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Effect of Supplementing Natural Feed Additives: Black Cumin, Fenugreek and Turmeric on the Growth Performance and Economic Efficiency of Broiler Chickens

[1]*Yonatan Kassu,* [2]*Berhan Tamir and* [3]*Etalem Tesfaye*

[1]Department of Animal and Range Science,
Wolaita Sodo University, P. O. Box 138, Wolaita Sodo, Ethiopia
[2]Department of Animal Production Studies, College of Veterinary Medicine
and Agriculture, Addis Ababa University, P. O. Box 34, Debre Zeit, Ethiopia
[3]Debre Zeit Agricultural Research Center, P.O. Box 32, Debre Zeit, Ethiopia

Abstract: A study was conducted to find the effect of black cumin (*Nigella sativa* L.), fenugreek (*Trigonella foenum-graecum* L.) and turmeric (*Curcuma longa* L.) seeds as natural feed additives on broiler performance. A total of 315 day-old unsexed broiler chicks (Cobb 500) were randomly allocated to seven treatment groups with three replicates of 15 each reared for 49 days. The experimental diets were: Control (T_0), black cumin seed 1 g kg^{-1} (T_1), black cumin 2 g kg^{-1} (T_2), fenugreek powder 1 g kg^{-1} (T_3), fenugreek 2 g kg^{-1} (T_4), turmeric powder 1 kg^{-1} , turmeric (T_5) and turmeric powder 2 g kg^{-1} (T_6). Live body weight (LBW), body weight gain (BWG) and average daily gain (ADG) of chickens was not influenced by the natural dietary treatments ($P \geq 0.05$) as anticipated through the experiment. Natural feed additive treatment diets ensured high feed conversion efficiency ($P \geq 0.01$) than the control diet group over starter and finisher phases. The supplementation of turmeric and black cumin both at 1 and 2 g kg^{-1} in the diet were highly improved FCR ($P \leq 0.01$) compared to birds in the control and fenugreek group. Performance Index (PI) values shows through the experimental period (T_1), (T_5) and (T_6), respectively resulted in extremely increase in PI value ($P \leq 0.01$) as compared to control (T_0) group. Better economic efficiency was recorded in T_1, T_5 (163.25%) and T_6 (156.41%) as compared to all the other dietary treatments and the control, respectively. These differences in relative economic efficiency (REE) showed that diet contained medicinal plant with such levels were more economical than the control diet and could be used economical as growth promoters. Therefore, turmeric and black cumin supplementation at 1g kg^{-1} might be acceptable for achieving optimum broilers performance, feed utilization and revenue cost ratio.

Key words: Black cumin · Fenugreek · Turmeric · Broiler performance · Economic efficiency

INTRODUCTION

The use of antibiotics in poultry feeds as a growth promoter is beneficial in improvement of production parameters and diseases prevention. However, the large utilization of antibiotics as growth promoters has led to the increasing resistance of pathogens to antibiotics and the accumulation of antibiotic residues in animal products and in the environment. This situation requires the world to restrict using antibiotic growth promoters in animal feeds [1,2]. The recent ban on the use of antibiotics as feed additives due to drug resistance in animals and the concern about the effect of drug residues in animals and consumable food products have driven the search for alternative feed additives, which are cheaper and safer for use as feed additives. Beneficial effects of bioactive plant substances in animal nutrition may include the stimulation of appetite and feed intake, the improvement in endogenous digestive enzyme secretion, absorption of nutrients and activation of immune response [3-5]. Furthermore, they show physio-pathological (anti-inflammatory, anti-oxidative) and anti-microbial activities (antibacterial, antiviral) [6-8].

Corresponding Author: Yonatan Kassu, Department of Animal and Range Science,
Wolaita Sodo University, P. O. Box 138, Wolaita Sodo, Ethiopia.

The positive impacts of medicinal plants are the result of synergy between complexes of active molecules, although detailed mechanisms of their actions in broiler chickens remains unclear [9]. Therefore, the objectives of the present study were set to investigate the effect of dietary supplementation of black cumin, fenugreek and turmeric at different level on growth performances and economic efficiency in commercial broiler chicken.

MATERIALS AND METHODS

Study Area: The experiment was carried out at Addis Ababa University college of Veterinary Medicine and Agriculture Poultry farm, Debre Zeit, located 47 km south east of Addis Ababa.

Preparation of the Experimental Diets: Three medicinal plants, namely *Nigella sativa L.* (black cumin), *Trigonella foenum-graecum L.* (fenugreek) and *Curicculum longa* (turmeric) was purchased from the vicinity local markets. The medicinal plants were washed with cold water and dried under shade. The dried turmeric root and fenugreek seeds were coarsely powdered, whereas, black cumin seed used as it is for feed formulation. The samples were further ground into powder by using a Wiley mill (Thomas® Wiley Cutting Mill) to pass through a 1 mm screen for proximate chemical analysis. The obtained powder was packed in a polythelene bag and preserved in the feed storage room until used for feed formulation.

Based on the chemical analysis result, seven treatment rations containing black cumin, fenugreek and turmeric at levels of 0, 1 and 2% of the total ration were formulated as: Control diet (T_0), black cumin seed 1 g kg^{-1} (T_1), black cumin 2 g kg^{-1} (T_2), fenugreek powder 1 g kg^{-1} (T_3), fenugreek 2 g kg^{-1} (T_4), turmeric powder 1 kg^{-1} (T_5) and turmeric 2 g kg^{-1} (T_6). The rations were formulated to be nearly isocaloric and isonitrogenous as shown in Table 2 with Metabolizable Energy (ME) content of 3000 kcal/kg Dry Matter (DM) and Crude Protein (CP) content of 22% during the starter phase of 1 to 28 days of age and ME content of 3200 kcal/kg DM and CP content of 20% for finisher phase of 29 to 49 days of age [10].

Management of Experimental Birds: A total of 315 Cobb 500 unsexed day-old broiler chicks with average initial body weight of 40.58±0.63 gram were randomly divided into seven dietary treatments and three replications per treatment thus having 15 chicks per replicate or pen. The birds were vaccinated against Newcastle (Hitchner-B1 at day 7 through an eye drop) and Lasota a booster dose at day 21 and Infectious Bursal Disease (Gumboro) at the age of 14 and 24 through chlorine free drinking water.

Table 1: Chemical composition of studied feed additives

Ingredients	DM%	Ash%	CP%	CF%	EE%	Ca%	P%	ME
Maize	90.33	9.11	6.89	4.62	2.4	1.66	0.30	3300.08
SBM	94.17	6.34	37.37	5.95	12.55	2.12	0.65	3847.28
NSC	92.93	7.5	36.79	16.03	8.16	1.44	0.65	2667.04
Wheat Bran	86.6	7.0	11.0	25.0	4.80	0.11	1.15	1709.02
Black cumin	94.37	12.29	25.77	14.73	36.88	1.94	0.75	4148.88
Fenugreek	92.77	7.98	46.71	8.30	7.03	1.62	0.25	3271.64
Turmeric	87.63	7.04	8.70	3.42	7.04	1.33	0.36	3884.34

**Nutrient per DM percentage, CF=Crude fiber; DM=Dry Matter; CP=Crude protein; EE=Ether Extract; Ca= Calcium; P=Phosphorous; SBM= Soya bean meal, NSC= Niger seed cake; ME= (kcal/kg DM).*

Health precaution and strict bio-security measures were taken during the entire experimental period. Before the commencement of the actual experiment, experimental pens, watering and feeding troughs were thoroughly cleaned, disinfected and sprayed against external parasites. The chicks were brooded using 200 watt electric bulbs with gradual height adjustment as sources of heat and light in a deep litter house covered with '*Teff*' straw. Feed were measured and offered twice a day while clean tap water was offered *ad libitum* throughout the experimental period.

Measurements: The amount of feed offered and refused per pen was recorded daily. Feed intake was determined as the difference between the feed offered and refused. Samples of feed offered and refused were taken daily per pen and pooled per treatment for the entire experimental period for chemical analysis.

Birds were weighed weekly in a group per pen and pen average was calculated. Body Weight (BW) change was calculated as the difference between the final and initial BW. Average daily BW gain (ADG) was calculated as the ratio of BW change to the number of experimental days. Feed consumption/gain (FCR) was computed as the ratio of ADG to daily feed consumption.

Performance index (PI): was calculated during studied growth periods according to the equation of [3-12] *PI* = (live body weight (kg) / feed conversion ratio) x 100. Mortality was registered as it occurred and mortality rate calculated.

Chemical Analysis: Samples of feed ingredients and treatment additives were analyzed for dry matter (DM), ether extract (EE), crude fiber (CF) ash and calcium

Table 2: Proportion of ingredients and gross composition of experimental diets

	Starter (1-28)							Finisher (29-49)						
Ingredients%	T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_0	T_1	T_2	T_3	T_4	T_5	T_6
Maize	56.97	56	56	57.50	58.31	57.75	57	60	60	59.52	61.5	61.50	60	60
SBM	28	28	28	28.48	28.30	29.61	29.67	20	20	20	20	19	20.45	20
Wheat bran	5.2	5.22	5	4	3	3	3	12.37	11.20	11	10	10	10	9
NSC	6.2	6.20	5.55	5.55	5	5.25	5	4	4.27	4	4	4	5	5.5
Limestone	2.33	2.28	2.18	2.20	2.10	2.18	2.12	2.4	2.30	2.2	2.22	2.18	2.25	2.18
Salt	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Vitamin-mineral Premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
DL-Methonine	0.30	0.5	0.17	0.17	0.17	0.12	0.12	0.18	0.18	0.18	0.18	0.18	0.18	0.18
L-Lysine HCl	0.15	0.3	0.25	0.25	0.27	0.24	0.24	0.20	0.20	0.25	0.25	0.29	0.27	0.29
Black cumin	-	1	2	-	-	-	-	-	1	2	-	-	-	-
fenugreek	-	-	-	1	2	-	-	-	-	-	1	2	-	-
Turmeric	-	-	-	-	-	1	2	-	-	-	-	-	1	2
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Calculated analysis%														
ME (kcal/kg DM)	2970	2995	2999	2898	2890	3005	2992	3198.90	3196.06	3199	3111	3117.4	3117.5	3123.36
CP%	21.75	21.95	21.93	21.60	21.90	21.80	21.92	19.60	19.50	19.75	20.00	20.05	19.61	19.63
Ca	1.06	1.04	1.00	1.10	1.05	1.35	1.40	1.04	1.13	1.12	1.02	1.16	1.07	1.09
P	0.46	0.49	0.5	0.48	0.46	0.44	0.48	0.57	0.59	0.56	0.55	0.57	0.53	0.58

SBM= Soya bean meal, NSC= Niger seed cake, T_0= Control basal diet, T_1= 1% black cumin, T_2= 2% black cumin, T_3= 1% fenugreek, T_4= 2% fenugreek, T_5= 1% turmeric, T_6= 2% turmeric, vitamin-mineral Premix contains, Vitamin A 1000 000 IU, Vitamin D 3200 000 IU. Vitamin E 1000 mg, Vitamin K3 225 mg, Vitamin B1 125 mg, Vitamin B2 500 mg, Vitamin B3 1375 mg, Vitamin B6 125mg, Vitamin B12 2 mg, Vitamin PP (niacin) 4, 000 mg, Folic Acid, 100 mg, choline chloride 37,500 mg, Calcium 29.7%, Iron 0.4%, Copper 0.05%. Manganese 0.6%, Zinc 0.7%, Iodine 0.01% Selenium 0.004%.

[13]. Nitrogen was determined by Kjeldhal procedure and crude protein (CP) was calculated by multiplying Nitrogen content by 6.25. Calcium was determined by atomic absorption spectrometer after dry ashing. The Metabolizable energy (ME) levels of feed ingredients was calculated using the formula ME (Kcal/kg DM) =3951 + 54.4 EE - 88.7 CF - 40.8 Ash [14].

Economic Efficiency (EE) Analysis: The feed cost per unit gain will be considered in order to evaluate the profitability of the medicinal plants inclusion levels on a net profit of bird sales. The economic efficiency was calculated as follows:

- Average BW (kg)
- Total revenue per bird sell (*assuming 80 ETB per kg BW constant for all treatment birds)*
- kg total feed consumption per bird
- Feed cost/ kg
- Total feed cost per bird
- Net revenue = Total revenue per bird ? Total feed cost per bird

  *Economical Efficiency (EE) = Net revenue / price of total feed consumed

  *REE= (E.E*100) / Control EE; where: control treatment group REE=100%

Statistical Analysis: Data were analyzed using the general linear models (GLM) procedures of SAS statistical package version 9.3 [15]. With the model consisting of treatments Duncan's multiple range tests were applied to separate the differences between treatment means.

RESULTS

Chemical Analysis: The proximate analysis of the feed ingredient and additives used in the experimental diets presented in Table 1. Fenugreek has a better composition of CP (46.70%), than black cumin and turmeric, while black cumin has higher CF (14.73%) and ash (12.3%) than fenugreek and turmeric, while, turmeric contained the lowest percent of CP (8.70%), CF (3.42%) and ash (7.04%), respectively. On the other hand, black cumin powder had the highest calculated metabolizable energy (4148.90 kcal/ kg). Higher energy level of black cumin could be due to higher fat level (36.88%) as compared to fenugreek (7.03%) and turmeric (9.63%), respectively. Values of live BW, BW gain (BWG), average daily gain (ADG) of the chicks fed on the experimental diets are shown in Table 3. There were no significant differences among treatments in live BW during the starter and finisher phase ($P \geq 0.05$). In regard to weight gains, similar trend was recorded as

Table 3: Effect of black cumin, fenugreek and turmeric supplemented diets on growth performance of broilers

	Treatments							
Parameters	T_0	T_1	T_2	T_3	T_4	T_5	T_6	P value
Initial BW	40.66±0.38	40.67±0.67	40.45±0.22	40.22±0.22	41.0±0.33	40.89±0.59	40.22±0.22	0.882
LBW (g/bird)								
Starter	881.11±11.43	847.78±21.16	862.89±29.41	811.33±22.06	791.30±31.17	858.0±40.85	909.56±29.70	0.123
Finisher	2088.89±31.50	2072.33±25.86	1956.60±66.81	1911.21±20.98	1856.25±0.98	2070.17±208.03	2097.10±37.10	0.315
BWG								
Starter	840.45±11.06	807.11±20.63	822.44±29.20	771.11±22.01	750.41±31.2	817.11±40.37	869.33±29.52	0.138
Finisher	1207.78±22.50	1224.56±26.0	1093.72±37.46	1099.88±41.44	1064.95±32.06	1212.17±190.41	1187.546±22.42	0.623
Overall	2048.23±31.15	2031.67±26.03	1916.16±66.60	1870.99±21.13	1815.36±0.88	2029.28±208.08	2056.87±37.04	0.315
ADG								
Starter	30.02±4.14	28.83±4.23	29.37±4.34	27.54±4.02	26.79± 4.27	29.19± 4.67	31.05±1.05	0.116
Finisher	57.51±1.07	58.31±1.24	52.08±1.79	52.37±1.98	50.71±1.53	57.72±9.07	56.55±1.07	0.623
Overall	43.77±6.17	43.57±6.62	40.73±5.16	39.96±5.63	38.75±5.41	43.45±7.59	43.80±5.74	0.993

*: P<0.05: *T_1= 1% black cumin, T_2= 2% black cumin, T_3= 1% fenugreek, T_4= 2% fenugreek, T_5= 1% turmeric, T_6= 2% turmeric, BW=body weight; LBW=live BW; BWG=BW gain; ADG=average daily gain*

Table 4: Effect of black cumin, fenugreek and turmeric supplemented diets on growth performance of broilers

	Treatments							
Parameters	T_0	T_1	T_2	T_3	T_4	T_5	T_6	P value
Feed intake (g/bird)								
Starter	68.89±10.34	51.78± 6.87	53.24±7.14	67.86±9.96	64.09 ±9.67	50.36±7.05	51.22±6.83	0.440
Finisher	151.79±9.64^{a}	102.92±3.65^{b}	113.88±5.23^{b}	171.21±9.43^{a}	162.96±9.86^{a}	119.82±5.90^{b}	120.54±6.39^{b}	<0.0001
Overall	5116.58±11.71^{ba}	3611.3±7.01^{c}	3882.27±8.11^{bc}	5495.35±13.73^{a}	5217.03±12.87^{ba}	3926.37±8.98^{bc}	3965.57±8.97^{bc}	0.0366
FCR								
Starter	2.24±0.0^{a}	1.87±0.05^{b}	1.87±0.05^{b}	2.45±0.06^{a}	2.44±0.14^{a}	1.81±0.06^{b}	1.76±0.08^{b}	<0.001
Finisher	2.69±0.25^{b}	1.84±0.12^{c}	2.19±0.08^{cb}	3.28±0.20^{a}	3.53± 0.20^{a}	2.22±0.22^{cb}	2.18±0.13^{cb}	<0.001
Overall	2.44±0.12^{b}	1.85±0.06^{c}	2.0±0.06^{c}	2.80±0.13^{a}	2.90±0.17^{a}	1.98±0.11^{c}	1.94±0.08^{c}	<0.001
Performance index								
Starter (1-28)	35.07±0.35^{dc}	48.09±3.68^{bac}	49.24±3.29^{bac}	31.46±2.77^{d}	36.82±7.83^{bdc}	53.14±6.86^{ba}	62.99±6.34^{a}	0.0065
Finisher (29-49)	68.26±12.77^{b}	131.0±16.88^{a}	80.88±5.11^{ba}	50.74±4.22^{b}	54.94±8.23^{b}	99.50±39.19^{ba}	92.35±1.89^{ba}	0.0256
Overall (1-49)	85.61±1.29^{b}	111.86±1.40^{a}	97.8±3.34^{ba}	68.26±0.75^{c}	64.01±0.03^{c}	104.55±10.51^{a}	108.10±1.91^{a}	<0.001
Mortality%	2.22	0	0	4.44	4.44	0	2.22	0.579
Survivability%	97.78±2.22	100±0.0	100±0.0	95.56±4.44	95.55±2.22	100±0.0	97.78±2.22	0.579

*: P<0.05; Means followed by the same letter in rows do not differ statistically from one another by the Duncan's multiple range test at 5% probability; FCR=feed conversion ratio; *T_1= 1% black cumin, T_2= 2% black cumin, T_3= 1% fenugreek, T_4= 2% fenugreek, T_5= 1% turmeric, T_6= 2% turmeric*

the previously obtained with body weights. It is evident that supplemental black cumin, fenugreek and turmeric to broiler basal diets statistically resulted in non-significant difference (P ≥ 0.05) with that of the control diets on both phases.

Similarly, there appeared dietary natural additives treatments did not affect (P ≥ 0.05) the ADG when broiler chicks fed black cumin, fenugreek and turmeric at value of 1 and 2 g kg-1 during the starter and finisher phases. There were no significant differences among treatments in feed consumption during the starter phase ($P \geq 0.05$). While the difference in feed intake between the diets was highly increased ($P \leq 0.01$) during the finisher period (49 days) (Table 4). Birds on the fenugreek supplemented diet and the control group were showed a higher ($P \leq 0.01$) feed intake during the 49 days of age, while there appeared a non-significant differences ($P \geq 0.05$) when broiler chicks fed both the treatment as well as the control diets during the starter phase. Birds fed diets supplemented with fenugreek at 1g kg^{-1} (171.21 g) and 2g kg^{-1} (162.96 g) has the highest amount of feed consumption value followed by the control diet (151.79 g). The overall feed consumption in the group was higher in T_3 than T_1, T_2, T_4, T_5 and T_6 but comparable with that of the control group (T_0).

Table 5: Effect of dietary levels of natural feed additives on economic efficiency

	Natural feed additive						
		Black cumin		Fenugreek		Turmeric	
Parameter	Control	1g kg^{-1}	2g kg^{-1}	1g kg^{-1}	2g kg^{-1}	1g kg^{-1}	2g kg^{-1}
Average BW kg	2.09	2.07	1.96	1.91	1.86	2.07	2.1
Feed intake per chick/kg	5.12	3.61	3.88	5.49	5.22	3.93	3.97
Feed cost per kg (ETB)	15.08	15.79	16.51	15.19	15.91	14.46	14.95
Total feed cost per chick	77.21	57.00	64.06	83.39	83.05	56.83	59.35
Selling revenue (ETB)	167.2	165.6	156.80	152.8	148.8	165.6	168.0
Net revenue (ETB)	89.99	108.6	92.74	69.41	65.75	108.77	108.48
Economic Efficiency (*EE*)	1.17	1.91	1.45	0.83	0.79	1.91	1.83
R.E.E	100	163.25	123.93	70.94	67.52	163.25	156.41

**Economic Efficiency (EE), Relative economical efficiency (REE), ETB= Ethiopian Birr, Total revenue per bird = assuming 80 ETB / kg live body weight. Current exchange rate: ETB = 0.04528 USD.*

From the result presented in Table 4, it was clear that a highly significant difference between treatments in FCR during the experimental periods was seen. Natural feed additive treatment diets ensured high FCR ($P \leq 0.01$) than the control diet group during both phases. The supplementation of turmeric at 2 and 1 g kg^{-1} and black cumin 1 and 2 g kg^{-1} in the diet vastly improved FCR ($P \leq 0.01$), respectively. There were no differences between fenugreek 1 and 2 g kg^{-1} groups and control groups ($P \geq 0.05$) during the starter phase.

In the finisher phase (28 to 49 days) similar pattern showed for fenugreek 1 or 2 g/ kg had 3.28-3.53 g feed/gram gains, respectively followed by control group (2.69 g feed/gram gains), being significantly impaired in FCR which means more feed is consumed to produce the same amount of meat than that needed in black cumin and in contrary turmeric at 1 or 2g kg^{-1} fed broiler groups that had a higher FCR of 1.8-2.2 g feed/gram weight, respectively ($P \leq 0.01$). Through the experimental period there was a similar trend to that of the finisher period as of supplementing turmeric at both 1g and 2g kg^{-1} levels (1.94 and 1.98) resulted ($P \leq 0.01$) in improved FCR compared to the control and fenugreek group. However, there were no significant difference ($P \geq 0.05$) between black cumin and turmeric fed birds both at 1 and 2 g kg^{-1} . Overall, the chicks fed with fenugreek at all ration did not utilize their diet efficiently as compared with those of the other treatment groups.

Performance Index (PI): Results presented in Table 4, indicated that there were significant differences among treatments in PI during the different experimental periods. Performance index values showed during the starter phase supplementing diet with turmeric at 2 and 1g kg^{-1} were significantly upturn PI values ($P \leq 0.01$). It is worthy to note that the fenugreek at 1g kg $^{-1}$ and control group recorded the lowest PI values, respectively. Performance index of the experimental groups during the finisher period (4-7 wks.) showed a substantial outcome ($P \leq 0.05$) as compared with control group. Among all tested dietary levels of studied additives, lower level of black cumin and turmeric had the best values of PI when compared to that of 2 g kg^{-1} upper levels. Moreover, through the experimental period there was a similar trend to that of the finisher phase as of supplementing black cumin at value of 1g kg^{-1} (111.89) and turmeric at value of 1 and 2g kg $^{-1}$ (104.55 and 108.10), respectively resulted in increased in *PI* value ($P \geq 0.01$) compared to the control group. Furthermore, survival rate was not changed among all treatments throughout the experimental period ($P = 0.05$). Overall mortality was 0.63% which is lower than accepted limit of commercial broiler.

Economic Efficiency: The results of economical efficiency (*EE*) and relative economical efficiency (*REE*) evaluation of feeding different experimental diets through the period of 49 days of age as affected by dietary black cumin, fenugreek and turmeric levels are presented in Table 5. It is obvious that including natural feed additives in the basal dietary treatments decreased production costs as compared to that of the control. It is worthy to note that supplementing 1g kg-1 levels of turmeric or black cumin to basal diets resulted to reduction in feed cost as compared to corresponding 2 g kg-1 levels.

Average *E.E* values of different treatments were 1.91 being the best for broilers fed black cumin and turmeric at 1 g kg^{-1} and 1.17 for chicks fed the control diet whereas the poorest value 0.83, 0.79 recorded from fenugreek 1 and 2 g kg^{-1}, respectively. According to the input-output analysis, the higher (REE) were recorded by the chicks fed

1 g kg^{-1} black cumin and turmeric diet group, followed by chicks fed 2 g turmeric and black cumin kg^{-1} of diet group, respectively.

DISCUSSION

The chemical analysis result revealed that fenugreek contain the highest CP content The present result is in agreement with the findings of Naidu *et al.* [16] who reported 43.8 CP%. In contrary, fenugreek had the lowest EE content which was similar to the findings of [17] who reported that 7.1% crude fat. Kochhar *et al*. [18] and El Nasri and El-Tinay [17] reported that fat, protein and fiber content of fenugreek seeds ranged from 6.53% to 7.1%, 24.4% to 25.8% and 6.28% to 9.3%, respectively. Al-Jasass and Al-Jasser [19] also reported that black cumin had 30–40% fat, 20–30% CP and 3.7–4.7% ash. Whereas according to the study of [20, 21] determined 288.5–298.4 g kg^{-1} CP content and 133.1-89.7 g kg^{-1} CF content in black cumin meal, respectively. Basavaraj *et al.* [22] also reported that CP, crude fat, CF and ash contents of turmeric were 6.72, 5.04, 3.96 and 7.72%, respectively. The results of the current study were not similar with the previous study that might be due to differences in many factors like location (soil type, altitude), plant strains (species and varieties), culture management and differences in extraction and analyzing methodology.

The effect of supplementing turmeric at both level resulted no change in LBW and BWG. This is in agreement with the findings of [23-26] who reported that broilers fed on turmeric 0.25, 0.50, 0.75 or 1, 10 and 20% level, respectively has no effect on live BW. Similarly, [27, 28, 29] reported that dietary turmeric had no change in LBW and BW gain of broiler chickens.

The current study in agreement with Abbas and Ahmed [30] who reported that the black cumin 1.5% had no effect on BW and BW gain. Similarly, Al-Mufarrej [31], exhibited non-significant differences in LBW between 7%, 1.4%, 2.1% or 2.8% black cumin treated groups compared to the control group. While, Ashayerizadeh *et al*. [32] reported black cumin exhibited higher BW gain compared to the garlic and control diet group.

The current study is comparable with Abbas, [33] who reported that consuming fenugreek seed did not-significantly affect LBW and BW gain relative to the control broiler diet. Conversely, [34-37]find out chicks fed on 1% fenugreek powder for 38, 15 and 42 days, respectively recorded significantly the heaviest BW and BWG compared to the control groups.

The lower body weight gain recorded during 0-42-day experimental period (1815.36 g) from fenugreek diet contain 2 g kg^{-1} which could be attribute to decreases in T_3 due to inhibition of triiodothyronine production by fenugreek seed [38]. Although, the anti-nutritional factors constitute in fenugreek like tannin, saponin and phytate. Tannins cause bind dietary protein and digestive enzymes to form complexes that are not readily digestible [39]. While, phytates potentially form complexes with minerals and dietary proteins and decreases their bioavailability [40]. Chicks fed diets supplemented with black cumin has low feed intake compared to all the treatments diets and control groups (see table 4). This is in agreement with Abbas and Ahmed [30] who mentioned that, addition of 1 or 2 g kg^{-1} ground black cumin to the broiler diet significantly decreased feed intake. Similarly, Durrani *et al*. [41] noticed that significantly lower feed consumption occurred as the result of offering black cumin to broilers at the rate of 40g/kg.

A similar result was obtained by Halle *et al*. [42] who explained that the addition of essential oil from black cumin affected feed intake in broilers. Furthermore, turmeric 1 and 2g kg^{-1} in the basal diet do not have significance difference in feed intake. This figure corresponds with Mondal *et al*. [26], reported that turmeric 0.5, 1 and 1.5% inclusion in the broiler diet do not have effect in feed intake. In former study by Wuthi-udomler *et al*.[43] and Durrani *et al*. [44] also observed less feed consumption in turmeric feed at 5g kg^{-1} of broilers diets. The present study finding in contradictory with Al-jaleel [45] and Mondal *et al*. [26] result that turmeric diet group had high feed intake compare to the control diet group.

Whereas, chicks fed on diets supplemented with fenugreek consumed significantly more feed. same report presented by different researchers [46, 47, 35] reported that fenugreek seeds supplemented diet significantly increased feed intake value during 42 days of age, while there appeared a no significant differences during the 21 days of age as compared with control group.

The improvement in feed intake with the addition of fenugreek in the present study could be attributed to the carbohydrates and their main component (galactomannan) which stimulated the appetizing and digestive process in animals. The increased FCR in the black cumin and turmeric treated birds were in agreement with the reports of Guler *et al*. [48] who reported an improved FCR value of birds treated with 1g kg^{-1} black cumin seeds at the age of 1 to 42 days. The effect of feeding different levels of black cumin on the performance of broiler chicks, (20, 30

and 40 gm/kg feed). The results revealed that level 40 gm/kg feed had significantly higher weight gain, with lowest feed intake and better feed efficiency and significantly higher dressing percentage as compared to the control [41]. Similarly, Khan *et al*. [49] found out 2.5 and 5.0%, black cumin seed groups had significantly improve feed conversion efficiency than the antibiotics and control. Also, black cumin oil and black cumin seed in broiler diet improved feed conversion [50, 51, 32].

The paramount FCR exhibited in turmeric 2g kg^{-1} followed 1g kg^{-1} , treated groups whereas the poorer FCR shown in fenugreek 1 and 2 g kg^{-1} group broilers. Broilers that received diet with 0.4 and 0.5% of turmeric powder utilized their diets more efficiently than the control group [36, 43, 44, 45 and 52]. also Mondal *et al*. [26] reported that supplementation of turmeric powder at the 0.5 and 1.5% has significant effect on FCR when compare to the control diet group.

This higher FCR in turmeric group is due to the active agent curcumin which is responsible for the increased bile acid secretion [53, 54]. Correspondingly, Platel and Srinivasan [55] observed that curcumin promote pancreatic digestive enzymes such as lipase, amylase and proteases, which play important roles in the digestion process. Moreover, Platel and Srinivasan, [56] observed an enhanced digestion and a reduction in feed passage time in the digestive tract as a result of curcumin.

In contrary fenugreek group show the lowest feed efficiency this is because fenugreek contains fenugreekine, a steroidal sapogenin peptide ester has hypoglycemic properties. It is shown to delay gastric emptying, slow carbohydrate absorption and inhibit glucose transport. Contrastingly the improvement in feed efficiency in black cumin and turmeric treatment diets it may be due to optimum antioxidant activity, stimulate, digestion and antibacterial properties of both black cumin and turmeric powder treated birds at both levels.

The effect of the natural additive treatments on performance through the experimental period and measured parameters are obviously variable. This may be attributable to differences in medicinal plant growing location, plant species, environment, composition of the various phytogenic additives and the concentrations of the active substances and their biological activity, respectively.

Mortality: In the present study only one bird from control and one from 2% dietary fenugreek group were died during the entire experimental period and no treatment related adverse effect was detected, except fenugreek group exhibit diarrhea at the beginning of the feeding trial especially in higher level encountered with diarrhea. This could be attributed by maximum concentration of saponin and alkaloids, which are one of the anti-nutritional factors present in the fenugreek. Also, through the experimental period supplementing fenugreek cause chicken body to smell maple syrup (bad odour). This is due to a metabolite called sotolon and the alkaloids (trigonelline). Mortality was detected only from heart failure, which frequently observed in rapid growing of broilers.

Economic Efficiency: Economical efficiency is defined as the net revenue per unit feed cost calculated from input output analysis as described by Hassan *et al*. [57]. The averages of improvement compared to the control diet due to feeding studied natural feed additives ranged between 23.93-63.25% for black cumin at 2g kg^{-1} , turmeric and black cumin at 1 g kg^{-1} , respectively. Moreover, better REE also recorded from turmeric 2g kg^{-1} (56.41%) which is superior relative economical than the control, black cumin 2g kg^{-1} and the fenugreek groups dietary diet groups.

These differences in relative economic efficiency (REE) showed that diet contained medicinal plant with such levels were more economical than the control diet and could be used economical as growth promoters. These improvements could be attributed to the better findings obtained either in growth performance, feed utilization of broilers or reducing the amount of feed required to produce BW gain. These results agree with finding of [51, 58-62] who reported that the inclusion levels of herbal feed additives in diets recorded the least cost/kg gain and the highest percent of economic efficiency compared with that of the un-supplemented diet.

CONCLUSION

Considering the results obtained in the current study it could be concluded that dietary inclusion of black cumin and turmeric may not increase feed consumption and BW gain in broiler chickens, but has the potential to improve feed efficiency. Nevertheless, dietary black cumin and turmeric supplementation (1g kg^{-1}) might be acceptable for achieving optimum broilers performance, feed utilization and revenue cost ratio. Therefore, they could be used as economical natural growth promoter. However, further studied are needed to characterize the medicinal plants with regard to their mode of action of nutrient digestibility, amino acid profile and content of anti-nutritional require more in-depth characterization.

RREFERENCES

1. Nisha, A.R., 2008. Antibiotic residues: A global health hazard. Veterinary World, 1(12): 375-377.
2. Raghdad, A. and A. Al-Jaleel, 2012. Use of turmeric (Curcuma longa) on the performance and some physiological traits on the broiler diets. The Iraqi Journal of Veterinary Medicine, 36(1): 51-57.
3. Ertas, O.N., T. Guler, M. Ciftci, B. Dalkilic and U.G. Simsek, 2005. The effect of an essential oil mix derived from oregano, clove and anise on broiler performance. International Journal of Poultry. Science, 4: 879-84.
4. Cross, D.E., R.M. McDevitt, K. Hillman and T. Acamovic, 2007. The effect of herbs and their associated essential oils on performance, dietary digestibility and gut microflora in chickens from 7 to 28 day of age. British Poultry. Science, 48: 496-506.
5. Steiner, T., 2009. Phytogenics in animal nutrition: natural concepts to optimize gut health and performance. Nottingham: Nottingham University Press.
6. Nasir, Z. and M.A. Grashorn, 2010. Effects of Echinacea purpurea and Nigella sativa supplementation on Broiler performance, carcass and meat quality, Journal of Animal Feed Science, 19: 94-104.
7. Toghyani, M., M. Toghyani, A.A. Gheisari, G. Ghalamkari and M. Mohammadrezaei, 2010. Growth performance, serum biochemistry and blood hematology of broiler chicks fed different levels of Black seed (Nigella sativa) and Peppermint (Mentha piperita), Journal of Livestock Science, 129: 173-178.
8. Toghyani, M., M. Toghyani, A. Gheisari, G. Ghalamkari and S. Eghbalsaied, 2011. Evaluation of cinnamon and garlic as antibiotic growth promoter substitutions on performance, immune responses, serum biochemical and hematological parameters in broiler chicks, Journal of Livestock Science, 138: 167-173.
9. Puvaca, N., V. Stanacev, D. Glamocic, J. Levic, L. Peric, V. Stanacev and D. Milic, 2013. Beneficial effects of phyto additives in broiler nutrition. World. Poultry Science Journal, 69(1): 27-34.
10. Leeson, S. and J.D. Summers, 2005. Commercial Poultry Nutrition. 3rd Edition, Nottingham University Press, Canada, pp: 398.
11. North, M.O., 1981. Commercial Chicken Production Manual, 2nd Edition. AVI Publishing Company Inc, USA.
12. Ali, M.A., 1999. Effect of probiotics addition to broiler rations on performance and some blood constituents. Egypt. Poultry, Science Journal, 19: 161-177.
13. AOAC., 2000. Food composition; additives; natural contaminants. In: Official Methods of Analysis of AOAC International, 17th (edited by H. William), Washington, DC, 2: 12-42.
14. Wiseman, J., 1987. Feeding of Non-Ruminant Livestock butter worth and Co. Ltd., London, UK.
15. SAS Institute Inc., 2010. Statistical Analysis Software Version 9.3. SAS Institute Inc., Cary, North Carolina, USA.
16. Naidu, M.M., B.N. Shyamala, J.P. Naik, G. Sulochanamma and P. Srinivas, 2011. Chemical composition and antioxidant activity of the husk and endosperm of fenugreek seeds. LWT - Food Science and Technology, 44: 451-56.
17. El-Nasri, N.A. and A.H. El-Tinay, 2007. Functional properties of fenugreek (Trigonella foenum graecum) protein concentrate, Food Chemistry, 103(2): 582-589.
18. Kochhar, A., M. Nagi and R. Sachdeva, 2006. Proximate composition available carbohydrates, dietary fiber and anti-nutritional factors of selected traditional medicinal plants, Journal of Human Ecology, 19: 195-199.
19. Al-Jasass, F.M. and M.S. Al-Jasser, 2012. Chemical composition and fatty acid content of some spices and herbs under Saudi Arabia conditions. The Scientific World Journal, 1: 859-892.
20. Abd El-Rahman, H.H., A.A. Abedo, F.M. Salman, M.I. Mohamed and M.M. Shoukry, 2011. Partial substitution of cumin ceed meal by jatropha meal as a potential protein source for fed. Africa Journal of Biotechnology, 10(68): 15456-15461.
21. Tekeli, A., 2014. Nutrıtıonal Value of Black Cumın (Nigella Sativa) Meal as an Alternatıve Proteın Source in Poultry Nutrıtıon Nutritional Value of Black Cumin (Nigella Sativa) Meal as an Alternative Proteın Source in Poultry Nutrition. Journal of Animal Science Advance, 4(4): 797-806.
22. Basavaraj, M., V. Nagabhushana, N. Prakash, S. Mallikarjunappa, M.M. Appannavar and P. Wagmare, 2010. Effect of dietary supplementation of Pulvis Curcuma Longa on the voluntary feed intake, nutrient digestibility and growth performance of Broiler rabbits under summer stress, Veterinary World, 3(8):369-372.
23. Namagirilakshmi, S., 2005. Turmeric (Curcuma longa) as nutraceutical to improve broiler performance. MSc, thesis, Tamil Nadu Veterinary and Animal Sciences University, Chennai, India.

24. Nouzarian, R., S.A. Tabeidian, M. Toghyani, G. Ghalamkari and M. Toghyani, 2011. Effect of turmeric Powder on Performance, Carcass Traits, Humoral Immune Responses and Serum Metabolites in Broiler Chickens, Journal of Animal Feed Science, 20: 389-400.
25. Qasem, M.A.A., M.S. Alhajj, A.R. Ger El Nabi and S.I. Al-Mufarrej, 2015. Effect of Turmeric Powder as a Dietary Supplement on Performance Indicator and Immune Responses in Broiler Chickens, Journal of Animal Veterinary Advance, 14(2): 30-35.
26. Mondal, M.A., T. Yeasmin, R. Karim, M.N. Siddiqui and M.A. Sayed, 2015. Effect of Dietary Supplementation of turmeric (Curcuma Longa) Powder on the Growth Performance and Carcass Traits of Broiler Chicks. SAARC J. Agri., 13(1): 188-99.
27. Mehala, C. and M. Moorthy, 2008. Production performance of broilers fed with Aloe vera and Curcuma longa (turmeric). International Journal Poultry Science, 7: 852-856.
28. Akbarian, A., A. Golian, H. Kermanshahi, A. Gilani and S. Moradi, 2012. Influence of turmeric rhizome and black pepper on blood constituents and performance of broiler chickens, Africa Journal of Biotechnology, 11: 8606-8611.
29. Abou-Elkhair, R., A. Ahmed and S. Selim, 2014. Effects of Black Pepper (Piper Nigrum), turmeric Powder (Curcuma Longa) and Coriander Seeds (Coriandrum Sativum) and Their Combinations as Feed Additives on Growth Performance, Carcass Traits of Broiler. Asian Australia Journal of Animal Science, 7 (6): 847-54.
30. Abbas, T.E. and M.E. Ahmed, 2010. Black cumin for poultry feed, World Poultry. Science Journal, 23: 66-80.
31. Al-Mufarrej, S.I., 2014. Immune-Responsiveness and Performance of Broiler Chickens Fed black cumin (Nigella Sativa L.) Powder. Journal. Saudi Social Agriculture Science, 13(1): 75-80.
32. Ashayerizadeh, O., B. Dastar and M.S. Shams, 2009. Use of Garlic (Allium Sativum), black cumin Seeds (Nigella Sativa L.) and Wild Mint (Mentha Longifolia) in Broiler Chickens Diets.pdf, Journal Animal Veterinary Advance, 8(9): 1860-63.
33. Abbas, R.J., 2010. Effect of using fenugreek, parsley and sweet basil seeds as feed additives on the performance of broiler chickens, International Journal Poultry Science, 9: 278-282.
34. Weerasingha, A.S. and N.M. Atapattu, 2013. Effects of fenugreek (Trigonella foenum-graecum L.) Seed Powder on Growth Performance, Visceral Organ Weight, Serum Cholesterol Levels and the Nitrogen Retention of Broiler Chicken. Tropical Agriculture. Research, 24(3): 289-95.
35. Mamoun, T., M. Mukhtar and M. Tabidi, 2014. Effect of fenugreek Seed Powder on the Performance, Carcass Characteristics and Some Blood Serum Attributes, Advance Research Agriculture Veterinary Science, 1(1): 6-11.
36. Al-Mashhadani, H.E., 2015. Effect of Different Levels of turmeric (Curcuma Longa) Supplementation on Broiler Performance, Carcass Characteristic and Bacterial Count, Egypt Poultry Science Journal, 35(I): 25-39.
37. Mahejabin, N., M. Mostofa, F. Akter, S. Das and M. Alam, 2015. Effects of Neem, turmeric and Papaya Leaf Extract Mixture on Growth Performance of Broilers, *International* Journal Natural Social Science, 2: 17-21.
38. Panda, S., P. Tahiliani and A. Kar, 1999. Inhibition of triiodothyronine production by fenugreek seed extract in mice and rats. Pharmacology Research, 40: 405-409.
39. Soetan, K.O. and O.E. Oyewole, 2009. The need for adequate processing to reduce the ant-nutritional factors in plants used as human foods and animal feeds: A review, African Journal Food Science, 3(9): 223-232.
40. Reddy, N.R., 2002. Occurrence, distribution, content and dietary intake of phytate. In: Reddy N.R, Sathe S.K (eds), Food Phytates. CRC Press, Boca Raton Florida, pp: 25-51.
41. Durrani, F.R., N. Chand, K. Zaka, A. Sultan, F.M. Khattak and Z. Durrani, 2007. Effect of different levels of feed added black seed on the performance of broiler chicks, Pakistan Journal Biology Science, 10: 4164-4167.
42. Halle, I., R. Thomann and G. Flachowsky, 1999. Effect of ethereal (essential) oil and oil seeds on the growth of broilers, Germany, 23: 469-472.
43. Wuthi-udomler, M., W. Grisanapan, O. Luanratana and W. Caichompoo, 2000. Anti-fungal activities of plant extracts. South East Asian Journal Tropical Medicine Public Health, 31(1): 178-182.
44. Durrani, F.R., M. I smail, A. Sultan, S.M. Suhail, N. Chand and Z. Durrani, 2006. Effect of Different Levels of Feed Added turmeric (Curcuma Longa) on The Performance of Broiler Chicks, Journal Agriculture Biology Science, 1(2): 9-11.

45. Al-Jaleel, R., 2012. Use of turmeric (Curcuma Longa) on the Performance and Some Physiological Traits on the Broiler Diets, The Iraqi Journal Veterinary Medicine, 36 (1): 5-57.
46. Michael, D. and D. Kumawat, 2003. Legend and archeology of fenugreek, constitutions and modern applications of fenugreek seeds. International Symposium, USA, 41-42.
47. Alloui, N., S. Aksa, M. Alloui and F. Ibrir, 2012. Utilization of fenugreek (Trigonella foenum-graecum) as Growth Promoter for Broiler Chickens, Journal World Poultry Research, 2(2): 25-27.
48. Guler, T., B. Dalk, O.N. Ertas and M. Çiftçi, 2006. The Effect of Dietary Black Cumin Seeds (Nigella Sativa L.) on the Performance of Broilers, Asian-Aust. Journal Animal Science, 19(3): 425-30.
49. Khan, S., J. Ansari and G. Abbas, 2012. Black cumin seeds as phytogenic product in broiler diets and its effects on performance, blood constituents, immunity and caecal microbial population, Italian Journal Animal Science, 11(77): 438-44.
50. Abu-Dieyeh, Z. and M. Abu-Darwish, 2008. Effect of Feeding Powdered Black Cumin Seeds (Nigella Sativa L.) on Growth Performance of 4-8 Week-Old Broilers, *Journal Animal Veterinary* Advance, 7(3): 292-96.
51. Abaza, I.M., M.A. Shehata, M.S. Shoieb and I.I. Hassan, 2008. Evaluation of Some Natural Feed Additive in Growing Chicks Diets, Int. J. Poult. Sci., 7(9): 872-79.
52. Al-Sultan, S.I., 2003. The effect of Curcuma longa (turmeric) on overall performance of broiler chickens, International Journal Poultry Science, 2: 351-353.
53. Platel, K. and K. Srinivasan, 2000. Stimulatory influence of select spices on bile secretion in rats. Nutr. Res., 20: 1493-1503.
54. Platel, K. and K. Srinivasan, 2004. Digestive stimulant action of spices: a myth or reality? Indian J. Med. Res., 119: 167-179.
55. Platel, K. and K. Srinivasan, 2000. Influence of dietary spices or their active principles on pancreatic digestive enzymes in albino rats. Nahrung., 44: 42-46.
56. Platel, K. and K. Srinivasan, 2001. Studies on the influence of dietary spices on food transit time in experimental rats. Nutr. Res., 21: 1309-1314.
57. Hassan, I., A.G. Abdallah and S. El-Wafa, 1996. Utilization of decorticated local cottonseed meal in broiler diets. Egypt Poultry Science Journal, 16: 31-49.
58. El-Latif, S.A., A. Faten Ahmed and A.M. El-Kaiaty, 2002. Effects of feeding dietary thyme, black cumin, dianthus and fennel on productive and some metabolic responses of growing Japanese quail, Egypt Poultry Science Journal, 22(1): 106-125.
59. Zeinab Abdo M.A., A.Z.M. Soliman and S. Barakat Olfat, 2003. Effect of hot pepper and marjoram as feed additives on the growth performance and the microbial population of the gastrointestinal tract of broilers, Egypt Poultry Science Journal, 23(I): 91-113.
60. Hassan I.I., A.A. Asker and G.A. El-Shourbagy, 2004. Influence of some medicinal plants on performance, physiological and meat quality traits of broiler chicks, Egypt Poultry Science Journal, 24: 247-266.
61. Osman, M., H.M. Yakout, H.F. Motawe and W.F. El-Arab, 2010. Productive, Physiological, Immunological and Economical Effects of Supplementing Natural Feed Additives to Broiler Diets. Egypt. Poult. Sci., 30(I): 25-53.
62. Jahan, M., 2012. Dietary black cumin (Nigella Sativa) on growth and meat yield performance of broilers, MSc Thesis, Bangladesh Agricultural University Mymensingh, Bangladesh.