Effects of different levels of turmeric, fenugreek and black cumin on carcass characteristics of broiler chicken

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Journal of Livestock Science (ISSN online 2277-6214) 8: 11-17
Received on 10/11/2016; Accepted on 3/1/2017

Abstract

A study was conducted to find the effect of black cumin (*Nigella sativa* L.), fenugreek (*Trigonellafoenum-graecum* L.) and turmeric (*Curcuma longa* L.) seeds as natural feed additives on broiler carcass characteristics. A total of 315-day-old unsexed broiler chicks (Cobb 500) were randomly allocated to seven treatment groups with three replicates (15 chicks each) reared for 49 days. The dietary treatments consisted of the basal diet as control, black cumin seed, fenugreek and turmeric powder at (1and 2 g kg^{-1} of the total ration). At the end of the experiment, two birds per replicate were randomly selected and slaughtered to determine carcass characteristics. The result revealed that commercial carcass yield was significantly influenced ($P \leq 0.05$) by the natural dietary treatments compare to the control birds. There was significant difference ($P \leq 0.05$) in edible carcass yield among the treatment groups. Supplementation with the natural feed additives significant promoted breast meat yield ($P \leq 0.05$). However, there is no significant change ($P \geq 0.05$) in thigh + drumstick, wing and back meat yield between the dietary treatments and the control group birds. There was no a significant difference ($P \geq 0.05$) in relative weight of liver, heart and GIT among treatment groups. However, supplementation of fenugreek powder at level of 1 and 2 g kg^{-1}had a significant effect ($P \leq 0.05$) on gizzard and giblet ratio as compared to the control. Abdominal fat ratio were significantly reduced ($P \leq 0.05$) due to dietary supplementation of turmeric at (1 to 2 g/kg) compared to that of the control and the other dietary treatment group birds. black cumin and fenugreek do not have effect in carcass traits. However, turmeric can be included as feed additive at a level of (1 and 2 g/kg in the total ration) for better and positive results on carcass yield and lean meat (breast meat) production which could reduce the risk of hyperlipidemia and increase consumer acceptability.

Keywords: Turmeric; Fenugreek; Black cumin; Carcass weight; Abdominal fat;

Introduction

The recent ban on the use of antibiotics as feed additives is due to drug resistance in animals and the concern about the effect of drug residues in animals and consumable food products. As this may negatively affect the profitability of the poultry, feed industries will have to search for new alternatives. Presently, there is an increasing interest to find alternative substances and strategies to improve the health status of the farm animals for human consumption (Wang *et al.,* 2015). Natural alternatives with similar beneficial effects like synthetic antibiotics have been intensified (Khan, 2011). Some phytogenic feed additives have been successfully incorporated into the feeding standard of poultry birds without any deleterious effect or toxic residues (Oyekunle and Owonikoko, 2002).

The increased use of medicinal plants in animal nutrition is the result of their positive properties like: anti-inflammatory properties, antiseptic, sedative, bactericidal, fungicidal, antiviral, antioxidant capacity, growth-promoting efficacy, dietary palatability, gut functions, immune stimulating effects, stimulation of the secretion of digestive enzymes and absorption of nutrients (Ertas*et al.,*2005; Cross *et al.,* 2007; Steiner, 2009). Prominent among these plants are turmeric (*Curcuma longa* L.), fenugreek (*Trigonellafoenum-graecum* L.) and black cumin (*Nigella sativa* L.). However, the results have not been consistent. Therefore, the purpose of the present study was to evaluate the effect of dietary supplementation of turmeric, fenugreek and black cumin on carcass characteristics of broiler chickens.

Materials and Methods

Study area

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

Preparation of the experimental diets

Three medicinal plants, namely *Nigella sativa L.* (black cumin), *Trigonellafoenum-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 1 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 (Leeson and Summers, 2005).

Management of experimental birds

A total of 315Cobb 500 unsexed day-old broiler chicks with average initial body weight of 40.58±0.63 gram was 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. 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. 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.

Table 1.Proportion of ingredients and gross composition of experimental diets

Ingredients %	***Starter (1-28)***								***Finisher (29-49)***					
	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
Vit-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	3198.9	3196.1	3199	3111	3117.4	3117.5	3123.4
CP %	21.75	21.95	21.93	21.60	21.90	21.80	21.92	19.60	19.50	19.75	20.0	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-mineralPremix contains, Vit.A 1000 000 IU, Vit.D 3200 000 IU. Vit.E 1000 mg, Vit.K3 225 mg, Vit.B1 125 mg, Vit.B2 500 mg, Vit.B3 1375 mg, Vit.B6 125mg, Vit.B12 2 mg, Vit. PP (niacin) 4, 000 mg, Folic Acid, 100 mg, choline chloride 37,500 mg, Ca 29.7 %, Fe 0.4 %, Cur 0.05 %. Mn 0.6 %, Zn 0.7%, I 0.01 % ,Se 0.004 %.

Carcass measurement

At the end of the experiment, a bird from each replicate whose live weight was closest to the mean weight of the birds were randomly selected, weighted and starved for twelve hours before slaughtering. The birds were humanly slaughtered by severing the jugular vein, exsanguination followed by dipped into hot water and defeathered. carcasses were manually eviscerated (removing of lower leg, head, heart, crop, pancreas, kidney, lungs, proventriculus, small intestine, large intestine, caeca and urogenital tracts) and suspended from the evisceration line and allowed to drain for 15 minutes prior to weighing (Yitbarek, *et al.*, 2016). The back, thighs, drumsticks, two wings and breast were used to evaluate the carcass yield on a commercial basis. Dressing percentage was calculated as the proportion of carcass weight to slaughter weight multiplied by 100.

Gizzard, skin and liver are edible in most places in Ethiopia and included in the edible component. These were added to the carcass weight and another version of dressing percentage was also calculated. The eviscerated carcass such as back, thighs, drumsticks, wings and breast were separated and weighed, and then their weight were divided by slaughter weight and multiplied by 100 to determine percentage weights of each component. (Yitbarek *et al.* 2016). The giblets (heart, gizzard and liver) were weighed and its percentage was calculated as the proportion of slaughter weight. Fat around the proventriculus and gizzard and against the abdominal wall and the cloacae was collected and weighed; and fat percentage was calculated as the proportion of slaughter weight.

Chemical analysis

Samples of feed ingredients and treatment additives were analyzed for dry matter (DM), ether extract (EE), crude fiber (CF) ash and calcium (A.O.A.C, 2000). 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 (Wiseman, 1987).

Statistical analysis

Data were analyzed using the general linear models (GLM) procedures of SAS statistical package version 9.3 (SAS, 2010). With the model consisting of treatments Duncan's multiple range tests were applied to separate the differences between treatment means.

Results

Growth performance The values of live BW, BW gain (BWG), average daily gain (ADG) of the chicks fed on the experimental diets are shown in Table 2**.** There were no significant differences between treatments in live BW

during the through experimentalperiod ($P \geq 0.05$). In regard to weight gains, similar trend was recorded as the previously obtained with body weights. It is evident that supplemental black cumin, fenugreek and turmeric to broiler do not have significant effect ($P \geq 0.05$) in BW and BWG.Similarly, there appeared dietary natural additives treatments did not affect ($P \geq 0.05$) the ADG when broiler chicks fed black cumin, fenugreek and turmeric at value of 1 and 2 g kg^{-1}. There were no significant differences among treatments in feed intake during the starter phase ($P \geq 0.05$). Birds on the fenugreek supplemented diet and the control group were showed a higher ($P \leq 0.05$) feed intake. 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 intake 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 2. Effect of black cumin, fenugreek and turmeric supplemented diets on growth performance of broilers

Parameters	Treatments							
	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)	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	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	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
Feed intake (g/bird)	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	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
Mortality %	2.22	0	0	4.44	4.44	0	2.22	0.579

*: 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*, FCR=Feed conversion Ratio.

Table 3. The effect of dietary inclusion of black cumin, fenugreek and turmeric on carcass component of broiler chicken

Parameters	Treatments							
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	P value
Slaughter Wt. (g)	2076.67 ±38.79	2003.33 ±46.95	1995.0 ±37.13	1878.33 ±42.85	1901.83 ±180.83	2020.0 ±112.90	2084.17 ±37.43	0.565
Carcass wt. (g)	1371.10 ±18.64^{ab}	1302.82 ±43.24^{ab}	1273.12 ±10.72^{ab}	1184.57 ±30.10^{b}	1161.8 8±80.31^{b}	1313.83 ±67.89^{ab}	1423.75 ±36.35^{a}	0.034
Carcass yield	66.07 ±0.69^{ab}	64.97 ±0.91^{bc}	63.88 ±0.77^{bc}	63.08 ±0.97^{cd}	60.89 ±0.76^{d}	65.15 ±1.08^{bc}	68.29 ±0.93^{a}	< 0.0001
Edible carcass wt. (g)	1524.13 ±17.05^{ab}	1460.47 ±44.75^{abc}	1437.07 ±14.17^{abc}	1330.42 ±30.17^{bc}	1303.62 ±60.9^{c}	1476.33 ±75.83^{abc}	1576.67 ±40.23^{a}	0.035
Edible carcass Dressing %	73.45 ±0.68^{ab}	72.85 ±0.75^{b}	72.11 ±0.84^{b}	70.84 ±0.54^{bc}	68.36 ±0.80^{c}	73.24 ±1.40^{ab}	75.61 ±0.83^{a}	< 0.0001

Carcass characteristics

The slaughter weight, thigh + drumstick, wings, heart, liver, gizzard and kidney percentages and GIT were not significantly different among treatments. However, there were a significant difference ($P \leq 0.05$) in commercial carcass yield and its percentage, edible carcass yield and its percentage, breast meat weight and its percentage, giblet percentage and back weight (Table 4).

Commercial carcass yield was affected ($P \leq 0.05$) by treatments. The commercial carcass weight was 131.10 g (T_0), 1302.82 g (T_1), 1273.12 g (T_2), 1184.57 g (T_3), 1161.88 g (T_4), 1313 g (T_5) and 1423.75 g (T_6). Inclusion of turmeric 2 kg^{-1} powder (T_6) caused a dose-dependent increase in carcass weight in comparison with the control (T_0) and other treatment group chickens ($P \leq 0.05$). The paramount results in terms of commercial carcass percentage in group T_6 (68.29%) followed by group T_0 (66.07%) and the least T_4 (60.89%).

Table 4. The relative weight of carcass yield and internal organ weight of broilers Chicken

Parameters	Treatments							
	T_0	T_1	T_2	T_3	T_4	T_5	T_6	P value
Breast (g)	638.93±21.06 ^{ab}	579.67±33.81^{bc}	548.80±6.61^{bc}	532.37±15.50 ^{c}	533.83±57.28 ^{c}	602.18 ±42.42^{abc}	685.88 ±20.40 ^{a}	0.014
Breast %	30.80±1.02 ^{ab}	28.85±1.17^{bc}	27.54±0.45^{c}	28.35±0.64^{bc}	27.94±0.82^{c}	29.72±0.65^{bc}	32.89±0.59^{a}	0.0004
Thigh +Drum (g)	430.17±9.61	415.32±14.75	423.08±8.03	387.32±12.46	370.93±40.06	425.20±25.95	442.27±10.84	0.198
Thigh + Drum%	20.73±0.43	20.79±0.90	21.23±0.48	20.64±0.61	19.40±0.6	21.05±0.46	21.23±0.43	0.262
Wing (g)	79.50±1.01	78.67±1.98	78.40±1.61	77.50±2.59	73.50±6.22	81.07±3.26	78.68±3.32	0.793
Wing%	3.83±0.04	3.93±0.08	3.93±0.05	4.13±0.12	3.88±0.06	4.03±0.11	3.77±0.09	0.065
Back (g)	222.50±7.51^{ab}	229.17±20.79 ^{a}	222.83±8.39 ^{ab}	187.38±7.46^{bc}	183.62±19.93 ^{c}	205.38 ±11.91^{abc}	216.92 ±5.07 ^{ab}	0.039
Back %	10.71±0.30	11.41±0.92	11.18±0.40	9.96±0.22	9.67±0.42	10.36±0.93	10.41±0.08	0.309
Gizzard (g)	32.0±2.33 ^{b}	33.35±1.44 ^{b}	31.38±1.06 ^{b}	37.10±1.52 ^{ab}	39.90±1.90 ^{a}	34.98±1.02 ^{ab}	36.0±3.06 ^{ab}	0.038
Gizzard%	1.54±0.11 ^{c}	1.67±0.08^{bc}	1.57±0.04 ^{c}	1.98±0.10 ^{ab}	2.14±0.11 ^{a}	1.75±0.06^{bc}	1.74±0.16^{bc}	0.001
Liver (g)	47.92±2.55	46.27±1.66	43.42±1.85	42.48±3.02	49.8±3.08	42.52±2.33	45.65±2.88	0.374
Liver %	2.31±0.11	2.32±0.05	2.18±0.11	2.27±0.17	2.68±0.26	2.11±0.03	2.19±0.13	0.163
Heart (g)	11.53±0.82	10.10±0.61	11.47±0.88	11.33±0.78	10.90±1.0	10.88±0.49	11.27±0.47	0.844
Heart %	0.56±0.04	0.51±0.03	0.58±0.05	0.60±0.03	0.59±0.05	0.55±0.04	0.54±0.02	0.673
Giblet (g)	91.45±5.11	89.72±2.11	86.27±1.31	90.92±3.17	100.08±4.40	88.38±2.87	92.92±2.35	0.129
Giblet %	4.41±0.24 ^{b}	4.48±0.08 ^{b}	4.33±0.10 ^{b}	4.85±0.20 ^{ab}	5.41±0.36^{a}	4.40±0.10 ^{b}	4.47±0.16 ^{b}	0.005
GIT (g)	87.50±7.81	89.95±7.04	95.68±7.77	95.0±7.21	101.70±8.47	84.37±4.27	98.02±9.28	0.682
GIT %	4.21±0.36	4.50±0.36	4.79±0.35	5.08±0.43	5.46±0.46	4.21±0.22	4.89±0.37	0.192
Abdominal fat (g)	30.48±4.22^{a}	31.40±5.14 ^{a}	31.62±2.60 ^{a}	30.90±5.70 ^{a}	23.03±4.0 ^{ab}	15.97±3.07 ^{b}	14.50±7.49 ^{b}	0.039
Abdominal fat %	1.47±0.20 ^{ab}	1.59±0.26 ^{ab}	1.58±0.12 ^{ab}	1.61±0.34 ^{a}	1.12±0.21^{abc}	0.84±0.14^{bc}	0.43±0.31 ^{c}	0.006

Commercial carcass yield was affected ($P \leq 0.05$) by treatments. The commercial carcass weight was 131.10 g (T_0), 1302.82 g (T_1), 1273.12 g (T_2), 1184.57 g (T_3), 1161.88 g (T_4), 1313 g (T_5) and 1423.75 g (T_6). Inclusion of turmeric 2 kg^{-1} powder (T_6) caused a dose-dependent increase in carcass weight in comparison with the control (T_0) and other treatment group chickens ($P \leq 0.05$). The paramount results in terms of commercial carcass percentage in group T_6 (68.29%) followed by group T_0 (66.07%) and the least T_4 (60.89%).

There was a significant difference ($P \leq 0.05$) in edible carcass yield among the treatment groups (Table 3). The dressing percentage of the edible carcass yield ranged from 68.36-75.61%. Inclusion of turmeric 2 kg^{-1} powder treatments (T_6) has the uppermost edible carcass percentage (75.61%) compare to all the natural feed additives treatment groups and control group birds (73.45%). Supplementation natural feed additives were significant promoted breast meat yield ($P \leq 0.05$)and the breast meat percentage (32.89%) were exhibited in broilers consumed 2 g kg^{-1} turmeric (T_6) than all the dietary treatments and control group. However, there is no marked significant effect ($P \geq 0.05$) in thigh + drumstick, wing and back meat yield between the dietary treatments and the control group.

There was no a significant difference ($P \geq 0.05$) in relative weight of liver, heart and GIT among treatment groups. However, supplementation of fenugreek powder at level of 1 and 2 g kg^{-1}had a significant effect ($P \leq 0.05$) on gizzard and giblet ratio as compared to the control and other dietary treatment groups. Abdominal fat ratio significantly decline ($P \leq 0.05$) due to dietary supplementation with turmeric at (1 to 2 g/kg) compared to that of the control and the other dietary treatment group birds.

Discussion

The commercial carcass which include two wings, two thighs, two drumsticks, back, and breast collectively referred to as a commercial carcass weight. Whereas, the edible carcass portions were calculated by adding the total edible offal to commercially important carcass components. The highest commercial carcass weight and edible dressing yield was found in birds fed turmeric 2 g kg^{-1} powder supplemented diets compared to the dietary treatments groups and control diet. This is in agreement with Al-Sultan (2003) who reported that 52% dressed carcass were obtained in bird fed with turmeric containing diet. Similarly, Al-jaleel (2012) and Mondal *et al.* (2015) used turmeric powder as a feed additives and found edible dressing percentage significantly increased by including 0.5%, 1.0% and 1.5%, turmeric powder in the diet, respectively. Although, higher dressing percentage i.e. 57% (Durrani*et al.*, 2006; Kurkure *et al.*, 2002) was observed when broilers fed with feed supplemented turmeric powder. Improvement to carcass weight and edible carcass weight in these experiments is attributed to the antioxidant activity of turmeric as it contains beneficial phytochemicals like curcumin, Ar-turmerones and curlone (Osawa*et al.*,

1995; Sugiyama *et al.,* 1996) through stimulation of protein synthesis in the gut by enzymatic system.However, previous studies like Hady *et al*. (2016) and Wang *et al.* (2015) reported turmeric has no effect in dressing percentage birds in consistence with the previous findings and current studies.

The highest percent of breast was recorded in bird fed 2g kg^{-1} turmeric. This is in agreement with earlier studies of Osawa*et al.* (1995), Durrani *et al.* (2006)and Hussein (2013) who indicated higher dressing percentage as well as breast weights of broilers fed a diet containing 5 g kg^{-1} of turmeric powder. Correspondingly, Wang *et al.* (2015) and Ukoha and Onunkwo (2016) recorded the highest dressed weight, and breast meat muscle weight in birds fed a diet containing 3% turmeric powder.

The increasing of breast weight may be due to optimum antioxidant activity of turmeric (curcumin a phenolic group, thetrahydro curcumin, cinamic acid, curlone and niacin) (Osawa*et al.,* 1995) that stimulates protein synthesis by bird enzymatic system (Hussein 2013). turmeric supplementation could increase the amount of lean meat ratio and reduce the risk of hyperlipidemia in the consumers.

The current study in disagreement with Mamoun *et al.* (2014) who reported that the gizzard weights decreased significantly with the addition of fenugreek in the diets of the broiler chicken. Additionally, the giblets ratio (liver, heart and gizzard) was increased in the bird fed fenugreek 1 and 2 g kg^{-1} of the fed diet, respectively. The increased weight of the gizzard and giblet weight reflects the increasing digestive or metabolic capacity of birds (Mushtaq *et al.,* 2014).

Fat deposition in the abdominal area of broilers is regarded as waste in the poultry industry, since it represents a loss in the market and reduced consumer acceptability. The results of the current study indicated that turmeric supplementation of broiler diets has the potential to reduce this type of waste by reducing abdominal fat content. In accordance with the current results, Nouzarian *et al*. (2011) reported addition of turmeric powder at (3.3, 6.6 and 10 g/kg of diet), Rajput *et al.* (2013) (150-200 mg/kg of feed), Hussein (2013) (5-9 g kg^{-1} of feed), Emadi and Kermanshahi (2006) (0.75 g/kg of the diet) and Wang *et al*. (2015) reported that dietary supplementation with turmeric at (100 to 300 mg/kg) markedly reduced the abdominal fat ratio compared to that of the control group birds.

The decrease in abdominal fat might be due to curcumin which has the potential to suppress or inhibited preadipocyte differentiation through the downregulation of lipogenesis in the liver (Ferguson, 2016) and curcumin believed to influence on adipocyte apoptosis or glucose withdrawn from blood (Sugihart*oet al.,* 2011). The same study also reported that curcumin supplementation inhibited hepatic fatty acid synthase (FAS) activity and increased beta oxidation of fatty acids. Curcumin has been shown to specifically downregulate FAS (Smith, 1994) leading to an effective decrease in fat storage. However, curcumin's effect on FAS activity is not well established (Asai and Miyazawa, 2001).

Conclusion Dietary inclusion of black cumin and fenugreek do not have any implication on carcass traits except fenugreek in gizzard weight. However, turmeric can be included as feed additive at a level of 1 and 2% in the total ration for better and positive results on carcass yield and lean meat (breast meat) production which could reduce the risk of hyperlipidemia and increase consumer acceptability.

Acknowledgment The authors are grateful to Wolaita Sodo and Addis Ababa University for their financial support. They are also highly indebted to all staff members of College of Veterinary Medicine and Agriculture, Addis Ababa University for their collaboration and facilitation.

Conflict of interests The authors declare that they have no competing interests.

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