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Effect of Feeding *Trigonella Foenum-graecum* on Growth Performance of Broiler Chicks

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Abstract: The present research aims to investigate the effect of using the whole seeds of fenugreek and their extracts in poultry ration formulation based on soya bean and sorghum. The fenugreek was offered in a ground/Milled Form (FM), Fenugreek residue after Extraction with solvents (FWE), Light Extract (EL) and Dense Extract (ED). The tested groups received: FM 5, 10 and 15, FWE 5, 10 and 15, SE 5, 10 and 15, ED 5, 10 and 15% and control. The tested parameters included weight gain (g), feed intake and the Feed Conversion Rate (FCR). The group fed on the highly extracted fenugreek gained 94 g in average more than the chicks in the control group, they achieved the highest body weight gain 1422 g in average. Lowest FCR value 1.48 was reported in the group fed on 10% light extract fenugreek seeds and finally, the group with the highest feed intake was that kept on 15% fenugreek. In conclusion, the fenugreek can be safely used to replace soya and sorghum in broilers starter and finisher ration without any adverse effects on the bird performance.

Key words: Broilers, fenugreek, nutrition, *Trigonella foenum-graecum*, seeds, finisher, broilers

INTRODUCTION

Throughout the history and worldwide, the seeds and leaves of fenugreek *Trigonella foenum-graecum* were used in human nutrition and traditional medicine. In addition, they were also used as forage for animal feeding (Altuntas *et al*., 2005; Janabi, 2012; Dogaru *et al*., 2003; Gyananath *et al*., 2000; Reda *et al*., 2001). Although, fenugreek is a well-known forage legume, its usage in ration formulation was limited due to its high contents of Anti-Nutritive Factors (ANF) such as tannins, phytates and oxalates. The presence of ANF leads to clear reduction of protein digestibility and amino acid absorption from the ration. However, like in other legumes, the adverse effects of the ANF can be reduced by the application of the appropriate treatment such as boiling (Kahn *et al*., 2001; Mir, 2003; Miller *et al*., 1996; Oncina *et al*., 2002; Petropoulus, 2002).

The medical benefits of feeding fenugreek seeds were proved by many researchers. In rats, the use of fenugreek ethane extract of 30-50 g for 4 weeks reduced the blood cholesterol with 18-26%. This effect was attributed to interaction between sapogenin and bile salts in the digestive tract (Sharma and Choudhary, 2017; Annida and Prince, 2004, 2005; Kandhare *et al*., 2015; Hannan *et al*., 2003). In another experiment, after oil extraction from fenugreek seeds, the rest was divided into two sub fractions, one contains the head and endosperm 79.5% fibers and the second contains cotyledons and associated parts 52.8% proteins and 7.2% saponins. Each sub fraction is mixed separately in the feed of diabetic dogs for 21 days (Ribes *et al*., 1986). While the first fraction controlled the hyperglycemia and reduced high levels of glucagon and somatostatin in blood plasma, the second fraction had no measurable effects (Petropoulus, 2002; Ribes *et al*., 1986; Zandi *et al*., 2014). One of the active ingredients present in fenugreek is diosgenin which is a naturally-occurring steroid saponin. Diosgenin is known to stimulate the production of growth hormones from the pituitary gland and inhibits the urease activity

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in the digestive tract (Sauvaire *et al*., 1991; Shang *et al*., 2002; Smit, 2014; Xu *et al*., 2002). This will effectively inhibit the splitting of urea into ammonia and CO_2 and therefore, reduces the emissions of ammonia from animals (Mir, 2003).

Sheep fed with a daily dose of 26.1 g in late spring for 24 h did not exhibit any metabolic or histopathological changes. The given substance was metabolized in the rumen to diosgenin, epismilagenin, smilagenona, smilagenina and tigogenin followed by the complete absence of diosgenin within 1 h (Busquet *et al*., 2006). *In vitro*, the incubation of fenugreek extract for 24 h with a diet consists of forage and concentrates in the ration 1:1 of in ruminal fluid reduces the concentration of ammonia N 30-50% (Mir, 2003; Busquet *et al*., 2006).

However, few publications dealing with the usage of fenugreek seeds and their extracts in poultry formulations could be found in literatures (Alloui *et al*., 2012; Billaud and Adrian, 2001; Criste *et al*., 2013; Adil *et al*., 2015; Koeleman, 2014; Abbas, 2010).

In poultry industry, fenugreek seeds were classically used as growth promoters, especially for broilers. When added to ration at certain concentrations, they improve both the body weight and the FCR and even the semen quality and the reproductive performance including egg mass and quality. The presence of the galactomannans and neurin stimulates the appetite and therefore increase the feed intake. While the improvement in body weight gain and FCR is mainly attributed to the high nutritional value of the seeds and the improvement in the micro-environment in the digestive tract. Some researchers link the improvement in body weight gain to the stimulatory effect of the seeds on the hypothalamus gland to stimulate hungriness center. The inclusion rate in the previously mentioned studies ranged from 0.5-3% (Adil *et al*., 2015). However, the nutritional value and the nutrient composition of the seeds varies according to the processing technique (Pandey and Awasthi, 2015). In most research, the use of fenugreek extract in ration was reported to improve the FCR, nutrient digestibility and reduces the excreted ammonia. In layers, the produced egg had higher weight, thicker shell, better yolk color and increased HDL cholesterol (Koeleman, 2014; Abbas, 2010). In opposite to these statements, other researchers reported that ground fenugreek seeds when given to laying hens up to 6 g/hen/d did not induce any effect on bird health, performance or productivity. Confusing data were also delivered by other researchers who reported that the use of 1 and 2% fenugreek in layers diet negatively influenced the egg production and the FCR (Abdouli *et al*., 2014). However, the serum cholesterol and triglyceride of the layers fed 2% fenugreek were significantly reduced compared to controls (Janabi, 2012; Criste *et al*., 2013; Adil *et al*., 2015). The present research aims to investigate the effect of feeding fenugreek seeds and their extracts on the growth performance of broiler chicks.

MATERIALS AND METHODS

Experiment design: The experiment was performed in Guadalajara's University, Mexico using 195 Cobb 500 one day old chicks, in Jalisco, Mexico. The birds were kept under observation during both the starter (1-21 days) and the finisher phases (22-28 days). They were offered isoprotein and isocaloric ration based on sorghum-soybean meal (Table 1 and 2). The birds were randomly divided into 12 groups in addition to a control group (3 repetitions/group; 5 birds/repetition, i.e., 15 birds/formulation) at a probability level of ($p<0.05$). The given formulations included the replacement of 5, 10 and 15% Milled Fenugreek seeds (FM), Fenugreek residue after Extraction with the solvents (FWE), Light Extract (EL) and highly Extract (ED). The groups were numbered as follow; FM 5, 10 and 15%, FWE 5, 10 and 15%, SE 5, 10 and 15%, ED 5, 10 and 15% and control. The obtained results were analyzed by a special software for the analysis of variance (Abdouli *et al*., 2014). The birds were monitored for their body weight gain, feed intake and FCR. At their first day, the chicks were vaccinated against Gumboro, Marek, Influenza and Newcastle. Later on, in the 7th day, the birds were vaccinated against Gumboro, Newcastle, infectious bronchitis and smallpox.

Extraction of fenugreek seeds: At first, different protocols with different solvents were compared for the extraction of the fenugreek seeds in the Laboratory of Food Science of the Technological Institute of Tlajomulco, Jalisco (ITTJ). The best results were achieved when using a mixture of hexane-alcohol-ether at a rate of 64:31:4 volume, respectively. The extraction process was conducted in a 45 L volume container. The milled fenugreek seeds 16.2 kg were added to 26 L of the extraction buffer. The contained was kept closed and subjected to strong stirring every 8 h for 21 days. After that, the fluids were drained and the solvents were removed from the solution by rotary evaporator at the pilot plant of the ITTJ. The remaining solution (1050 mL) was separated into upper layer (the light extract;

Table 1: Treatment diets 1-13 (1-21 days of age)

	Treatments (%)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Ingredients (%)	FM 5	FM 10	FM 15	FWE 5	FWE 10	FWE 15	EL 5	EL 10	EL 15	ED 5	ED 10	ED 15	Tests
Sorghum	51.50	49.110	47.110	51.40	48.810	47.110	53.10	53.10	53.10	53.10	53.10	53.10	53.10
Soya paste	27.30	25.000	22.400	27.20	25.000	22.000	30.20	30.20	30.20	30.20	30.20	30.20	30.20
Ground fenugreek	5.00	10.000	15.000	0.00	0.000	0.000	21.00	42.00	63.00	0.00	0.00	0.00	0.00
Whole fenugreek seeds	0.00	0.000	0.000	5.00	10.000	15.000	0.00	0.00	0.00	19.30	38.60	58.90	0.00
Gluten maize	7.50	7.500	7.500	7.50	7.500	7.500	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Oil	3.40	3.20	2.800	3.60	3.600	3.300	3.90	3.90	3.90	3.90	3.90	3.90	3.90
Ca carbonate	1.85	1.850	1.850	1.85	1.850	1.850	1.85	1.85	1.85	1.85	1.85	1.85	1.85
Ca ortophosphate	1.40	1.400	1.400	1.40	1.400	1.400	1.40	1.40	1.40	1.40	1.40	1.40	1.40
Salt	0.39	0.390	0.390	0.39	0.390	0.390	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Lysine	0.11	0.000	0.000	0.11	0.000	0.000	0.11	0.11	0.11	0.11	0.11	0.11	0.11
Methionine	0.15	0.150	0.150	0.15	0.050	0.050	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin and mineral	1.40	1.400	1.400	1.40	1.400	1.400	1.40	1.40	1.40	1.40	1.40	1.40	1.40

Table presents the used diets in the treatments no. 7-13 in the first 21 days of life (stage of initiation). The offered diets were isoproteic and provided in addition 3000 kcal EM/kg, 1.1% lysine 0.5% methionine, 1.25 arginine, 0.8% threonine, 1% Ca and 0.45% P. The required vitamins and minerals were covered through a commercial premix

Table 2: Treatment diets 1-13 (between 22-28 days of age)

	Treatments (%)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Ingredients (%)	FM 5	FM 10	FM 15	FWE 5	FWE 10	FWE 15	EL 5	EL 10	EL 15	ED 5	ED 10	ED 15	Tests
Sorghum	54.63	53.240	51.230	55.260	53.240	50.910	57.600	57.600	57.600	57.600	57.600	57.600	57.60
Soya paste	21.50	18.700	16.000	21.200	18.350	15.750	23.480	23.480	23.480	23.480	23.480	23.480	23.48
Fenugreek ground	5.00	10.000	15.000	0.000	0.000	0.000	21.000	42.000	63.000	0.000	0.000	0.000	0.00
Whole fenugreek seeds	0.00	0.000	0.000	5.000	10.000	15.000	0.000	0.000	0.000	19.300	38.600	58.900	0.00
Gluten maize	7.00	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.00
Oil	6.50	5.920	5.630	6.270	6.270	6.200	6.550	6.550	6.550	6.550	6.550	6.550	6.55
Ca carbonate	1.70	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.70
Ca ortophosphate	1.30	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.30
Salt	0.30	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.300	0.30
Lysine	0.18	0.000	0.000	0.000	0.000	0.000	0.180	0.180	0.180	0.180	0.180	0.180	0.18
Methionine	0.05	0.000	0.000	0.000	0.000	0.000	0.050	0.050	0.050	0.050	0.050	0.050	0.05
Vitamin and mineral	1.20	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.20
Pigment	0.64	0.640	0.640	0.640	0.640	0.640	0.640	0.640	0.640	0.640	0.640	0.640	0.64

Table present the used diets of treatments 7-13 in the finalization stage (22-28 days). The offered diets were isoproteic with 20% protein and iso-caloric with 3200 kcal EM/kg. Additional feed ingredients included 1% lysine, 0.38% methionine, 1.25 arginine, 0.74% treonine, 0.9% Ca and 0.35% P. The daily requirements of vitamins and minerals were covered through a commercial premix

550 mL) which was less viscous than the lower layer (the dense extract; 500 mL). The extraction and extract analysis was carried out according to the standard extraction protocols (AOAC, 1990; Anonymous, 1997; Bradford, 1976).

RESULTS AND DISCUSSION

Although, the fenugreek seeds have a high nutritional value and are being used in classical human medicine worldwide, very little research works studied their possible use in poultry nutrition. In traditional medicine, they are used for the treatment of infections, diabetes, hyperlipidemae and other purposes. However, the presence of anti-nutritional factors limit their usage as feed additive for poultry (Oncina *et al*., 2002; Zandi *et al*., 2014; Busquet *et al*., 2006; Adil *et al*., 2015).

Recent *in vitro* studies drew the attention to fenugreek seeds as a rich source of high digestible proteins (22% proteins) for ruminants due to the anatomical and physiological differences between the digestive system in ruminants and poultry (Sharma and Choudhary, 2017; Annida and Prince, 2004; Busquet *et al*., 2006; Adil *et al*., 2015). The present research aimed to investigate whether different treatments of the seeds via extraction could keep their nutritional value and eliminate the antinutrient factors. Fenugreek seeds were given to broilers in the first 4 weeks of their life. The fenugreek was offered in one of three forms but in different concentrations as mild whole seeds as seed extracts (light and dense extracts) or the residues remained after extraction. The chemical composition of both light and dense extract was analyzed and the birds were monitored for their feed intake, weight gain and FCR.

Table 3: Analysis of the fenugreek extracts

Extracts	Free fatty acids (%)	Iodine (%)	Phosphatids (%)	Esterines (%)	Volatile material (%)
Mild	1.46	85.81	16.71	92	ND
Heavy	10.07	0.00	ND	0.0	40.07

ND = Non Detected

Table 4: Results feed chickens with fenugreek (1-28 days)

Treatments	Diet (%)	Initial weight	Final weight	Weight gain	Feed intake	Feed conversion rate
1	FM 5	45.27	1183.000	1136.96*	2082.86*	1.831*
2	FM 10	44.69	754.000	709.31*	2112.50	2.978*
3	FM 15	44.02	550.200	505.53*	1839.34	3.663*
4	FWE 5	43.99	1094.600	1051.22*	2213.46	2.106*
5	FWE 10	45.05	652.900	607.42*	2161.93	3.556*
6	FWE 15	44.76	510.000	465.21*	2251.17	4.839*
7	EL 5	44.62	1403.900	1357.63*	2182.23	1.605*
8	EL 10	43.88	1383.900	1341.12*	1989.73	1.485*
9	EL 15	46.32	1446.500	1400.08*	2205.33	1.575*
10	ED 5	44.86	1356.300	1310.62*	2135.23	1.628*
11	ED 10	41.32	1463.100	1422.25*	2152.82	1.511*
12	ED 15	46.74	1323.900	1275.99*	2091.08	1.637*
13	Tests	43.80	1372.600	1328.08*	2085.52	1.570*

*Significant difference ($p<0.05$)

Extracts of fenugreek: Both mild and heavy fenugreek extracts were analyzed where many differences in the chemical composition could be detected (Table 3). The light extract represents the upper layer of the total extracted volume (supernatant) while the dense extract represents the lower dense layer of the solution. Chemical analysis of the extracts revealed the presence of esterines 92 and 0.0%, Iodine 85.81 and 0.0%, 16.71 and 0.0% of phosphatides and free fatty acids (1.46 and 10.07%) in both mild and dense extracted seeds, respectively. Significant differences were found in the total weight gain and the final body weight at the end of the experiment ($p<0.05$). However, the results obtained from group 11 (10% ED) were superior to those of group 12 (15% ED). Meanwhile, the use of ground fenugreek seeds (in groups 1-3) or seed residue after the extraction process (groups 4-6) resulted in a lower weight gains ($p<0.05$) with respect to the control group. On the other hand, the feed intake by the poultry did not show any significant differences among all investigated groups. There were also no significant differences in FCR between the control group and those fed on fenugreek seed extracts (groups 7-12; Table 4) in opposite to the first 6 groups (1-6) which had a higher feed conversion rate when compared to the control group (Table 4). The used of different forms of fenugreek seeds and their extract did not positively or negatively influence the mortality rate among the birds. Coefficients of variation of the above variables were acceptable for giving confidence to the results.

The obtained data from the present research showed that the use of mild whole fenugreek seeds or the residues after extraction with organic solvent had no nutritional benefits to the birds in all tested concentrations. The birds fed on mild fenugreek seeds or their residues after extraction (groups 1-6) suffered from unexpected significant drop in their body weight gain compared to the control group without the alteration in the amounts eaten by the birds. This, in turn, resulted in a significant increase of the FCR of the groups 1-6 in the present research. The remaining groups 7-12 in the present research received fenugreek seed extracts. Both light and dense extracts used in this experiment failed to improve the body weight gain to the control group in variable degrees. However, the use of 10% dense extract resulted in an increase of 94 g which is equivalent to 7% increase in the weight gain of the control birds. In opposite to the groups 1-6, there was no significant difference in the FCR among birds of these groups (group 7-12) and the control group.

The use of seed extract seems to be better than the use of whole/crushed seeds or seed residues due to the absence of the ANF which enabled the birds from profiting from other available nutrients in the extract. Although, the body weight gain can be strongly affected by the use of the residue after extraction, however, the mortality rate was constant low among all tested groups. The obtained data agree with many of the previous researches (Dogaru *et al*., 2003; Gyananath *et al*., 2000; Alloui *et al*., 2012) but also disagrees with other researchers (Oncina *et al*., 2002; Zandi *et al*., 2014; Busquet *et al*., 2006). In addition, the present results counteract the hypothesis by Duru *et al*. (2013) who attributed the decrease in feed intake due to the

hyperglycemic effect of the fenugreek seeds on blood glucose level which is reflected on the amount of feed intake by the birds. Although, the obtained data agree with the broad lines of Abdel-Rahman *et al.* (2014) yet the use of herbal mixture by the research team makes it difficult to determine the effect of separate plants included in the ration or possible synergetic effect among them.

This confusion in data interpretation may be attributed to many factors such as the difference in the type and source of the seeds, differences in primary treatment of the seeds/mixed feed, the form of inclusion (crushed, whole seeds, residues, only seed extract), the method of extraction if extracted (using organic solvents, or cold/hot pressed), the presence of certain feed additives that minimize the effect of the Anti-Nutritional Factors (ANF) (as feed enzymes) or other herbs which have a synergetic or antagonistic effect with the active ingredients present in the fenugreek seeds, it may also depend on the concentration of the seeds in the feed (ranged from 0.5-6%) or a combination of many of these factors.

CONCLUSION

Based on the obtained data from the present research, the extracts of fenugreek seeds can be safely used in broilers starter and finisher rations without any adverse effects on the bird performance or livability. Even the addition of 10% dense seed extract in the diet resulted in an improvement in the weight gain with 7% and FCR with 1%. However, these improvements were statistically insignificant.

RECOMMENDATIONS

In opposite to the use of seed extract, the mild seeds of fenugreek and their residues after extraction are not recommended to be used as feed additive in broilers starter-finisher feed and can result in dramatic decrease in the body weight gain.

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