Response of broiler chickens to diet containing fenugreek seed (*Trigonella foenum-graecum L.*) as a natural feed additive

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Abstract

The experiment was conducted to study the effect of addition of fenugreek seed (*Trigonella foenum-graecum L.*) as supplementation at two levels in the diet of broiler chickens on body weight, weight gain, feed consumption, feed conversion, antibody titer, carcass quality, liver and kidney functions, oxidative stability of fat, serum cholesterol, histopathological changes, and economical evaluation. A total of 30, day-old broiler chicks were distributed in 3 experimental groups fed control diet supplemented with 0.0%, 1%, and 2% fenugreek seed meal during the experimental period. At 45 days of the experiment, results indicated that supplementation of the diet with 1% fenugreek improved weight gain, feed conversion, antibody titer against New castle virus, and fat stability. Blood glucose and cholesterol levels were reduced.

Introduction

The population in Egypt is currently increasing at a rapid rate. At this time, one of the most important objectives is to supply the Egyptians with enough food. This means that the agricultural production has to be increased and the animal production continually has to be intensified with the exploitation of new food sources. On the other hand, the performance of the animal should be improved by the best breeding, feeding and the use of factors which may have a positive effect on the food acceptability; texture and quality and on the animal side by altering digestion, absorption and metabolism to the most benefit.

The improved performances were achieved by using feed additives claimed to be safe for animal and human beings. The best and safe food is produced from animals or poultry reared under health and hygienic conditions and fed safe feeds without using undesirable techniques or chemicals. In this respect, the feed industry has to play a vital role in the human food chain (**32**). It is illegal for food to contain harmful residues because they are considered unsafe substances. However the public health problems, which may be associated with the presence of residues in the food, include allergies (**24**), drug resistance (**45**), and carcinogenesis (**47**).

The best and safe feed additives are produced from natural origin and be fed safely without undesirable effects such as fenugreek, black seed....etc. Fenugreek (*Trigonella foenum-graecum L.*) is an annual plant from the family *Fabaceae (Leguminosae)*, originated in India and is native cultivated in South Europe, Northern Africa, India and Egypt. Fenugreek is characterized by an early emergence, a high nitrogen fixing capacity, and two complementary crops can be grown on the same land in one year. In Egypt, about 19,684 feddans / year are cultivated with fenugreek producing 16,807 tons / year of fenugreek dry crop and 1,052 feddans / year new lands are cultivated also producing 675 tons fenugreek dry crop per year **(2)**.

The ground seeds are used as supplement to wheat and corn flour for bread making. Seed extract is used also in preparing drinks. Fenugreek seed powder is used as a feed additive in the production of preserved meat. Owing to the seed content of mucilage, it helps relieve sore throttle and is useful in the treatment of asthma and difficult breathing and is considered an appetizer and helps in digestion. Fenugreek seeds have also been recognized as a potential source of diosgenin, a basic compound in the hemisynthesis of steroidal sapogenins such as cortisone and sex hormones **(11)**.

Due to its content of diosgenin, a steroidal sapogenin belonging to the group of tri-terpenes, is of great interest in the pharmaceutical industry since it has an estrogenic effect on the mammary gland, plays an important role in the control of cholesterol metabolism and produces changes in lipoxygenase activity in human erythroleukemia cells. It also changes the megakarycocyte cells **(31)**. The seeds of fenugreek are reported to have hypoglycemic and hypocholesterolemic effects **(27)**. It is well known that the seeds of fenugreek contain relatively large amounts of galactomannan in the endosperm **(36)**, the soluble gel fraction of fenugreek seeds constituted the major portion of the seed coat (including the endosperm) polysaccharides, most of which consisted of galactomannan (Mannose: galactose ratio of 1.5:1).

Table (1): Chemical composition and mineral content of fenugreek

Item %	In Egypt*	In Sudan**	In India***
Moisture	11.15	4.3	2.4
Crude protein	33.8	27.3	25.4
Crude fiber	5.76	6.7	NA
Ash	3.56	3.8	NA
Total lipids	7.51	6.7	7.9
Total carbohydrates	40.6	51.2	NA
Mineral (mg/100 g)			
Calcium	186	158	70.2
Magnesium	152	NA	160
Phosphorus	348	415	368
Zinc	4.11	9.9	6.9
Iron	21.6	22.5	12.6
Cobalt	0.6	NA	NA

NA = Data not available. *(1) ** (29) *** (43).

Galactomannan is known to exert beneficial health effects, especially in diabetic and hypercholesterolemic animals and humans **(41).** On a weight basis, galactomannan is five times as viscous as starch, and is one of the most viscous polysaccharides known **(46)**. There are several reports about the chemical composition and mineral content of fenugreek seeds are presented in Table (1).

This study was designed to investigate the effect of feeding broiler chicks diet containing two levels of fenugreek seed meal as a feed supplement on growth performance, antibody titer, liver function tests, fat quality of the carcass, carcass measurements, histopathological examination and economical evaluation.

Material and methods

1- Chickens, diets and management

A total of 30-one-day-old Hubbard broiler chicks were obtained from a commercial hatchery. Feed and water were offered ad-libitum and were fed a common starter diet for 16 days.

Table (2): Composition of chick basal diets

Feed ingredients	%
Ground yellow corn	50. 338
Soybean meal (solvent-extracted, 44% CP)	30.730
Broiler concentrate (51.98% CP) *	10.00
Oil	6.932
Mineral-vitamin premix**	1.00
DL. Methionine	0.04
Dicalcium phosphate	0.96
Total	**100.00**
Calculated energy and nutrients* **	
Crude protein	22.99
Metabolizable energy	3199.8
DL-methionine	0.46 + 0.04 (supp.)
Lysine	1.24
Calcium	1.06
Available phosphorus	0.536

* **Composition:** Meat and bone meal 45% CP, corn gluten 60% CP, meat and bone meal 50% CP, fish meal 65% CP, Soybean meal 44% CP, salt, limestone, dicalcium phosphate, vitamin premix , mineral premix + choline, DL–methionine, and L-lysine hydrochloride. Company of Soya Egypt for feed production, portion 191 Pelpeis road, 10th Ramadan city East Governorate (reg. No. 7164, Ministry of agriculture), Egypt.

** **Each 3 Kg contain:** Vitamin A = 12,000,000 IU, D3 = 2,200,000 IU, E = 10,000 mg, K3 = 2,000 mg, B1 = 1,000 mg, B2 = 5,000 mg, B6 = 1,500 mg, B12 = 10 mg, Niacin = 30,000 mg, Biotin = 50 mg, Folic acid = 1,000 mg, Pantothenic acid = 10,000 mg, Zinc = 50,000 mg, Manganese = 60,000 mg, Iron = 30,000 mg, Copper = 4,000 mg, Iodine = 1,000 mg, Selenium = 100 mg, Cobalt = 100 mg, Calcium carbonate to 3 Kg. Purchased by Multivita for animal nutrition, 6th October city, Egypt, registered by Adisseo combany, France.

***NRC (30).

At 17 days of age, chicks were split into three equal groups (10 birds per group). Each group was housed in an individual cage. One of them was fed a basal diet; the second and third groups were fed the basal diet supplemented with 1% and 2% fenugreek seed meal, respectively (Table 2). The different groups were accommodated in separate floor pens and maintained under good ventilation and continuous lightening program. The experimental diets were offered at the age of 17th day. All birds were raised according to routine practices in terms of vaccination and prophylactic measures.

2. Experimental procedure

A. **Chicks** had free access of feed and water and were vaccinated according to the sanitary programs for this category and coccidiostats was applied in prophylactic dose.

B. Feed consumption was recorded for each treatment. Live body weight in grams was measured for all birds at the beginning of the experiment and was weekly repeated at the same time.

C. Measurements of some blood constituents

By the end of the experiment blood samples were collected during slaughtering for separation of serum for the quantitative determination of aspartate transaminase (AST) and alanine transaminase (ALT) **(37)**, total serum protein **(18)**, serum albumin **(13)**, total serum cholesterol **(44)**, and serum uric acid **(12)** and total serum creatinine **(16)**. The serum was also used for determination of serum glucose **(42)** and serum triglycerides **(26)**.

D. Determination of immune response

The immune response was evaluated by measuring humeral immunity throughout heamagglutination inhibition (HI) test against Newcastle disease virus **(9)**. The results of HI titer of the sera samples were recorded and was given titer reference number (TRN) **(23)**, then they subjected to data analysis to calculate the geometric mean HI antibody titer. The weight of spleen, thymus and bursa of fabricuius were determined as they considered the immune responsible organs.

E. Carcass yield

At the end of the experiment (45 days of age) three representative birds from each test group were slaughtered after 12h fast for carcass yield measurements. The last includes the weight of slaughtered carcass, oven ready carcass or eviscerated carcass weight in which feathers; intestine, inner organs were removed in addition to the head, neck and feet. Edible organs and in special liver, heart, pancreas, gizzard and crop and lymphoid organs were also recorded.

F. Measuring lipid deterioration:

- **Oil or fat extraction from broiler meat**

Various solvents or solvent combinations have been suggested as extractants, but most lipid analysts use chloroform-methanol (2:1 by volume) as suggested **(15)**. The endogenous water in the tissue is a ternary component of the system. The extract is shaken and equilibrated with one fourth its volume of a saline solution, when the mixture partitions into two layers, of which the lower is composed of chloroform-methanol-water in the proportions 86:14:1 (by volume) and contains virtually all of the lipids,

while the upper phase consists of the same solvents in the proportions of 3:48:47 (by volume), respectively, and contains much of the non-lipid contaminants. Breast and thigh meat were excised from 3 carcasses per dietary treatment. The samples from each carcass used for determination of physicochemical properties for oxidative stability measurements.

- **Refractive index:** The refractive index was measured using Azeiss refractometer at 25 °C and the results were standardized at 40 °C **(5).**
- **Determination of peroxide value:** The peroxide value was measured **(5).**
- **Acid and iodine values:** They were measured according to the tentative method **(6).**
- **Thiobarbituric acid (TBA) number:**

This method is used for the determination of the volatile aldehydes which formed during rancidity of oils employing the reaction of thiobarbituric acid (TBA) with these aldehydes, forming quantitative colored complex compound. The intensity of this color can be measured photometrically to be a useful guide to the degree of rancidity. The method of **Sedlaceck (39)** was applied with some little modification. The thiobarbituric acid solution was prepared by weighing 1 g of TBA in 100 ml measuring flask then 50ml distilled water was added and 2 ml of 3 N NaOH. The flask was gently heated in a water bath until the TBA was completely dissolved. After cooling 0.4 ml of HCl 3 N was added and completed to the mark. Five gm of the oil was weighed in a round bottom flask of 500 ml, 50 ml HCl 3 N was added using some little glass balls to regulate boiling. The flask was connected to distillation apparatus using water – bath and volatile oxidation products were condensed and collected in 100 ml cylinder. A stop watch was used to regulate the speed of distillation process to collect 30 ml of the distillate in 6 minutes, 20 ml of distillate was pipetted in a test tube 20 x 200 mm and one ml TBA reagent was added followed by one ml phosphoric acid (conc.). The contents of the tube was thoroughly mixed and then gently heated in a water bath for 35 minutes. Blank experiment was carried under the same conditions and the intensity of the formed red color was measured spectrophotometrically are, 450 nm and established as extinction.

- **Histopathological studies**

The liver, proventriculus and intestine of different chick groups were sampled to be histopathologically examined. The samples were fixed in formalin solution (10%). The specimens were cut at 5-7 microns and stained with hematoxylin & eosin **(8)**.

G. Financial cost

As broiler industry is based on momentary returns rather than maximal chick performance. The main purpose of this item of the study is to investigate the economical possibility of using fenugreek seeds as natural growth promoter in broiler chick diets. According to guide lines of economic evaluation, the production costs include: chick price, feed cost, management care, and final body weight. The economical efficiency of the present study could be calculated from input-output analysis based mainly upon the total feeding cost and the prevailing selling price of live body weight.

H. Statistical analysis:

The data were subjected to ANOVA and *t*-test procedures. Statements of statistical significance were based on $P < 0.05$ **(22).**

Results and discussion

1- Growth performance

Weight change and weight gain of broilers as affected by the addition of fenugreek seeds to the diets at two levels (1 or 2%) during the experimental period (17-45 days of age) are presented in Tables (3 and 4). Averages of live body weight of all treatments at the beginning of the experiment were nearly similar. Results indicated that addition of fenugreek seeds during the growing period had slightly increased body weight gain for chicks fed diets containing 1% fenugreek seeds followed by those fed 2% level, especially in the last week of the experimental period. Results of feed conversion (Table 5) indicated that dietary supplementation of fenugreek improved feed conversion of broiler chicks. This improvement may be attributed to the inhibition effect of fenugreek of about 85-90% of aflatoxins formation **(14)**. In this respect, other work **(28)** demonstrated the presence of phytoestrogens in fenugreek seeds which have antifungal and antioxidant actions.

Table (3): Effect of fenugreek seeds supplementation in the diet of broiler chicks on live body weight (g).

Age / days	The experimental groups		
	Control	1% fenugreek	2% fenugreek
At 17 days	446 ± 14.3 *a*	430 ± 8.9 *a*	420 ± 8.9 *a*
At 20 days	636 ± 18.3 *a*	632 ± 37.2 *a*	530 ± 10.9 *b*
At 27 days	1040 ± 24.5 *a*	1012 ± 23.3 *ab*	962 ± 10.2 *b*
At 34 days	1380 ± 101.9 *a*	1380 ± 20 *ab*	1320 ± 37.4 *b*
At 41 days	1844 ± 21.3 *a*	1772 ± 44.9 *a*	1656 ± 60.4 *a*
At 45 days	1944 ± 56.3 *a*	1970 ± 62.4 *a*	1952 ± 61.8 *a*

Also the presence of viscous polysaccharides (galactomannan) will slow the rate of gastric emptying which determines the rate at which nutrients are exposed to the digestive enzymes and absorptive surface in the small intestine and hence may increase the rate of nutrient absorption **(17)**.

Table (4): Effect of fenugreek seeds supplementation in the diet of broiler chicks on weight gain (g).

Age / days	The experimental groups		
	Control	1% fenugreek	2% fenugreek
17 - 20 days	190 ± 19.2	202 ± 34.9	126 ± 13.2
20 - 27 days	404 ± 16	380 ± 17.8	432 ± 18.5
27- 34 days	420 ± 49	368 ± 28. 7	358 ± 41.5
34 - 41 days	380 ± 49	392 ± 38.7	336 ± 31.8
41 - 45 days	100 ± 21.9	198 ± 29	296 ± 27.8
17 - 45 days	1498 ± 58.7*a*	1540 ± 70.9*a*	1532 ± 61.1*a*

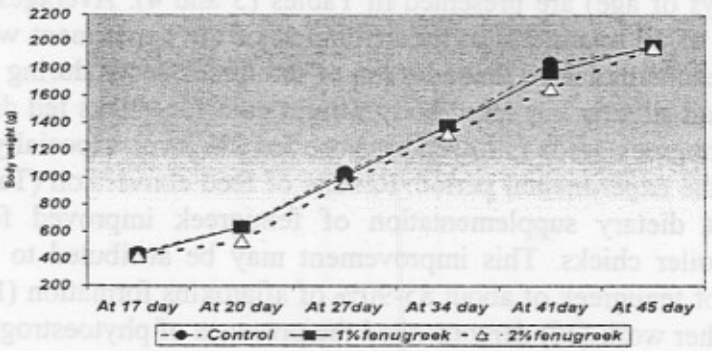

Fig. (1) Growth curve of the experimental groups of broiler chicks.

On the other side, it was suggested that fenugreek improves peripheral glucose utilization which contributes to an improvement in glucose tolerance **(33)**. Results presented in Table (5) shows that there is a slight increase in feed intake with addition of 2% fenugreek in the diet. This result can be attributed to the presence of steroid saponins (appetite-stimulating) in fenugreek seeds which increased feed intake and motivation to eat.

Table (5): The effect of different fenugreek levels in the diet on chick performance

Item	The experimental groups		
	Control	1% fenugreek	2% fenugreek
Average daily feed intake (g)	109.6	109.6	110.3
Total body weight gain (Kg)	1.498	1.540	1.532
Average daily weight gain (g) "28 days"	53.5	55.0	54.71
Feed conversion ratio[1]	2.05	1.99	2.016
Total energy intake (Kcal/day)[2]	350.7	350.7	353.0
Energy/kg body gain (Kcal)[3]	6555.1	6376.4	6452.2
Total protein intake (g/day)[4]	25.2	25.2	27.4
Protein/kg body gain (g)[5]	471.03	458.18	500.8

1. Feed conversion ratio = Feed intake (g) / Average daily body weight gain (g).
2. Total energy intake (Kcal/day) = Daily feed intake (Kg) X ME per Kg diet.
3. Energy/kg body gain (Kcal) = Total daily energy intake X 1000 g / average daily body gain (g).
4. Total protein intake (g) = Daily feed intake (g) X protein%.
5. Protein / Kg body weight gain (g) = Total daily protein intake X 1000 g / average daily body gain (g).

Feed conversion ratio of chick groups showed no significant change but comparatively, the 1% level was the best. Similar results were seen for energy and protein consumed per kg body gain.

2-Carcass characters

Data presented in Table (6) showed that broilers fed diets supplemented with 1 or 2% fenugreek seeds decreased percentages of dressing, oven ready, heart and edible organs but the differences were insignificant compared to the control group. These results agreed with those obtained by other work **(7)**. On the other hand, the intestinal length of broilers fed on diets with 1 or 2% fenugreek seeds showed significant increase while the intestinal width did not affected.

Table (6): The effect of different fenugreek levels in the diet on carcass yield of broiler chicks

Item	Experimental groups		
	Control	1%fenugreek	2%fenugreek
• Live weight at slaughter (g)	1966.6±85.1	2046.6±104.7	1920± 136.1
Items as % of live body weight			
• Slaughtered carcass	86.16 0.81a	85.05 ± 0.43a	84.07 ± 1.14a
• Oven ready carcass	71.2 ± 0.95a	69.75 ± 0.53a	68.47 ± 1.57a
• Edible organs	2.92 ± 0.04a	2.67 ± 0.05a	2.66 ± 0.18a
• Liver	2.34± 0.085a	2.14 ± 0.062a	2.13 ± 0.158a
• Heart	0.466± 0.02a	0.42 ± 0.16ab	0.426 ± 0.014b
• Gizzard and crop	2.69 ± 0.17a	2.42 ± 0.156a	2.66 ± 0.37a
• Pancrease	0.208± 0.01a	0.166 ± 0.02a	0.196 ± 0.26a
Intestinal length (cm)	163.67± 1.3a	190 ± 0.0b	198.3 ±1.6c
Intestinal width (cm)	1.2 ± 0.046a	1.11± 0.083a	1.3 ± 0.1a

3- Immunization and lymphoid organs

The lymphatic tissues (spleen, thymus, and bursa of fabricius) have a considerable role in bird's immunity **(21)**. The effect of fenugreek seeds on lymphoid organs and antibody titer are presented in Table (7). Results showed that the value of antibody titer increased significantly ($p<0.05$) by addition of fenugreek seed to broilers diet up to 2% as compared to the control group. This improvement in antibody titer may be due to galactomannan in fenugreek seed. This improvement of HI titer can agree with results of similar researches **(10)** which indicated that fenugreek has a stimulatory effect on immune functions in mice. In his study it was found that an aqueous extract of fenugreek increased delayed type of hypersensitivity, delayed T-cell hypersensivity (DTH) response, phagocytic index and phagocytic capacity of macrophages. Humoral immunity as measured by plaque-forming cell (PFC) showed also an elevated response. On the other side, fenugreek seed at level of 1% increased thymus weight which was higher than control and the 2% treatment, while the bursa weight was not affected by addition of fenugreek at these levels.

Table (7): The effect of different fenugreek levels in the diet on immunization and lymphoid organs

Item	The experimental groups		
	Control	1%fenugreek	2%fenugreek
Haemagglutination inhibition (HI) titer*	3.3 ± 0.6a	8 ± 0.0b	10.6 ± 2.6c
Weight of lymphoid organs (% of live weight at slaughter):			
• Spleen	0.109±0.02a	0.094±0.009a	0.11±0.017a
• Thymus	0.25±0.046a	0.36±0.066a	0.25±0.049a
• Bursa of fabricius	0.085±0.01a	0.069±0.01a	0.069±0.004a

*HI test with 8 Haemaglutination units and 1% chickens RBCs

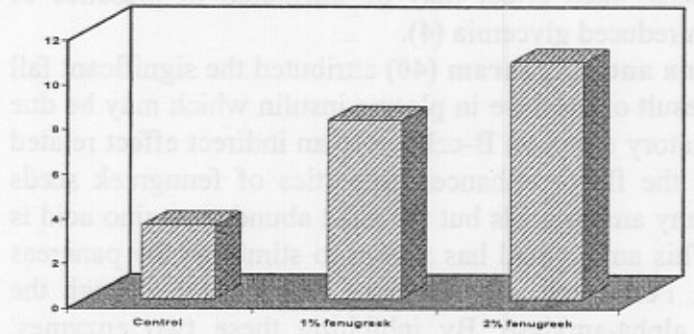

Fig (2): Antibody production of different experimental groups.

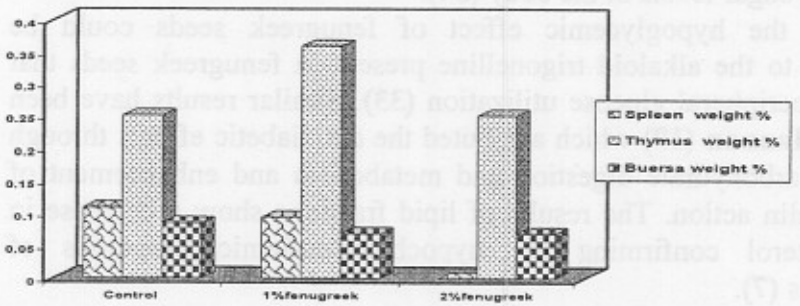

Fig (3): The effect of different fenugreek levels on lymphoid organs.

4-Effect on some blood constituents

Effect of fenugreek seeds on some blood constituents of broiler chicks are shown in Table (8). The addition of fenugreek seeds to chick diet increased serum content of total protein and albumin. It is known that the change in albumin levels reflects the change in the liver function, since the liver is the site of albumin synthesis but globulin is formed by lymphatic tissues **(21)**. In this respect, **Azouz (7)** found that total protein and globulin of serum increased significantly by feeding Hubberd broiler chicks on diets supplemented with fenugreek seeds. The increment in total serum proteins may be attributed mainly to that the fenugreek seeds may stimulate the thyroid gland directly as T_3 and T_4 of serum increased significantly and led to increased serum protein content **(20)**. With regarded to serum glucose, the present results show a decrease in glucose level indicating the hypoglycemic effect of fenugreek seeds, such effect may be attributed to presence of galactomannanas which reduced glycemia **(4)**.

In this side, **Sharama and Raghuram (40)** attributed the significant fall in blood glucose as a result of increase in plasma insulin which may be due to either a direct stimulatory effect on B-cells or to an indirect effect related to the palatability and the flavor enhancer properties of fenugreek seeds **(33)**. Fenugreek has many amino acids but the most abundant amino acid is 4-hydroxyisoleucine. This amino acid has shown to stimulate the pancreas to release insulin **(38)**. Fenugreek also regulates blood sugar through the enzymes sucrase and alpha-amylase. By inhibiting these two enzymes, fenugreek can help slow the break down of carbohydrates into sugar further reducing blood sugar levels in the body **(34)**.

Moreover, the hypoglycemic effect of fenugreek seeds could be attributed also to the alkaloid trigonelline present in fenugreek seeds that may improve peripheral glucose utilization **(33)**. Similar results have been explained by **Hannan (19)** which attributed the antidiabetic effects through inhibition of carbohydrate digestion and metabolism and enhancement of peripheral insulin action. The results of lipid fractions show a decrease in serum cholesterol confirming the hypocholesterolemic properties of fenugreek seeds **(7)**.

Raghuram (33) stated that fenugreek seeds or extracts increased the excretion of bile acids and so reduced cholesterol content of serum due to the presence of unsaturated fatty acids in the seed.

Table (8): Effect of different fenugreek levels in the diet on some blood constituents of broiler chicks

Item	Unit	Experimental groups		
		Control	Fenugreek 1%	Fenugreek 2%
Liver function:				
Total protein	g / dl	2.3±0.06ac	2.7 ± 0.1b	2.5 ± 0.06bc
Albumin	g / dl	1.2 ± 0.17a	0.85 ± 0.03a	0.6 ± 0.06a
Globulin	g / dl	1.1 ± 0.11a	1.85 ± 0.9b	1.9± 0.17b
A\G ratio	-----	1.1 ± 0.14a	0.45 ± 0.03b	0.3 ± 0.06b
ALT	U / L	4.8 ± 0.35a	3.2 ± 0.23b	3.2 ± 0.28b
AST	U / L	13.0 ± 0.0a	13.0 ± 1.61a	13.0 ± 1.5a
Glucose:	mg / dl	255 ± 1.7a	239 ± 1.15b	241 ± 2.9b
Lipid fractions:				
Cholesterol	mg / dl	118 ± 2.9a	92 ± 3.46b	89 ± 0.57c
Triglycerides	mg / dl	97 ± 1.15a	83 ± 1.5b	71 ± 0.58c
Kidney function:				
Creatinine	mg / dl	0.10±0.005a	0.15 ± 0.03a	0.2 ± 0.03a
Uric acid	mg / dl	3.6 ± 0.23a	3.9 ± 0.14a	3.7 ± 0.3a

On the other side, **Lanksy (25)** attributed this effect to steroid saponins which may either compete with cholesterol at binding sites or interfere with cholesterol biosynthesis in the liver. They added that soluble fibers and mucilage content of fenugreek seeds may block cholesterol absorption from the intestine so reduced its level in the serum. In the same side, **AL-Habori (3)** found that fenugreek and its extracts reduced the levels of cholesterol, triglycerides and Low Density Lipoprotein (LDL-cholesterol) with no effect on High Density Lipoprotein (HDL-cholesterol). This selective reduction in LDL-cholesterol results in the improvement of the ratio of HDL-cholesterol to LDL-cholesterol. Reduction of serum cholesterol is usually accompanied with its decrease in tissue or meat. This conclusion is very valuable for broiler meat consumers, especially those with atherosclerosis. The improvement of the plasma lipid profile by fenugreek treatment further supports the use of fenugreek seeds as a hypolipidaemic agent in the improvement of lipid disorders. Results of liver function enzymes showed that no significant change in level of AST and ALT compared to the control. The data concerning creatinine and uric acid

in serum as indicator of kidney function showed no characteristic trend, since all experimental diets are nearly similar in dietary crude protein.

5-Effect on oxidative stability of fat from broiler chicks

The physical and chemical values of fat obtained from previously refrigerated and frozen meat samples and liver were influenced by the supplementation of fenugreek seeds in the diet (Table 9). Birds fed diet supplemented with fenugreek seeds had lower TBA and peroxide values of refrigerated breast and thigh tissues and thus showed greater oxidative stability than samples taken from birds fed control diet. The dietary fenugreek seeds can influence the oxidative stability of muscle and liver of broiler chicks. The antioxidant effect of fenugreek seeds may be attributed to the presence of phytoestrogens and vitamin C, also **Ravikumar & Anuradha (35)** stated that the level of antioxidants were higher in normal rat which was fed the fenugreek supplemented diet compared with control animals and they also showed that disrupted free radical metabolism in diabetic animals may be normalized by fenugreek seed supplementation in the diet.

Table (9): The physicochemical properties of fat from the experimental broiler chicks

Item	Experimental groups		
	Control	1% fenugreek	2% fenugreek
Tissue fat:			
• **Acid value**	9.67 ± 0.04	10.76 ± 0.046	9.18 ± 0.098
• **Iodine number**	68.43 ± 0.067	65.87 ± 0.081	66.44 ± 0.18
• **Peroxide value**	2.95 ± 0.023	2.94 ± 0.14	2.40 ± 0.086
• **TBA value**	4.37 ± 0.21	3.24 ± 0.024	2.26±0.0017
• **Refractive index**	1.3425±0.001	1.34151±0.001	1.3425±0.0006
Liver fat:			
• **Acid value**	19.65± 0.21	19.97± 0.023	15.01± 0.086
• **Iodine number**	66.66± 0.95	66.76± 0.91	64.01± 0.092
• **Peroxide value**	1.07±0.034	0.97± 0.023	1.02± 0.017
• **TBA value**	2.65±0.30	2.1± 0.029	2.26± 0.063
• **Refractive index**	1.35448±0.0007	1.3585±0.0018	1.3585± 0.001

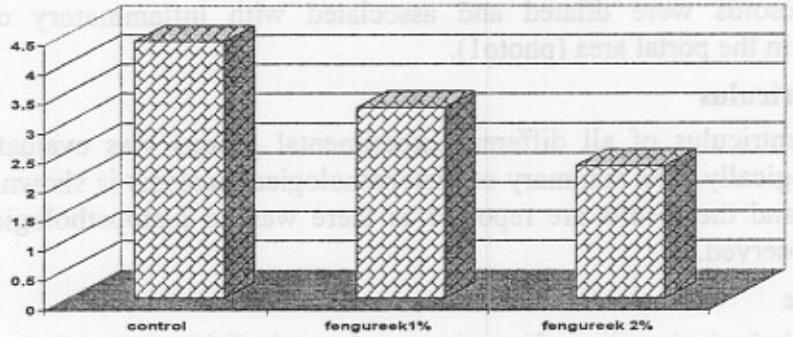

Fig (4): Effect of different levels of fenugreek in the diet on TBA concentration of meat.

6-Histopathological examination of some internal organs

- **Liver:** The histological examination of liver is presented in Table (10) and photo 1-3.

Table (10): Histopathological findings of broiler chicks fed different dietary treatments.

Items	Control	1% fenugreek	2% fenugreek
Liver	No histopathological alteration was observed	No histopathological alteration was observed	The central and portal veins as well as the hepatic sinusoids were dilated and associated with inflammatory cells infiltrations in the portal area (photo1)
Pro-Ventricul-us	No histopathological alteration was observed	No histopathological alteration was observed	No histopathological alteration was observed
Small intestine	No histopathological alteration was observed	Inflammatory cells infiltration was detected in the lamina propria (photo 2)	Massive number of inflammatory cells infiltration were observed in the lamina propria (photo 3)

The histological examination of liver of broiler fed diet supplemented with 2% fenugreek seed revealed that the central and portal veins as well as the hepatic sinusoids were dilated and associated with inflammatory cell infiltrations in the portal area (photo1).

- **proventriculus**

The proventriculus of all different experimental groups was evaluated histopathologically. The summary of histopathological analysis is shown in Table (10) and the results are reported as there was no histopathological alteration observed.

- **Intestine**

The histopathological studies of intestine are shown in Table (10) and photo 2 and 3, where the results are reported in broiler chicks.

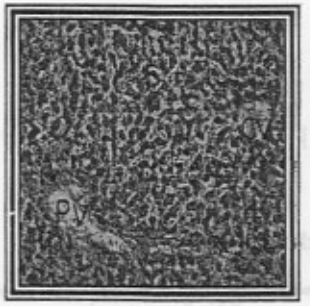

Photo (1): Liver of broiler fed diet supplemented with 2% fenugreek showing dilatation in central vein (CV), portal vein (PV) and sinusoid (S) with inflammatory cells infiltration in portal area (arrow). (H &E x 40).

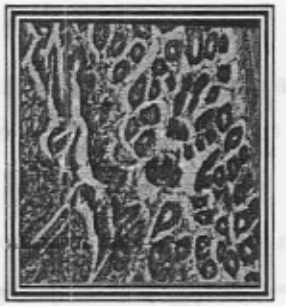

Photo (2): Intestine of broiler fed diet supplemented with 1% fenugreek showing inflammatory cells infilteration was detected in the lamina propia (L). (H &E x 40)

Photo (3): Intestine of broiler fed diet supplemented with 2% fenugreek showing massive number of inflammatory cells infiltration was detected in the lamina propia (L). (H &E x40).

In the groups fed diets containing fenugreek seeds, inflammatory cells infiltration was detected in the lamina propria (photo 2). This may be attributed to effect of galactomannan.

7- Economical efficiency

Feed cost for broilers fed diet containing 1% and 2% fenugreek seeds were 6.23 LE and 6.35 LE /chick (Table 12), being higher than that of the control group which was 6.13 L.E/ chick.

Table (11): Price list of different ingredients used in the diet formulation (year 2006)

Diet ingredients and additives	Price L.E. / Kg
Yellow corn	0.966
Soybean meal 44%	1.695
Concentrate mixture 52% protein	3.066
Dicalcium phosphate	3.33
Oil	4.00
Mineral-vitamin premix	7.33
DL. Methionine	24.00
Fenugreek seed	3.00

Table (12): Economic evaluation of different experimental diets

Item	Unit	Experimental groups		
		Control	1% fenugreek	2% fenugreek
• Cost / ton diet	L.E.	1705.88	1735.88	1765.88
• Final body weight	Kg	1.944	1.970	1.952
• Aver. daily feed intake	g	109.6	109.6	110.3
• Price per chick	L.E.	3.25	3.25	3.25
• Management per chick	L.E.	0.5	0.5	0.5
• Feed cost up to 17 days	L.E.	1	1	1
• Feed cost (17-45 days)	L.E.	5.13	5.23	5.35
• Total feed cost /chick	L.E.	6.13	6.23	6.35
• Total cost/chick[1]	L.E.	9.88	9.98	10.1
• Selling price /kg live weight	L.E.	8.5	8.5	8.5
• Total revenue/chick[2]	L.E.	16.524	16.745	16.592
• Net revenue/chick[3]	L.E.	6.644	6.765	6.492
• Economic efficiency[4]	L.E.	0.672	0.678	0.643
• Relative economic efficiency[5]	L.E.	100	101.82	97.71

1. Total cost per chick = Total feed cost + Management of chick (L.E.) + chick price (at the start of the experiment, L.E.). 2. Total revenue per chick (L.E.) = Final body weight (Kg) X selling price of Kg chick live body weight (L.E.). 3. Net revenue per chick (L.E.) = Total revenue per chick (L.E.) – (Total costs per chick (L.E.). 4. Economic efficiency = Net revenue per chick (L.E.) / total costs per chick (L.E.). 5. Relative economic efficiency = Economic efficiency of each experimental group /economic efficiency of the control X 100.

On the other side, the total revenue values of experimental groups fed diet supplemented with 1% fenugreek were higher than other groups due to the higher final live body weight. Finally the relative economical efficiency of diet containing 1% fenugreek seed was higher than control diet. Such diet was recorded as the lowest feed cost needed to obtain one Kg live body weight. Generally, the fenugreek seed as natural growth promoter in broiler diet improved the broiler chick performance without negative economical changes.

From the previous results, it can be concluded that supplementation of the broiler diet with 1% fenugreek seed can improve broiler performance, oxidation stability of broiler meat, modulate the cholesterol profile in the serum which can be reflected in the meat and make an advantage for human diets. In the future, the researches in this area need more work due to the maximum benefits from not only improving food animal performance but also reducing the risk of chronic diseases of human beings (high blood cholesterol, high blood pressure, heart diseases,...etc.).

References

1. **Abd El-Aal, M.H. and E.H. Rahma (1986):** Changes in gross chemical composition with emphasis on lipid and protein fractions during germination of fenugreek seeds. Food Chemistry 22: 193-207.
2. **Agricultural economic publication (A.E.P.) (1999):** Ministry of Agricultural and Land Reclamation. ARE.
3. **AL-Habori, M., AL-Aghbari, A. and AL-Mamary, M. (1998):** Effects of Fenugreek seeds and its extracts on plasma lipid profile: a study on rabbits. Phytotherapy Res. 12, 572-575.
4. **Ali, L.; A.K. Azad Khan; Z. Hassan; M. Mosihuzzaman; N. Nahar; T. Nasreen; M. Nur-e-Alam and B. Rokeya (1995):** Characterization of the hypoglycemic effects of *Trigonella foenum graecum* seed. Planta med. 61:358-360.
5. **A.O.C.S. (1966):** Official and tentative methods of analysis. 2nd ed. Chicago, Illianos, USA.
6. **A.O.C.S. (1975):** Official and tentative methods of analysis. 2nd ed. Chicago, Illianos, USA.
7. **Azouz, H.M.M. (2001):** Effect of hot pepper and fenugreek seeds supplementation on broiler diets. Ph.D Thesis, Poultry Nutrition Dept. Faculty of Agriculture, Cairo University.
8. **Banchroft, J.D.; Stevens, A. and Turner, D.R. (1996):** Theory and practice of histological techniques. Fourth Ed. Churchil Livingstone, NewYork, London, San Francisco, Tokyo.

9. **Beard, C. W. (1989):** Serologic procedures. In a laboratory manual for the isolation and identification of avian pathogens. 3d ed. H. G. Purchase et al., eds. Kennett Square, PA: American Association Avian Pathologists, pp. 192 – 200. Lib. Cat. Card No. 89-80620.
10. **Bin-Hafeez B, Haque R, Parvez S, Pandey S, Sayeed I, Raisuddin S (2003):** Immunomodulatory effects of fenugreek (Trigonella foenum graecum L.) extract in mice. Int Immunopharmacol. Feb. 3(2):257-65.
11. **Brenac,P and Y. Sauvaire (1996b):** Accumulation of sterols and steroidal sapogenins in developing fenugreek pods: possible biosynthesis in situ. Phytochemistry, 41: 415-422.
12. **Caraway, W., (1963):** Determination of uric acid, In: Stand. Clin. Chem., 4: 239.
13. **Doumas, B.T. and H.G. Biggs (1972).** In Standard Methods of Clinical Chemistry. Quantitative colorimetric determination of albumin in serum or plasma. Academic press, New York, 7: 175.
14. **El-Shayeb, N.M.A. and S.S. Mabrouk, (1984):** Utilization of some edible and medical plants to inhibit aflatoxin formation. Nutrition Reports International, 29 (2): 273-282.
15. **Folch, J., Lees, M. and Stanley, G.H.S. (1957):** Preparation of lipid extracts from brain tissue. *J. Biol. Chem.*, 226, 497-509.
16. **Folin, O.Z. (1934):** Phys. Chem. 268: 228.
17. **Gallaher, Daniel D., and Barbara O. Schneeman (2001):** "Dietary Fiber." In *Present Knowledge in Nutrition.* 8th ed., edited by Barbara A. Bowman and Robert Russell. Washington, D.C.: ILSI Press.
18. **Gornal, A.G.; C.J. Bardawil and M.M. David (1949).** Quantitative colorimetric determination of total protein in serum. J. Biol. Chem., 177: 751.
19. **Hannan JM, Ali L, Rokeya B, Khaleque J, Akhter M, Flatt PR, and Abdel-Wahab YH (2007):** Soluble dietary fiber fraction of the Trigonella foenum-graecum (fenugreek) seed improves glucose homeostasis in animal models of type 1 and type 2 diabetes by delaying carbohydrate digestion and absorption, and enhancing insulin action. Br. J. Nutr. Mar; 97 (3): 514-21.
20. **Hassan, M.S.H. (2000):** Physiological studies on egg cholesterol and immunity in layers. Ph.D. thesis, Animal production Dept., Faculty of Agriculture, Cairo University.
21. **Jones, F.A. and P.D. Bark (1979):** Chemical diagnosis of disease Brown, S.S., F.L. Mitchell and D.S. Young (Eds.) Elsevier, Biomedical press, Amsterdam, New York, Oxford, P: 325-363.
22. **KaleidaGraph ™ computer program (2000):** Data Analysis and Graphic Presentation for Business, Science and Engineering. Version 35b5 March 22.
23. **Kaleta, E. F. and O. Siegmann (1971):** Vergleichende Untersuchung über den Nachweis hämagglutinationshemmender und virusneutralisierender Antikörper nach Vaccination gegen die Newcastle disease. Archiv für Geflügelkunde 35, 79-83.
24. **Katz, S.E. and and Brady, L.S. (1993):** Antibiotic residues in food and their significance. Antimicrobials in food. Edited by: P. Michael Davidson, & Alfred larry Branen.

25. **Lanksy, P.S.; H. Schilcher; J.D. Phillipson and D. Loew (1993):** Plants that lower cholesterol. First world congress on medicinal and aromatic plants for human welfare (WOCMAP), Maastricht, Netherlands, 19-25 July 1992. Acta-Horticulturae. 1993, No. 332, 131-136 (Abs.).
26. **Lowell M. L., P. H. Rolph, (1973):** Stable reagent for determination of serum triglycerides by calorimetric H and Z consideration method. Clin. Chem., 19 (3): 339.
27. **Madar, Z. and I. Shomer (1990):** Polysaccharide composition of a get fraction derived from fenugreek and its effect on starch digestion and bile acid absorption in rats. J. Agric. Food Chem. 38: 1535-1539.
28. **Mazur, W.M.; J.A. Duke; K. Wahala; S. Rasku and H. Adlerereutz (1988):** Isoflavonoids and Lignins in Legumes: Nutritional and Health aspects in human. J. Nutr. Biochemistry, 9: 193-200.
29. **Nour, A.A. and B.I. Magboul (1986):** Chemical and amino acid composition of fenugreek seeds grown in Sudan. Food Chemistry 22: 1-5.
30. **Nutrient Requirements of Poultry, Ninth Revised Edition (1994).** National Research Council, National Academy Press, Washington, D. C.
31. **Ortuno, A,; R. Oncino; J.M. Botia and J.A. Del Rio (1999):** Regulation of the diosgenin expression in Trigonella Foenum graecum plants by different plant growth regulators. Food Chemistry 65: 227-232.
32. **Raghavan, V. (1997):** Application of quality control concepts on broiler production. American Soybean Association. The International Poultry Farming site.
33. **Raghuram, T.C.; R.D. Sharma: B. Sivakumar and B.K. Sahay (1994):** Effect of a fenugreek seed extract on feeding behaviour in the rat. Metabolic endocrine correlates. Pharmacol. Biochem. Behav., 45: 369-374.
34. **Raju J., Gupta D., Rao AR., Yadava PK., Baquer NZ., (2001):** Trigonellafoenum graecum (fenugreek) seed powder improves glucose homeostasis in alloxan diabetic rat tissues by reversing the altered glycolytic, gluconeogenetic and lipogenic enzymes. Mol. Cell Biochem. 224 (1-2): 45-51.
35. **Ravikumar P, Anuradha CV. (1999):** Effect of fenugreek seeds on blood lipid peroxidation and antioxidants in diabetic rats. Phytother Res. May;13(3):197-201.
36. **Reid, J.S. and H. Meier (1970):** Formation of reserve galactomannan in the seed of trigonella foenum graecum. Photochemistry 9: 513-520.
37. **Reitman, S. and S. Frankel (1957):** Got and Gpt transaminase determination in serum and plasma. Am. J. Clin. Path., 28: 56.
38. **Sauvaire Y, P Petit, C Broca, M Manteghetti, Y Baissac, J Fernandez-Alvarez, R Gross, M Roye, A Leconte, R Gomis, and G Ribes (1998):** 4-Hydroxyisoleucine: a novel amino acid potentiator of insulin secretion. Diabetes 47: 206-210.
39. **Sedlaceck, B.A.J. (1969):** Handbuch der Lebensmittel Chemie, Band, IV Springer-Verlag, 875.
40. **Sharama,R.D. and T.C. Raghuram (1990):** Hypoglycemic effect of fenugreek seeds in non-insulin dependent diabetic subjects. Nutrition Research, 10 (7): 731-739.
41. **Srichamroen A., T. Vasanthan, B. Ooraikul, T. K. Basu (2005):** IFT Annual Meeting, July 15-20 – New Orleans, Louisiana, USA.

42. **Trinder, p. (1969):** Enzymatic colorimetric determination of glucose in serum, plasma or urine. Ann. Clin. Biochem. 6: 24.
43. **Udayasekhara Rao P. and R.D. Sharma (1987):** An evaluation of protein quality of fenugreek seeds (Trigonella foenum graecum) and their supplementary effects. Food Chemistry 24: 1-9.
44. **Watson, S (1960):** Cholesterol determination in serum. Clin. Chem. Acta., 5: 637.
45. **Weaver, L.D. (1992):** Antibiotics in milk and meat: Perceptions and realities. Vet. Med. 87:1222-1228.
46. **Whistler, R.L. and C.L. Smart (1953):** Galactomannans, Chapter XI (In) "Polysaccharide Chemistry", Academic Press, New York.
47. **WHO, (1996):** World Health Organization WHO Tech. Rep. Ser. 426 Edited by Barragry, T.B.: Vet. Drug therapy. LEA and Febiger, Philadelphia. London, Chapter 14.

الملخص العربى

مدى استجابة كتاكيت التسمين للتغذية على علائق تحتوى على بذور الحلبة كاضافة غذائية طبيعية

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إجريت هذه التجربة الغذائية بكلية الطب البيطري بمشتهر وقد صممت هذه التجربة لتقيم تأثير استخدام إضافة بذور الحلبة بمستوى صفرو١٪ و٢٪ من عليقة كتاكيت التسمين على النمو وخواص الذبيحة والإستجابة المناعية ووظائف الكبد والكلى ودرجة ثبات الدهن ضد الأكسدة والتقييم الإقتصادى والتغيرات الهستوباثولوجية. وقد استخدمت كتاكيت تسمين هبرد عمر١٧ يوم وتم تقسيمها بصورة عشوائية الى ثلاث معاملات، الأولى غذيت على عليقة كنترول والمعاملتين الأخريين غذيت على عليقة الكنترول مضاف اليها ١٪ و٢٪ بذور حبة البركة واستمرت التغذية لمدة ٢٨يوم وأوضحت النتائج المتحصل عليها على الأتى : كان هناك تأثير إجابى للعليقة المضاف إليها١٪ بذور الحلبة على النموالإستجابة المناعية ضد مرض النيوكاسل ودرجة ثبات الدهن ضد الأكسدة ومن الجانب الإقتصادى كان هناك زيادة فى الناتج الربحى النهائى وعلى الجانب الاخر لم يكن هناك أى تاثير على خواص الذبيحة أو أى تأثير عكسى على وظائف الكبد والكلى ولا توجد تغيرات هستوباثولوجية وكان هناك تأثير ممثل فى خفض تركيز الكولستيرول والجلوكوز فى الدم مما يترتب على ذلك من نتائج مستحبة فى جودة اللحوم صحياً وفى النهاية يمكن القول بأن اضافة بذور الحلبة الى كتاكيت التسمين أدى إلى نتائج جيدة على التغذية و الرعاية.