.0 ^d
T ₂	180	9760 ^b	184	13134 ^c	188.4	9715.93 ^b	184.13	10870.0 ^b
T ₃	185	9683 ^c	180	13442 ^b	183.68	9611.89 ^c	182.89	10912.0 ^b
T ₄	172	9688 ^c	182	12800 ^d	180.3	9625.70 ^c	178.10	10705.0 ^c
T ₅	196	10863 ^a	192	14919 ^a	192.11	10542.0 ^a	193.37	12108.0 ^a
SE±	8.55	11.32	7.71	10.34	10.20	19.23	9.49	19.82
C.D. at 5%	N.S.	34.15	N.S.	31.16	N.S.	57.96	N.S.	64.55

(Interpretation: Means bearing different superscripts within a column significantly ($P<0.05$))

the end of 10th weeks. In the experimental trial-II (winter season) there were significant differences among the treatment group T₅ over T₁, T₂, T₃ and T₄. The Kaveri chicks in T₅ group consumed significantly higher average weekly quantity of water (14919 ml) as compared to T₁ (12218 ml), T₂ (13134 ml), T₃ (13442 ml) and T₄ (12800 ml).

In the experimental trial-III (rainy season) there were significant differences among the treatment group T₅ over T₁, T₂, T₃ and T₄. The Kaveri chicks in T₅ group consumed significantly higher average weekly quantity of water (10542 ml) as compared to T₁ (9478.84 ml), T₂ (9715.93 ml), T₃ (9611.89 ml) and T₄ (9625.70 ml). whereas, average weekly water intake among treatment T₃ and T₄ were at par with each other.

The pooled analysis of three trials showed that there were significant differences among the treatment group T₅ over T₁, T₂, T₃ and T₄. The Kaveri chicks in T₅ group consumed significantly higher average weekly quantity of water (12108 ml) as compared to T₁ (10422 ml), T₂ (10870 ml), T₃ (10912 ml) and T₄ (10705 ml). It has been observed that the highest water intake was noted in T₅ group Kaveri receiving 0.5% Black cumin seed and 0.5 % Garlic mash followed by antibiotic in T₂, 1% Garlic in T₄, 1% Black cumin seed in T₃ and lowest water intake i.e. in T₁ control at the end of 10th weeks. It that synergetic effect of black cumin and garlic increases water intake rate in Kaveri birds.

The results obtained in experimental trial-I, II and III i.e. in winter, summer and rainy seasons indicate that the increased water consumption in summer season as compared to the winter and rainy seasons. Temperature and relative humidity are important factors for increased water consumption in the summer season as compared to winter and rainy seasons, during experimental period minimum and maximum temperature was recorded as 9.0 and 32.1°C in winter, 12.0 and 34.5°C in rainy and 15.5 and 39.5°C in summer season, respectively. The water intake was increased due to high temperature recorded in summer season as compared to winter and rainy seasons. Findings of the present investigation regarding the effect of black cumin and garlic combination significantly increasing water consumption than sole feeding and antibiotic group are in agreement with Ahmad Shafiq (2018) who reported that black cumin supplementation increased water intake of Vanaraja birds as compared to control. Bhalsing (2016) showed that the chicks supplemented with 0.08% spirulina consumed significantly (P<0.05) higher average weekly quantity of water as compared to control.

CONCLUSION

For the Kaveri birds, adding black cumin seed and garlic mash to their diets improved both their live weight and weight gain. The feed consumption, feed conversion

efficiency and water intake of the Kaveri diet were all enhanced by the inclusion of black cumin seed and garlic mash as a herbal feed supplement. Therefore, it is recommended to replace antibiotics in the basal diet with a mixture of black cumin seed and garlic mash (@ 0.5+0.5%) in equal amounts.

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