Ethiop. J. Agric. Sci. 30(3) 129-142 (2020)

The effect of Supplementing Fenugreek (*Trigonella foenum-graecum L.)* Seed Powder on Growth Performance, Carcass Characteristics and Meat Quality of Cobb 500 Broilers Reared on Conventional Ration

Medina Yassin, Ajebu Nurfeta*, and Sandip Banerjee
Hawassa University, College of Agriculture, School of Animal and Range Sciences, P.O.Box, 540, Hawassa, Ethiopia

አህፅሮት

የዚህ ጥናት ዓላማ የአብሽ ዱቄት በስጋ ዶሮዎች ዕድገት አፈፃፀም፣ በስጋ ባህሪዎች እና በስጋ ጥራት ላይ ያለውን ውጤት ለማጥናት ነዉ:: በቁጥር 156 የሚሆኑ የአንድ ቀን ዕድሜ ያላቸው ፆታቸው ያልተለየ የስጋ ዶሮ ዝርያዎች (ኮብ 500) በዘፈቀደ ለአራት አያያዝ ቡድኖች ተመደቡ:: እያንዳንዳቸው ለ42 ቀናት የሚቆዩ 13 ጫጩቶች በአያያዝ ቡድኖች ሦስት ጊዜ ተበዝተው በዘፈቀደ ተመደቡ:: የሙከራው አመጋገብ መደቦች 1 (T1፣ የተመጣጠነ የስጋ ዶሮ ምግብ)፣ (T2) T1+1 በመቶ የአብሽ ዱቄት፣ (T3) T1+2 በመቶ የአብሽ ዱቄት፣ (T4) T1 + 3 በመቶ የአብሽ ዱቄት የተመገቡ ናቸው:: የአብሽ ዱቄት ደረጃዉ በጨመረ ቁጥር የደረቅ ንጥረ-ነገር ፍጆታ ጨምሯል:: የT3 እና የT4 አያያዝ ቡድኖች ከT1 እና T2 የምግብ ፍጆታ ጋር ሲነፃፀር ከፍተኛ ፕሮቲን እና የኃይል ሰጪ ፍጆታ ጨምረዋል:: የT4 እና የT3 የዕለት ተዕለት ትርፍ አማካይ መጠን ከፍ ብሏል:: በአጠቃላይ ጊዜ T4 ከፍተኛ የዕለት ተዕለት ትርፍ ሲኖረው T1 ግን ዝቅተኛ ነበር:: በማጠናቀቂያው ወቅት እና በሙሉ ጊዜ T4 ከT1 እና ከ T3 አያያዝ ቡድኖች ጋር ሲነፃፀር ከፍ ያለ የምግብ ቅልጥፍናው ውጤታማ ነበር:: የአብሽ መጠን ሲጨምር የታረደ ዶሮ ሚዛን፣ የሚበሉ የሆድ ዕቃዎች፣ የማይበሉ የሆድ ዕቃዎች እና የጭን ክብደት ጨምሯል። አቃፊ፣ ጀርባ እና ታፋ T3 እና T4 ላይ ያሉ ነበሩ:: የT4 አንገት እና ፈረሰኛ እና መላላጫ ከT1 እና T2 የበለጠ ነበር:: እንደ አጠቃላይ T4 አያያዝ ቡድን ከፍተኛው የስጋ ክብደት ነበራቸው:: የአብሽ ዱቄት እንደ ተጨማሪ የተሰጣቸው ቡድኖች ከፍተኛ የስጋ መጠን ነበራቸው:: በ T1 የተመደቡ ዶሮዎች ከፍተኛ የሆድ ስብ ነበራቸው። በተጨመረው ቡድን መካከል ምንም ልዩነት ሳይኖር ፣ የምግብ አዘገጃጀቱ፣ አመድና የፕሮቲን ይዘት ከፍ ያለ ነበር :: በቡድን T1 ስር የነበሩት ሲበሰል ከፍተኛው የስጋ የማነስ፣ ፒኤች መጠን ከፍ ማለት እና የውሃ የመያዝ አቅም ነበረው :: በአሁኑ የሙከራ ሁኔታ የተመጣጠነ የስጋ ዶሮ ምግብ ውስጥ የአብሽ ዱቄት 3በመቶ ሲጨምር የተሻለ ውጤት ታይቷል ::

Abstract

A study was conducted to evaluate the effect of fenugreek (Trigonella foenum-graecum L.) seed powder on growth performance, carcass characteristics and meat quality of broilers. A total of 156 day-old unsexed broiler chicks (Cobb 500) were randomly assigned to four treatment groups in a completely randomized design with three replicates of 13 chicks each which lasted for 42 days. The experimental diets were: Control (T1, commercial broiler diet), T1 + 1% fenugreek seed powder (T2), T1 + 2% fenugreek seed powder (T3), T1 + 3% fenugreek seed powder. The dry matter intake increased with increasing the levels of fenugreek seed powder in the ration. The crude protein and metaboizable energy intake for T3 and T4 was higher (P<0.05) than those fed T1 and T2 diets. The average daily gain (ADG) for T4 and T3 was higher (P<0.05) than those fed T1 diets while T2 had an intermediate value during the growing phase. During the finisher and the entire period the highest (P<0.05) ADG was for T4 while the lowest (P<0.05) was for T1. During the finisher phase and entire period T4 had higher (P<0.05) feed conversion efficiency compared with T1 and T3 diets. The slaughter weight, uneviscerated carcass, eviscerated carcass and thigh weight increased (P<0.05) with increasing levels of fenugreek seed powder. Thorax, back and drumstick for T1 was lower (P<0.05) than that of T3 and T4. Neck and breast muscle for T4 was greater (P<0.05) than that of T1 and T2. The highest (P<0.05) total carcass weight was for T4. The

fenugreek supplemented group had the highest (P<0.05) dressing percentage. The control diet (T1) had the highest abdominal fat. The dry matter, ash and protein content of the meat were higher (P<0.05) in the broilers receiving fenugreek supplemented diet, with no significant differences among the supplemented group. The control diet (T1) had the highest (P<0.05) cooking loss, pH and water holding capacity. It can be concluded that better performance was observed when fenugreek seed powder is added up to 3% in commercial broiler diet under conditions of the current experiment.

Keyword: Broiler, fenugreek seed powder, performance, carcass and meat quality

Introduction

Ethiopia has the largest livestock population in Africa and the livestock population is considered to be the tenth in the world Poultry rearing plays an important economic, nutritional and socio-cultural role in the livelihood of rural households in many developing countries, and the same is true for Ethiopia. In Ethiopia, chickens play important role as supplier of eggs and meat in many parts of the country and serve as a source of income.

The cost of feed is a major component influencing the net return obtained from commercial chicken production. Inclusion of feed substitutes/ additives can improve the profitability of the venture and there has been study to ascertain this effect (Yesuf *et al.,* 2017). Successful broiler enterprise is influenced by optimal feed intake across the growing period. Optimal feed intake is dependent on several factors such as temperature and relative humidity and the composition of the diet.

One of the possible alternatives used to improve the efficiency of feed utilization and performance of chickens are phytogenic additives which include a group of natural feed additives; derived from herbs, spices or other plants or their extracts in the form of essential oils (Windisch *et al*., 2008). The use of phytochemicals has shown an increasing trend over the years because the use of antibiotics as growth promoters is banned in poultry and livestock production in many parts of the world (Toghyani, 2010).Spices are among the phytogenic compounds which are generally included as feed additives for chickens. Results of a study by Windisch *et al*. (2008) indicated the antimicrobial and growth promotant effects of a range of phytogenic feed additives which include fenugreek (*Trigonella foenumgraecum L.*).

Findings of a study by Nazar and El-Tinay (2007) reported that fenugreek seeds contain 28.4% crude protein and other phytochemicals. The endosperm of the seed has high content of saponin (4.63%) and protein (43.8%) (Naidu *et al.,* 2010). Moreover, fenugreek seeds are rich in protein, fat, total carbohydrates and minerals viz. calcium, phosphorus, iron, zinc, magnesium (Gupta *et al*., 1996), fatty acids predominantly linoleic, linolenic, oleic and palmitic (Schryver, 2002).

It becomes imperative to ascertain the feed additives of the plant supplements so that the appropriate feed additive can be assessed. The objective of the study was to assess the effect of including different levels of fenugreek (*Trigonella foenum-gracecumal L*) seed powder on growth performance, carcass characteristics and meat quality traits of broilers fed commercial concentrate.

Materials and Methods

Preparation of the experimental diets

The experiment was carried out at the poultry farm of the School of Animal and Range Sciences, Hawassa University, Ethiopia. The seeds of fenugreek were purchased from the local market. The seeds were washed with cold water and dried under shade and the dried seed was roasted for 20 minutes until the seeds were light brown. The roasted fenugreek seeds were coarsely powdered using 2 mm sieve size. The fenugreek seed powder (FSP) was packed in a polyethylene bag and stored until used for the experiment. The commercial broiler grower and finisher rations were purchased from the feed processing company of Alema Farm in Debre Zeit, Ethiopia.

Preparation of experimental house

The experimental house was divided using wire mesh into 12 equal sized pens (2 m x 2 m). Each pen was provided with two bulb lamps (60 watts each) for continuous lightening and heating during night time. The experimental pens were properly washed and cleaned and covered with deep litter floor using sawdust to 5 cm depth and disinfected using HI7 disinfectant.

Experiment lay out and experimental procedure

The experiment was conducted in a completely randomized design consisting of 4 dietary treatments with three replicates per treatment and each replicate consisted of 13 chickens of both sexes. The treatments were:

1. Control, commercial broiler diet only (T1, 0FSP)
2. T1 plus 1% fenugreek seed powder (T2, 1%FSP)
3. T1 plus 2% fenugreek seed powder (T3, 2%FSP)
4. T1 plus 3% fenugreek seed powder (T4, 3%FSP)

The study was conducted over 6 week period (42 days). The chicks were randomly assigned to the pens in the brooder house and offered the corresponding diets. The pelleted grower ration was offered for three weeks (21days) followed by finisher (pelleted) ration up to the last week (42 days) of the study period. Feed and water were provided *ad libitum*. The feed offered and refusal was recorded daily. Body weights were recorded in the morning at 8.00 AM at weekly intervals throughout the experimental period.

Management of experimental chickens

A total of 156 one-day-old broiler chicks (Cobb 500) were purchased from Alema farms, Debreziet, Ethiopia. The chicks were vaccinated against Marek's disease on 1 day, Newcastle disease on 7 and 21days and Infectious Bursal Disease, IBD (Gumboro) on 14 and 28 days of age. All chickens were reared according to the recommendation of the Cobb 500 broiler management guideline. The chicks were kept in the brooder house together and they were fed commercial crumble starter (CP=20.5% and ME= 3000 kcal/kg DM) for seven days of adaptation period. After seven days the birds were offered experimental diets.

The temperature was maintained at 33°C in the brooding house during the first week by fixing a 200W-incandescent bulb. Moreover, supplementary heat from charcoal was used together with bulbs to provide heat during the cool nights. When the temperature was high the windows of the room were opened to facilitate ventilation. Temperature was gradually decreased by 2.5°C each week until the broilers got acclimatized to the room temperature.

The chickens were on the commercial grower pellet and finisher feed for 6 weeks each. Clean water was available at all times. The feeds were offered in plastic plates and round feeders and water was provided in plastic fountains. The chicks were offered their respective diets twice a day at 8:00 and 16:00 hours in two equal portions throughout the experimental period. Chickens were weighed individually to determine body weights.

Measurements of performance of broiler

Daily feed consumption and body weight were measured and feed conversion was determined. Feed offered and refusal was recorded daily in the morning at 8.00 AM. Birds were weighed in the morning at 8.00 AM on a weekly basis. The amount of feed consumed and average body weights of chickens were estimated on the replicate group basis. Feed conversion efficiency (FCE) was calculated as: FCE= weekly weight gain/ weekly feed intake.

Carcass measurement

At the end of the experiment one male and one female from each replicate whose live weights were close to the mean weight of the chickens in the pen were randomly selected, weighted and starved of feed overnight but not water. The live weight and the starved weight were taken and they were humanly slaughtered by severing the jugular vein. They were allowed to bleed and defeathered and the head and shanks were removed. Carcasses were manually eviscerated. The neck, back, wings, breast, thighs and drumsticks and non-carcasses were divided into edible offal, skin, gizzard, lungs and liver and non-edible offal were blood, feather, shank, head, pancreas, kidney, spleen, proventriculus and intestine Aberra *et al*. (2012) noted that under Ethiopian context the thigh and drumstick, breast,

wing, neck and back are the most important and gizzard, liver, heart and skin are considered as edible offals and their yields are categorized as carcass weight. Thus, the total edible meat was the sum of carcass weight and edible organs. The dressing percentage on eviscerated and eviscerated basis was determined by dividing total carcass by unevecerated and slaughter weight and multiplied by 100, respectively.

Chemical analysis of fenugreek and broiler meat

The DM content of feed samples was determined by drying in oven at 105^{o}C overnight (AOAC, 2000). Ash was determined by complete burning of the sample at 550^{o}C for 5h in a muffle furnace. Nitrogen (N) was determined using the Kjeldjhal method and then the crude protein (CP) was calculated as N × 6.25 (AOAC, 1995). Crude fiber and mineral (Ca and P) contents were analyzed using AOAC (1990) method. Ether extract were assessed using soxhlet extractor according to the methods suggested by AOAC (2000). All samples were analyzed in duplicates at Animal Nutrition and Food Science Laboratory of College of Agriculture, Hawassa University. Metabolizable energy (ME) of the rations was determined by indirect method according to Wiseman (1987) as follows:

ME (kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.8 ash.

Measurement of breast meat quality

Water Holding Capacity (WHC) was measured using a sample of 5 g of raw meat from breast (2 samples per replication were used). Each sample was cut into smaller pieces and covered with two filter papers (qualitative 185 mm circles, fine crystalline retention) and two thin plates of quartz material/ plane glass and then pressed with weight of 2500 g of cast iron for 5 min. The meat sample was removed from filter paper and their weight was divided by initial sample weight and expressed as a percentage.

The pH value of meat samples was examined according to the method reported by Ockerman (1985). The pH meter was calibrated with standard buffers of pH 4.0 and 7.0 at 25ºC. A sample (10g) homogenized in distilled water (90 ml) was transferred into the beaker and electrode along with temperature probe. The constant reading appeared on pH meter base was noted and recorded as pH value.

Breast meat samples (10 g) were cooked at an internal temperature of 90°C for 30 minutes. Samples were then removed and put under cold water to cool down for 45 minutes, then dried with a filter paper and weighed to determine cooking loss. Cooking loss was determined by expressing cooked sample weight as a percentage of precooked sample weight (Yang *et al*., 2006):

Cooking loss (%) = [(cooked sample weight- precooked sample weight / precooked sample weight)] ×100. All samples were analyzed in duplicates.

Statistical analysis

Data were analyzed using the GLM procedure of SAS Institute (2010). Treatment effects ($P<0.05$) were separated using Tukey Range (HSD) test. The following statistical model was used to analyze the data:

$Yij = \mu + ti + eij$, where;

Yij = individual values of the dependent variables

μ = overall mean

ti = treatment effect

eij= error term

Results and Discussion

Chemical composition of broiler diets and fenugreek seed

The chemical composition of the broiler diets and fenugreek seeds are presented in Table 1. The grower and finisher pellets had 19% and 18% CP; 3150 and 3210 kcal ME/kg DM.

The analyses on grower and finisher broiler rations showed that the diet formulations meet the nutritional requirements set for Cobb 500 broilers by the breeding company (Table 2). The CP content of the roasted fenugreek seeds powder (FSP) is in close agreement with the findings (43.8% CP) of Naidu *et al.* (2011). However, the values as obtained in this study are higher than those reported (27.0, 29.2) by Srinivasan (2006) and Devasena *et al*. (2010), respectively. The differences in the crude protein content may be due to the varietal differences and/or due to post harvest handling of fenugreek seeds as indicated by Basu *et al*. (2014). The ether extract (EE) content of FSP obtained in the present study was similar with the findings of Srinivasan (2006). However, the result in the current study indicated that the EE content was higher than those reported by Devasena *et al*. (2010). The study further indicates that the EE values obtained in this study were higher than the findings of Elbushra (2012) and Abbas (2010) who reported EE values of 9.49 and 10.76%, respectively. The EE content of fenugreek seeds can be influenced by the stage of maturity and post-harvest management of the seeds (Shaheb, 2015). The total EE influences the energy content of the seeds (Silvia *et al*, 2012). The EE percentage also is influenced by the moisture content of the seeds, as the moisture content decreases the percentage of oil in the seed increases (Nithya *et al*., 2017).

Table 1. Chemical composition of broiler diets and fenugreek seed powder

Chemical composition (%DM)								
Feed	DM%	Ash	EE	CP	CF	Ca	P	ME (kcal/kg DM)
Grower	90.2	5.5	9.0	19	5.5	0.75	0.53	3150
Finisher	89.6	5.0	8.0	18	5.5	0.65	0.49	3250
Fenugreek seed	95.3	6.12	7.03	43.8	7.4	0.41	0.95	3435

CF= crude fiber; CP = crude protein; DM= dry matter; EE = ether extract; ME (kcal/kg DM) = metabolizable energy.

Table 2. Chemical composition (%DM) of the grower and finisher experimental rations

Chemical composition	Growth phase				Finisher phase			
	T1	T2	T3	T4	T1	T2	T3	T4
DM%	90.2	91.2	91.3	92.6	89.6	90.6	91.4	92.0
Ash	6.6	6.61	6.7	6.7	6.5	6.6	6.85	7.0
EE	4.0	5.3	5.3	5.4	5.0	5.6	5.9	6.2
CF	7.6	7.8	7.6	7.6	7.6	7.6	7.6	7.6
CP	22.1	22.5	23.0	23.7	23.1	24.5	24.7	26.3
Ca	0.59	0.65	0.68	0.70	0.51	0.60	0.68	0.76
P	0.51	0.57	0.60	0.62	0.46	0.55	0.64	0.70
ME (kcal/kg DM)	3229	3276	3296	3302	3288	3313	3321	3330

DM= dry matter; EE= Ether extract; T1=Control without FSP; T2=feed containing 1% of FSP; T3=feed containing 2%FSP; T4=feed containing 3%FSP. ME=Metabolizable energy; CP=Crude protein; FSP=fenugreek seed powder

Dry matter and nutrient intake

The dry matter and nutrient intake during the grower and finisher phase are presented in Table 3. The highest ($P<0.05$) dry matter intake during grower, finisher and entire experimental period was for T4 while the lowest ($P<0.05$) was for T1. The DM intake increased with increasing the levels of fenugreek seed powder in the ration. The CP and ME intakes for T2, T3 and T4 were higher ($P<0.05$) than those fed T1 diets, and generally, increased with increasing levels of FSD in the diets.

The dry matter intake in the current study indicated that supplementation of FSP in broiler diets improved feed consumption, which can be due to the improvement of palatability of the feed containing FSP. The findings are in close accordance with the study by Alloui *et al.* (2012)) who reported that the palatability of feedstuffs containing fenugreek seeds are improved because of the presence of high levels of the carbohydrate fraction, galactomannan, in the fenugreek seeds. The improvement in feed intake with the addition of fenugreek seed could be mainly attributed to this carbohydrate, which might have stimulated the appetizing and digestive process in chickens (Steiner, 2009).

In present study, feed intake was on the highest for broilers supplemented with 3% FSP (T4) during grower and finisher phases which is in agreement with the report of Alloui *et al*. (2012) who reported that feeding fenugreek seeds at 3% of the feed in broiler chickens significantly increased feed intake due to the presence of galactomannans and neurin which stimulate the appetite. However, the present result is contrary to the report of Awadein *et al*. (2010) who found that fenugreek seeds had no significant effect on feed consumption compared to the chickens reared on control diet.

Table 3. Effect of supplementing fenugreek seed powder on dry matter and nutrient intake of broilers during grower and finisher phases

Intake	Treatment				
	T1	T2	T3	T4	SEM
Grower:					
DMI (g/bird/day)	79^{d}	86.5^{c}	89.8^{b}	94.58^{a}	1.31
ME (kcal/bird/day)	249.05^{c}	272.47^{b}	282.3^{a}	288^{a}	4.62
CP (g/bird/day)	15.02^{c}	16.47^{b}	17.2^{a}	18.0^{a}	0.3
Finisher:					
DMI (g/bird/day)	95.87^{d}	110.13^{c}	125.67^{b}	139.5^{a}	2.16
ME (kcal/bird/day	311.63^{d}	357.9^{c}	408.4^{b}	453.5^{a}	7.02
CP (/g/bird/day)	17.3^{d}	19.9^{c}	22.73 ^{b}	25.3^{a}	0.39
Entire period:					
Total DMI (g/bird/day)	87.5^{d}	98.3^{c}	107.8^{b}	115.6^{a}	1.48

^{abcd} means within the same row bearing different superscripts are significantly different; T1=Control, without FSP;T2=feed containing 1% of FSP;T3=feed containing 2%FSP; T4=feed containing 3%FSP. SEM= Standard error of the mean= SL= significant level, DMI=Dry matter intake; ME=Metabolizable energy; CP=Crude protein; FSP=fenugreek seed powder.

Body weight gain and feed conversion ratio in broiler

The average daily body gain and feed conversion efficiency are shown in Table 4. The average daily gain (ADG) for T4 and T3 was higher ($P<0.05$) than those fed T1 diets while T2 had an intermediate value during the growing phase. During the finisher and the entire period the highest ($P<0.05$) ADG was for T4 while the lowest ($P<0.05$) was for T1. . The highest feed conversion efficiency (FCE) was for T1 while the FCE did not vary among the chicks receiving T4, T3 and T2 diets during the grower phase. During the finisher phase and entire period T4 had higher ($P<0.05$) FCE compared with T1 and T3 diets.

Fenugreek seed powder addition at various levels to broiler diets in this study improved the performance of the chicks. This result is consistent with the report of Alloui *et al*. (2012) who found that addition of fenugreek seed in broiler diets increased average daily gain. Moreover, Hind *et al*. (2013) reported increased daily gain and feed intake due to the stimulative effect of FSP on the digestive system of broilers. The improvement in body weights has been attributed to the presence of essential fatty acids and high quality proteins in the fenugreek seeds (Murray *et al*., 1991).

During grower and finisher phase, T4 (3% FSP) had higher body weight gain than other treatments which is consistent with the report of Rabia (2010) who found that 3% of FSP in the feed as best inclusion level for enhancing the performance and body weight of broiler chicken. On the other hand, Awadein *et al*. (2010) reported that fenugreek seeds had no significant effect on body weight compared to the chickens reared on control diet. Fenugreek seed powder addition at various levels in broiler diets in this study improved the feed conversion efficiency which

is in agreement with the findings of Hamden *et al*. (2010) who reported that inclusion of FSP improved feed conversion efficiency of broiler chicks.

Table 4. The effect of supplementing fenugreek seed powder on growth performance and feed conversion efficiency of broilers during grower and finisher phases

Treatment						
Body weight	T1	T2	T3	T4	SEM	SL
Grower phase:						
Initial body weight (g)	400	400	400	400	4.52	NS
Final body weight (g)	1478^{b}	1529^{ab}	1563^{ab}	1594^{a}	23.61	*
Total weight gain (g/bird)	1077^{b}	1129^{ab}	1163^{a}	1194^{a}	20.2	*
Average daily gain (g/bird/day)	51.3^{b}	53.8^{ab}	55.4^{a}	56.9^{a}	0.96	*
Finisher phase:						
Initial body weight (g)	1478^{c}	1529^{b}	1563^{ab}	1594^{a}	12.52	*
Final body weight (g)	2896.3^{c}	3415^{b}	3630^{b}	4102^{a}	66.6	*
Total weight gain (g/bird)	1419^{c}	1886^{b}	2067^{b}	2508^{a}	62.32	*
ADG (g/bird/day)	67.6^{c}	89.8^{b}	98.4^{b}	119.4^{a}	2.96	*
Entire period:						
Total weight gain (g/chick)	2497^{c}	3015^{b}	3230^{b}	3702.7^{a}	66.44	*
ADG (g/chick/day)	59.5^{c}	71.8^{b}	76.9^{b}	88.1^{a}	1.58	*
FCE:						
Grower	0.65^{a}	0.63^{b}	0.63^{b}	0.61^{b}	0.01	*
Finisher	0.72^{c}	0. 79^{ab}	0.83^{b}	0.87^{a}	0.0013	*
Entire	0.68^{c}	0.73^{ab}	0.71^{bc}	0.75^{a}	0.01	*

^{abc} P<0.05means within the same row bearing different superscripts are different;T1=feed without FSP;T2= 1% FSP;T3=2%FSP; T4= 3%FSP. SEM= Standard error of the mean, SL= significant level, ADG= average daily gain, FSP=fenugreek seed powder. FCE=feed conversion efficiency.

Carcass characteristics of broilers

The carcass parameters of broilers fed broilers diet and different levels of fenugreek seed powder are presented in Table 5. The slaughter weight, uneviscerated carcass, eviscerated carcass and thigh weight increased (P<0.05) with increasing levels of fenugreek seed powder. Thorax, back and drumstick for T1 was lower (P<0.05) than that of T3 and T4. Neck and breast muscle for T4 was greater (P<0.05) than that of T1 and 2. The highest (P<0.05) total carcass weight was for T4. The fenugreek supplemented group had the highest (P<0.05) dressing percentage.

The linear improvement in carcass development through the inclusion of FSP in the current study may be due to appropriate utilization of protein made available to the chickens in their feeds (Elbushra, 2012). The results also indicated that the dressing percentages (eviscerated and uneviscerated) were higher in the chickens receiving the supplementary diet which is consistent with the findings of Yesuf *et al.* (2017). This may be due to the fact that the protein from FSP has a higher digestibility leading to better muscular development. Personal observation

indicates that the weight of the breast muscles (*M pectoralis, major, minor*) and muscles surrounding the fibula (*M fibularis, M. flexor, M gastrocnemius*) were well developed among the chickens provided with the supplemented feed, which can be due to their appropriate development owing to proper utilization of nutrients provided (Zhai *et al*., 2012). The high breast weight may also be due to optimal development of the fibula indicating proper utilization of calcium provided in the diets (Abbas, 2010). The weights of the back, thorax and the wings too were proportionately higher among the chickens receiving the supplementary diet, which may be due to better skeletal development owing to better Ca utilization (Amoroso *et al*., 2013). The breast muscles and the drumsticks are also the most important carcass cuts and hence higher weights of these muscles have higher economic values (Mamoun, 2014).

The findings of this study are in close agreement with the findings of Abbas (2010) who showed that broilers fed on 1% and 2% fenugreek seed powder supplementation exhibited higher dressing percentages when compared to un supplemented group which could be due to better muscle growth among the group provided with FSP. Delimaris (2013) reported improvement in the dressing percentage of broilers supplemented with fenugreek seed powder up to 3% of their diet due to higher dry matter and crude protein intake. Contrary to the results of the current study, Alloui *et al.* (2012) reported that feeding 3% of FSP had no significant effect on dressing percentage.

Table 5. Effect of supplementing fenugreek seed powder on carcass characteristics of broilers

	Treatment				
Weight(g)	T1	T2	T3	T4	SEM
Slaughter	2840^{c}	3378^{b}	3537^{b}	4042^{a}	65.5
Un eviscerated	2451^{c}	3043^{b}	3208^{b}	3675^{a}	63.7
Eviscerated	1543^{c}	2186^{b}	2423^{b}	2763^{a}	74.4
Neck	62.5^{c}	104.2^{b}	135^{ab}	145^{a}	8.8
Thorax	178^{c}	227^{bc}	259^{ab}	301^{a}	13.3
Wing	152^{b}	207^{a}	227^{a}	259^{a}	18
Back	224^{c}	298^{bc}	338^{ab}	418^{a}	25.9
Breast	535^{c}	813^{b}	890^{ab}	973^{a}	32.9
Drumstick	177^{c}	238^{bc}	298^{ab}	319^{a}	17.4
Thigh	216^{c}	260^{b}	317^{b}	347^{a}	19.6
Dressing percentage with Un eviscerated	62.9^{b}	71.7^{a}	76.8^{a}	75.0^{a}	1.35
Dressing percentage with eviscerated	54.4^{b}	64.5^{a}	68.2^{a}	68.2^{a}	1.37
Total carcass (g)	1543^{c}	2186^{b}	2464^{b}	2763^{a}	74.4

^{abc} P<0.05means within the same row bearing different superscripts are different;T1=diet without FSP,T2=diet containing 1% of FSP,T3=diet containing 2%FSP, T4=diet containing 3%FSPSEM= Standard error of the mean.

Edible and non-edible offal

Edible and non-edible parts of the broiler carcass are shown in Table 6. Weight of edible offals was not significantly different among the treatments. Head, feather and shank weight for T1 was greater (P<0.05) than T2 while the other treatments had intermediate values. The kidney weight for T4 was greater (P<0.05) than T1

while T2 and T3 had intermediate values. The control diet (T1) had the highest abdominal fat.

In the current experiment the weight of gizzard, proventriculus and heart was similar among the treatments which are consistent with the report of Abbas (2010) who observed similar weights in these organs. The weight of liver increased with increasing levels of FSP in the diet which is similar to the finding by Yesuf *et al*. (2017) who reported that supplementation with FSP increased liver weights in broilers. To the contrary Abbas (2010) reported that supplementing fenugreek seed powder in broilers diet had no significant effect on liver weight.

Lower abdominal fat was observed at high level of Fenugreek seed powder (3%) which is in agreement with the report of Dixit *et al.* (2005) who observed that fenugreek had fat reducing activity due to the presence of lecithin and choline. The reduction of abdominal fat in chickens fed alternative protein source was accompanied by a reduction in muscle fat contents. These changes in fat deposition most likely resulted from changes in lipid metabolism (Dixit *et al.*, 2005). On the other hand, Abbas (2010) found that various level of fenugreek seed powder supplementation had no influence on the weight of abdominal fat.

Table 6. Effect of supplementing fenugreek seed powder on edible and non-edible carcass parts of broilers

	Treatment				
	T1	T2	T3	T4	SEM
Edible:					
Skin	195	154	161	193	12.9
Gizzard	51	44	49	56	3.28
Liver	49^{b}	57^{ab}	58^{ab}	65^{a}	3.7
Heart	18	15	14	18	2.1
Non Edible:					
Blood	78	93	75	96	6.9
Head	71^{a}	60^{b}	63^{ab}	68^{ab}	2.5
Feather	102^{a}	86^{b}	93^{ab}	90^{ab}	3.7
Shank	109^{a}	88^{b}	91^{ab}	100^{ab}	4.9
Proventriculus	15	11	12	15	1.3
Kidneys	12^{b}	14^{ab}	13^{ab}	18^{a}	1.3
Spleen	5	5	5	5	0
Intestine	97	83	80	98	5.3
Abdominal fat	50^{a}	38^{b}	37^{bc}	30^{c}	2.0

^{abc} P<0.05means within the same row bearing different superscripts are different;T1=diet without FSP;T2=diet containing 1% of FSP;T3=diet containing 2% FSP; T4=diet containing 3% FSP. SEM= Standard error of the mean;; FSP=fenugreek seed powder.

Meat quality

The findings as presented in Table 7 indicates that the dry matter, ash and protein content of the pectoral muscles (*P major and P minor*) were higher (P<0.05) in the broilers receiving fenugreek supplemented diet, with no significant differences across them. However, the values were higher than those chickens in the control diet. The control diet (T1) had the highest (P<0.05) cooking loss, pH and water

holding capacity. The high moisture content of the breast muscles in the non-supplemented treatment makes the meat more succulent (Ali and Zahran, 2010). Such succulent meat has a higher market acceptance when compared to muscles with less succulence which was obtained from the muscles of the chickens provided with supplementary diets (Beski *et al*., 2015).

The pH of the meat cuts indicates that the meat of broilers raised on T1 diet may have low keeping quality, which may be because of higher (neutral) pH of the flesh (Comert *et al*., 2016). The cooking loss in the current study was lower for the meat obtained from the broilers supplemented with FSP, which might have resulted from the high protein content of their diet. This is in agreement with the finding of Petracci and Cavani (2011) who reported that the cooking loss is lower among the chickens receiving high protein diet. Mukhtar *et al.* (2013) found that supplementation of fenugreek seed powder in broiler diet produced moderate meat quality due to anti fat properties of the fenugreek.

Table 7. Effect of supplementing fenugreek seed powder on meat quality of broilers

	Treatment				
Analysis	Control (T1)	1% FSP (T2)	2% FSP (T3)	3% FSP (T4)	SEM
Dry matter (%)	21.29^{b}	29.37^{a}	29.04^{a}	29.87^{a}	1.823
Ash (%)	1.192^{b}	3.047^{a}	3.01^{a}	2.98^{a}	0.29
Moisture (%)	82.71^{a}	74.57^{b}	72.83^{b}	73.75^{b}	1.486
Protein (%)	21.3^{b}	29.37^{a}	30.54^{a}	30.2^{a}	1.52
Fat (%)	3.86^{a}	2.93^{ab}	2.16^{b}	1.78^{b}	0.37
Cooking loss (%)	31.53^{a}	24.87^{b}	22.68^{bc}	19.37^{c}	1.2
pH	6.51^{a}	5.85^{b}	5.59^{bc}	5.28^{c}	0.14
WHC (%)	34.31^{a}	30.87^{b}	30.3^{c}	28.14^{d}	0.04

FSP= fenugreek seed powder; WHC =Water holding capacity.

Conclusion

Inclusion of up to 3% of fenugreek seed powder in the diet of broilers did not affect the palatability of the diet Addition of fenugreek seed powder improved feed intake compared to the control. Feed intake increased with increasing level of FSP inclusion in the diet. Broilers supplemented with FSP also showed better average daily gain and carcass characteristic compared to the control group. The abdominal fat content decreased and the dressing percentage increased as the level of FSP in the diet increased. Moreover, the meat of the broilers supplemented with FSP had high crude protein content, lower cooking loss, reduced fat content and lower water holding capacity relative to the control. It can be concluded that better performance was observed when fenugreek seed powder was added up to 3% in commercial broiler diets under conditions of the current experiment.

References

Abbas RJ. 2010. Effect of using fenugreek, parsley and sweet basil seeds as feed additives on the performance of broiler chickens. Int. J. Poult. Sci. 9(3): 278-282.

Aberra Melesse, Tegene Negesse and Worknesh Tiruneh. 2012. Nutrient composition and effect of feeding different levels of *Moringa stenpetala* leaf meal on carcass traits of Rhode Island Red dual purpose grower chicks. Ethiopian. J. Anim. Prod.12 (1): 37-50.

Ali FH and Zahran DA. 2010. Effect of growth enhancers on quality of chicken meat during cold storage. Advance J. Food Sci. Tech. 2(4): 219-226.

Alloui N, Aksa SB, Alloui MN and Ibrir. F. 2012. Utilization of fenugreek (Trigonella foenum-graecum) as growth promoter for broiler chickens. World. J. Poult. Res. 2(2): 25-27.

Amoroso L, Baraldi ASM, Barreiro FR, Pacheco MR, Alva JCR, Soares NM and Melaré MC. 2013. Bone densitometry and calcium serum levels in chickens treated with filtered or unfiltered water. Revista Brasileira de Ciencia Avícola. 15(4): 379-384.

AOAC. 1990. Official Methods of Analysis.15th edition.AOAC. Inc. Anc. Arlington, Virginia, U.S.A. 1298 pp.

AOAC. 2000. Food composition, additives and natural contaminants. Official Methods of Analysis of AOAC International, Vol. II, 17th (edited by H. William), Washington, DC. pp. 12–42.

Awadein NB, Eid YZ and Abd El-Ghany FA. 2010. Effect of dietary supplementation with Phytoestrogens sources before sexual maturity on productive performance of Mandarah hens. Egypt. Poult. Sci. 30: 829-846.

Basu A, Basu SK, Kumar A, Sharma M, Chalghoumi R, Hedi A and Cetzal-Ix W. 2014. Fenugreek (*Trigonella foenumgraecum L.*), a potential new crop for Latin America. American. J. Soc. Iss. Hum. 4(3): 148-162.

Comert M, Şayan Y, Kırkpınar F, Bayraktar OH and Mert S. 2016. Comparison of carcass characteristics, meat quality, and blood parameters of slow and fast grown female broiler chickens raised in organic or conventional production system. Asian-Australasian. J. Anim. Sci. 29(7): 987.

Delimaris I. 2013. Adverse effects associated with protein intake above the recommended dietary allowance for adults. ISRN. Nutr. http://dx.doi.org/10.5402/2013/126929.

Devasena B, Rama Prasad J and Rao A K. 2010. Evaluation of fenugreek (*Trigonella foenugraecum*) seed residue for incorporation in livestock rations. Indian. J. Anim. Nutri. 27 (1):70-72.

Dixit P, Ghaskadbi S, Mohan H and TPA Devasagayam. 2005. Antioxidant properties of germinated fenugreek seeds. Phytotherapy Res. 19: 977–983.

Elbushra ME. 2012. Effect of dietary Fenugreek seeds (*Trigonella foenum*) as natural feed addition on broiler chicks performance. J. Sci. Technol. 13:27-31.

Gupta K, Thakral KK, Arora SK and Chowdhary MI. 1996. Structural carbohydrate and mineral seeds. Ind. Cocoa Arecen. Spec. J. 20: 120.

Hind AA, Saadia AA and Khalid ME. 2013. Effect of Different Natural Feed additives Compared to Antibiotic on Performance of Broiler Chicks under High Temperature Environment. Bullet. Environ. Pharmacol. Life Sci. 2: 139-144.

Mamoun T, Mukhtar A and Mohamed HT. 2014. Effect of Fenugreek seed powder on the Performance Carcass Characteristics and Some Blood Serum Attributes. Adv. Res. Agri. Vet. Sci. 1: 6-11.

Mukhtar MA, Mohamed KA Amal OA and Ahlam AH. 2013. Response of broiler chicks to different dietary levels of clack cumin oil as a natural growth promoter University of Bakht Alruda. J. Sci. 7: 185-190.

Murray RK, Granner DK, Mayes PA and Rodwell VW. 1991. The Text Book of Harpers Biochemistry. 22nd Edition. Applecton and large Norwalk, Connecticut/Loss Altos, California.

Naidu MM, Shyamala B, Naik JP, Sulochanamma G and Srinivas P. 2011. Chemical composition and antioxidant activity of the husk and endosperm of fenugreek seeds. LWT – Food Sci. Techn. 2: 451–456.

Ockerman HW. 1985. Quality control of post- mortem muscle tissue (13th ed.). Colombus, OH, USA: The Ohio State University.

Petracci, M and Cavani C. 2011. Muscle growth and poultry meat quality issues. Nutr. 4(1): 1-12.

Rabia JA. 2010. Effect of using Fenugreek, Parsley and Sweet Basil seeds as feed additives on the performance of broiler chickens. Int. J. Poult. Sci. 9: 278-282.

SAS Institute Inc. 2010. Statistical Analysis Software Version 9.3. SAS Institute Inc., Cary, North Carolina,USA.

Schryver T. 2002. Fenugreek total health, Basch, E., C. Ulbricht, G. Kuo, P. 24: 42-44.6.

Shaheb MR, Islam MN, Nessa A and Hossain MA. 2015. Effect of harvest times on the yield and seed quality of French bean. SAARC. J. Agri. 13(1): 1-13.

Silvia D, Masturah MF, Aris YT,Wan Nadiah WA, and Bhat R. 2012. The effects of different extraction temperatures of the screw press on proximate compositions, amino acid contents and mineral contents of Nigella sativa meal. Am. J. Food, Tech. 7: 180-191.

Srinivasan K. 2006. Fenugreek (*Trigonella foenum-graecum*): A review of health beneficial physiological effects. Food-Reviews. Int. 22: 203–224.

Steiner T. 2009. Phytogenics in Animal Nutrition. Natural Concepts to Optimize Gut Health and Performance. Nottingham University Press.

Toghyani MA, Geisari G, Ghalamkari M, Mohammadrezaei. 2010. Growth performance, serum biochemistry and blood hematology of broiler chicks fed different levels of black seed (*Nigella sativa* L.) and peppermint (*Mentha piperita*). Lives Sci. 129: 173-178.

Windisch W, Schedle K, Plitzner C and Kroismayr A. 2008. Use of phytogenic products as feed additives for swine and poultry. J. Anim. Sci. 86: 140-148.

Wiseman J. 1987. Feeding of Non-Ruminant Livestock. Butterworth and C.Ltd. 370 pp.

Yang HS, Moon SS, Jeong JY, Choi SG, Joo ST and Park GB. 2006. Effect of sodium bicarbonate injection in pre-rigor porcine *M. Longissimus lumborum* on pork quality. Asia-Aust. J Anim. Sci. 19: 898-904.

Yesuf KY, Mersso BT, and Bekele TE. 2017. Effects of different levels of turmeric, fenugreek and black cumin on carcass characteristics of broiler chicken. Livest.. 8: 11-17.

Zhai W, Araujo LF, Burgess SC, Cooksey AM, Pendarvis K, Mercier Y and Corzo A. 2012. Protein expression in pectoral skeletal muscle of chickens as influenced by dietary methionine. Poult. Sci. 91(10): 2548-2555.