

## **Effect of Feeding Fenugreek (*Trigonella-Foenum-Graecum*) Seed Powder and Vitamin E on Growth Performance, Feed Conversion Efficiency and Carcass Parameters in Broilers**

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### **Abstract**

*Present investigation was appraised to study the effect of feeding fenugreek seed powder and vitamin E on feed consumption, live body weight, body weight gain, feed conversion efficiency, dressing percent, giblet weight and intestinal viscera analyzing experimental data collected from 120 birds of Cobb-400 strain carried out at Poultry Research and Training Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology, Modipuram, Meerut. Birds utilized were selected randomly and divided into four equal groups, each were fed varying diets. The average feed consumption was found to be  $3446.07 \pm 0.33$ ,  $3538.57 \pm 0.50$ ,  $3528.45 \pm 1.09$  and  $3613.07 \pm 1.58$  g in  $T_1$ ,  $T_2$ ,  $T_3$  and  $T_4$  groups, respectively. Overall average feed consumption at six weeks was observed as  $3531.54 \pm 0.8$  g. This trait was found to have significant difference ( $P < 0.05$ ) between all the treatments. Average body weight gain was found to have the magnitude of  $1947.57 \pm 0.62$ ,  $2094.900 \pm 1.28$ ,  $2110.03 \pm 0.73$  and  $2186.43 \pm 0.53$  g in  $T_1$ ,  $T_2$ ,  $T_3$  and  $T_4$  groups, respectively. Overall average body weight gain for all the treatment groups at six weeks was observed as  $2084.73 \pm 0.79$  g ranging from  $1947.57 \pm 0.62$  g ( $T_1$ ) to  $2186.43 \pm 0.53$  g ( $T_4$ ). All the treatment groups showed significant difference for six weeks body weight gain. Feed conversion efficiency was found to be significantly different among all the treatments averaging to  $1.69 \pm 0.00$  at six weeks of age. For treatments  $T_1$ ,  $T_2$ ,  $T_3$  and  $T_4$  dressing percent was computed as  $68.02 \pm 0.78$ ,  $68.56 \pm 0.57$ ,  $68.19 \pm 0.51$  and  $68.78 \pm 0.55$  while giblets (heart, liver and gizzard) has weighed with quantum of  $3.33 \pm 0.11$ ,  $3.55 \pm 0.03$ ,  $3.45 \pm 0.12$  and  $4.34 \pm 0.13$  percent, respectively. Similarly, intestinal viscera (%) for all groups were found to be  $3.21 \pm 0.08$ ,  $3.55 \pm 0.18$ ,  $3.82 \pm 0.03$  and  $4.10 \pm 0.05$ , respectively. Carcass traits considered for the present study were found to have significant difference among them. According to present trial, combined inclusion of fenugreek seed powder and vitamin E as 2.0g and 50mg per kg of feed has adjudged to be better proposition to improve the overall performance.*

Key words: *Fenugreek, vitamin E, growth and carcass traits, broilers*

### **Introduction**

The world poultry industry has grown consistently since 1940s and the broiler industry has now occupied second place by volume in the world just after pork. Chicken meat represents 29 percent of total meat production from farm animals. Poultry farming in India has transformed itself from backyard venture in to a dynamic agro-industry in few decades and currently possess third and fourth place in egg and broiler production, respectively. Growth promoters are chemical and biological substances added to poultry feed with the aim of improving growth, feed utilization, disease resistance and vitality, regulation of the intestinal micro-flora, reduced morbidity and mortality

and in this way realize better production and financial returns. Various types of feed additives such as antibiotics, enzymes, hormones, prebiotics, probiotics, herbal products etc. are used as growth stimulants in poultry production. Fenugreek is an annual legume cultivated across the world, is one of the herbs having multi-functional properties. Husk (seed coat) contains higher amount of polyphenols (103.8 mg of Gallic acid equivalent) and total dietary fiber (77.1%). Seeds are utilized as appetizer and help in digestion; improve growth performance and health status (Abou El-wafa et al., 2003). Vitamin E is primarily known as an antioxidant in reducing cellular free radical damage

but it may also influence the development and maintenance of defense mechanism through multiple functions (Gershwin et al., 1985). Vitamin E consists of two families of compounds, the tocopherols and tocotrienols, characterised by a 6-chromanol ring and an isoprenoid side chain. The members of each family are designated alpha (á), beta (â), gamma (ã), and delta (ä) according to the position of methyl groups attached to the chroman nucleus. Therefore, 8 stereoisomers of the large vitamin E family are possible but only the RRR-form occurs naturally. Tocopherols and tocotrienols are differentiated by their phenyl “tails” as these are saturated in the tocopherols but unsaturated in the tocotrienols.

To get better production and financial returns from a broiler farm, growth promoters are generally added to poultry feed aiming to improve the growth, feed utilization, stimulation of immune system and increased vitality, regulation of intestinal micro-flora, reduced morbidity and mortality by optimizing hepatic functions of the birds. Therefore, present investigation was designed with the intension of getting maximum yield of edible part of broiler’s body per unit of feed offered, which in turn can contribute substantially to raise the overall availability of chicken meat per capita.

### Material and Methods

Data collected on 120 randomly selected unsexed 4-way cross broiler chicks of Cobb-400 strain for growth, feed conversion efficiency and carcass parameters from experimental broiler flock maintained at Poultry Research and Training Centre, SVPUA&T, Meerut were analyzed for the present investigation. Fenugreek seed powder, Vitamin E and day old broiler chicks were procured from localized market in Meerut district. Four diets with different levels of fenugreek seed powder and vitamin E provided to four groups of birds having three replicates in each group and 10 birds in each replicates. Identical conditions for housing, brooding, feeding and watering on the scientific line were made available to every treatment throughout the entire span of experiment.

Dietary plan of the trial envisaged T<sub>1</sub>- Basal ration (control), T<sub>2</sub>- Basal ration + Fenugreek seed powder @ 2g/kg of feed, T<sub>3</sub>- Basal ration + vitamin E @ 50 mg/kg of feed and T<sub>4</sub>- Basal ration + Fenugreek seed powder 2g/kg + vitamin E 50mg/kg of feed.

#### Measurement of parameters

##### Growth performance

Body weight gain was recorded from 1-6 weeks of age using digital and brawn balance. It was

calculated by the following equation:

Body weight gain = B.W at the end of week - B.W at the beginning of week

Actual feed consumption was calculated by collecting feed residues at weekly interval. Gain : Feed ratio was calculated by using the following formula

$$\text{G:F ratio} = \frac{\text{Weight gain (g)}}{\text{Feed intake (g)}}$$

Similarly, feed conversion ratio was calculated as the ratio of feed intake and weight gain using formula given below:

$$\text{FCR} = \frac{\text{Total feed consumed (g)}}{\text{Total body weight gain (g)}}$$

#### Carcass parameters

Three broiler birds were selected randomly from each treatment and weighed for live weight after allowing them fast for overnight. Halal method of slaughter was practiced. Following carcass traits were measure.

Dressed weight = Live weight – blood, feathers, head, shank and skin losses.

$$\text{Dressing (\%)} = \frac{\text{Dressed weight (deskinned)}}{\text{Live weight}} \times 100$$

$$\text{Giblet weight} = \frac{\text{Weight of organ in grams}}{\text{Live body weight in grams}} \times 100$$

$$\text{Intestine viscera} = \frac{\text{Weight of organ in grams}}{\text{Live body weight in grams}} \times 100$$

Data were analyzed by using Completely Randomized Design (CRD) under uniform and standard management practices following one way ANOVA procedure of SPSS version 20 (SPSS for windows, V 20.0; SPSS Inc., Chicago, IL, USA). The linear model adopted was:

$$Y_{ijk} = \mu + T_j + W_k + (T \times W)_{ij} + e_{ijk}$$

Where, Y<sub>ijk</sub> = Dependent Variable;  $\mu$  = Overall Mean; T<sub>j</sub> = Mean effect of Treatments (j = 1 ...8); W<sub>k</sub> = Mean effect of Week (k = 1 ...6) and e<sub>ijk</sub> = Unexplained residual element assumed to be independent and normally distributed. Testing of significance was done as per Duncan Multi Range Test (DMRT).

### Results and Discussion

#### Growth performance of experimental birds

In the present investigation, average feed consumption was estimated as 3446.07 ± 0.33, 3538.57 ± 0.50, 3528.45 ± 1.09 and 3613.07 ± 1.58 g for T<sub>1</sub>,

T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> group, respectively whereas overall average feed consumption was computed as 3531.54 ± 0.87 g up to sixth weeks of age (Table 1). Magnitudes for the trait ranged from 3446.07 ± 0.33 g (T<sub>1</sub> group) to 3613.07 ± 1.58 g (T<sub>4</sub> group). Feed consumption for the trait among all the treatment groups was differ significantly (P<0.05) with each other which may be attributed to genetic as well as environmental reasons. Results extracted in the study were supported by Darshana B. Bhaisare *et al.* (2014), Tariq Mamoun *et al.* (2014), Gogary El, *et al.* (2015) and Shashi Kant *et al.* (2015).

Similarly, varying estimates for body weights at different ages were observed for the treatment groups and overall average body weight gain was found to be 2117.00±0.62 g during first week of age (Table 2). The body weight gain during 0-1 week of age ranged from 1958.91±0.34g (T<sub>1</sub> group) to 2227.08±0.81g (T<sub>4</sub> group). It is also showed that lowest body weight was observed for T<sub>1</sub> which was found to have significant difference (P<0.05) with the other treatment groups. Present results may be compared with the reports of various researchers. Similar results were reported by Nadir Alloui *et al.* (2012) Weerasingha A.S. (2013), Darshana B. Bhaisare *et al.* (2014) and R.M. Patel *et al.* (2014).

Body weight gain up to 6 weeks of age ranged from 1947.57±0.62 to 2188.43±0.52 (Table 3). Results were differing significantly for the treatments adjudged for the trait. The average feed conversion efficiency was found as 1.76 ± 0.00, 1.68 ± 0.00, 1.67 ± 0.00 and 1.65 ± 0.00 for T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> group, respectively. Overall average feed conversion efficiency (FCE) has been estimated as 1.69 ± 0.00 up to six weeks of age. The feed conversion efficiency (FCE) up to 6 weeks of age for all the treatment groups differ significantly. Results extracted in the study were supported by the findings of Singh V.S. *et al.* (2013), Safarizadeh and Zakeri (2013), Safaei *et al.* (2013), Rodica Diana Criste *et al.* (2013).

#### Carcass parameters of experimental birds

Mean value of dressing percentage for the groups has been presented in Table 4. The mean values of dressing percentage were 68.02 ± 0.78, 68.56 ± 0.57, 68.19 ± 0.51 and 68.78 ± 0.55 percentage in group T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub>, respectively. The dressing percentage of the all groups was found to be non-significant (P<0.05). However, dressing percent of broiler chicks differ significantly among the treatment and did not differ in their interaction during study period. Comparable results were shown by Farman Ullah Khan, *et al.* (2009), Rabia J. Abbas (2010) Omar J.

Table 1: Average feed consumption (g) of broiler chicks for different age groups under various treatments

Age (wk)	Treatments				Overall Mean	Pooled SEM	CD
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>			
0-1	141.80 <sup>a</sup>	151.84 <sup>c</sup>	148.11 <sup>b</sup>	152.82 <sup>d</sup>	148.64	0.51	1.79
1-2	381.93 <sup>a</sup>	390.29 <sup>b</sup>	394.87 <sup>c</sup>	408.52 <sup>d</sup>	393.90	0.451	1.58
2-3	409.52 <sup>a</sup>	434.19 <sup>c</sup>	427.03 <sup>b</sup>	437.85 <sup>d</sup>	427.15	0.44	1.51
3-4	764.83 <sup>a</sup>	782.23 <sup>b</sup>	785.87 <sup>c</sup>	803.06 <sup>d</sup>	784.00	0.29	1.02
4-5	829.40 <sup>b</sup>	829.84 <sup>b</sup>	820.78 <sup>a</sup>	848.07 <sup>c</sup>	832.02	0.39	1.52
5-6	918.57 <sup>a</sup>	950.16 <sup>b</sup>	951.78 <sup>b</sup>	962.73 <sup>c</sup>	945.81	0.79	2.84
Up to 6 <sup>th</sup> weeks	3446.07 <sup>a</sup>	3538.57 <sup>c</sup>	3528.45 <sup>b</sup>	3613.07 <sup>d</sup>	3531.54	0.87	3.38

Table 2: Average live body weight (g) of broiler chicks for different age groups under various treatments

Age (wk)	Treatments				Overall Mean	Pooled SEM	CD
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>			
Day old	38.34 <sup>a</sup>	38.69 <sup>a</sup>	38.09 <sup>a</sup>	38.64 <sup>a</sup>	38.44	0.32	NS
0-1	163.07 <sup>a</sup>	165.66 <sup>b</sup>	167.44 <sup>c</sup>	176.81 <sup>d</sup>	168.24	0.62	2.21
1-2	372.02 <sup>a</sup>	411.73 <sup>c</sup>	397.94 <sup>b</sup>	427.16 <sup>d</sup>	402.21	0.77	2.69
2-3	605.49 <sup>a</sup>	672.31 <sup>b</sup>	682.74 <sup>c</sup>	772.32 <sup>d</sup>	683.22	0.57	2.03
3-4	1032.91 <sup>a</sup>	1074.99 <sup>b</sup>	1083.37 <sup>c</sup>	1187.61 <sup>d</sup>	1094.72	0.33	1.26
4-5	1477.91 <sup>a</sup>	1681.22 <sup>b</sup>	1682.17 <sup>b</sup>	1703.05 <sup>c</sup>	1636.08	0.39	1.43
5-6	1958.91 <sup>a</sup>	2134.25 <sup>b</sup>	2148.12 <sup>c</sup>	2227.08 <sup>d</sup>	2117.00	0.62	2.25

Table 3: Average body weight gain (g) of broiler chicks at different ages and feed conversion efficiency at 6th weeks under various treatments

Age (wk)	Treatments				Overall Mean	Pooled SEM	CD
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>			
0-1	124.73 <sup>a</sup>	126.97 <sup>b</sup>	129.35 <sup>c</sup>	138.17 <sup>d</sup>	129.80	0.86	2.29
1-2	208.95 <sup>a</sup>	246.07 <sup>c</sup>	230.49 <sup>b</sup>	250.35 <sup>d</sup>	233.96	0.98	3.34
2-3	233.47 <sup>a</sup>	260.57 <sup>b</sup>	284.64 <sup>c</sup>	345.16 <sup>d</sup>	280.96	0.89	3.36
3-4	427.41 <sup>c</sup>	402.68 <sup>a</sup>	400.63 <sup>a</sup>	415.28 <sup>b</sup>	411.50	0.61	2.37
4-5	444.99 <sup>a</sup>	606.22 <sup>d</sup>	598.79 <sup>c</sup>	515.44 <sup>b</sup>	541.36	0.51	1.86
5-6	508.00 <sup>c</sup>	453.03 <sup>a</sup>	465.95 <sup>b</sup>	524.02 <sup>d</sup>	487.75	0.84	3.00
Up to 6 <sup>th</sup> week	1947.57 <sup>a</sup> (1.76 <sup>d</sup> )	2095.56 <sup>b</sup> (1.68 <sup>c</sup> )	2110.03 <sup>c</sup> (1.67 <sup>b</sup> )	2188.43 <sup>d</sup> (1.65 <sup>a</sup> )	2085.39(1.69)	0.71(0.001)	2.50(0.002)

\*Values with in parentheses are feed conversion efficiency under various treatments up to the 6<sup>th</sup> weeks of age

Table 4: Effect of feeding fenugreek seed powder and vitamin E on dressing percent, giblet weight and intestinal viscera under various treatments

Parameter	Treatments				Overall Mean	Pooled SEM	CD
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>			
Dressing percent	68.02 <sup>a</sup>	68.56 <sup>a</sup>	68.19 <sup>a</sup>	68.78 <sup>a</sup>	68.38	0.60	NS
Giblet weight (%)	3.33 <sup>a</sup>	3.55 <sup>a</sup>	3.45 <sup>a</sup>	4.34 <sup>b</sup>	3.62	0.10	0.36
Intestinal viscera (%)	3.21 <sup>a</sup>	3.55 <sup>b</sup>	3.82 <sup>bc</sup>	4.10 <sup>c</sup>	3.67	0.09	0.35

Abo, *et al.* (2016), K.Y. Yesuf, *et al.* (2016), Yonatan Kassu *et al.* (2016).

Similarly, giblet percentage of boiler chicks significantly differs between the treatments and did not differ in their interaction. Estimated values of giblet weight were observed to be 3.33±0.11, 3.55±0.03, 3.45±0.12 and 4.34±0.13 percent for group T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub> respectively. Non-significant difference was observed for giblet weight for all the treatment groups except T<sub>4</sub>.

Averages for intestinal viscera for all four groups have also been presented in Table 4 and were computed as 3.21±0.08, 3.55±0.18, 3.82±0.03 and 4.10±0.05 percent in group T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, and T<sub>4</sub>, respectively. The study revealed that intestinal viscera percentage was higher in T<sub>4</sub> with magnitude of 4.10±0.05 which was differ significantly with T<sub>1</sub> and T<sub>2</sub>, respectively while T<sub>3</sub> was show the non-significant difference with T<sub>2</sub> and T<sub>4</sub> group. The average of feed consumption during different weeks from 1<sup>th</sup> to 6<sup>th</sup> weeks was found to be almost analogous for all groups. Body weight and feed efficiency was observed significantly higher in treatments groups either fed with fenugreek seed powder (FSP) and vitamin E combination of both in comparison to control group. Similarly, the feed conversion efficiency was also significantly higher in treatment groups. The usefulness

of *Trigonella foenum-graecum* and *Tocopherol* as growth promoter and appetizer has improved feed conversion efficiency and increased live body weight which may be attributed to its high content of vitamin E and antioxidant present in fenugreek seed and vitamin E antimicrobial, immunomodulatory anti-stress, antipyretic, antiasthmatic and analgesic activities present in FSP. The dressing percentage was observed better in methi and vitamin E supplemented groups. Also the giblet and intestinal viscera percentage percent in treatments groups with Methi and vitamin E supplementation was more when compared with the non-supplemented groups. Present observation may be compared with the findings of Ihsan T. Tayeb *et al.* (2012), Jafari *et al.* (2012), Gamel Ai, *et al.*, (2013), R.M.Patel, *et al.* (2017) for carcass parameters.

## References

- Abou E.L., Wafa S., Sayed M.A.M., Ali S.A., Abdallah A.G (2003). Performance and immune response of broiler chicks as affected by methionine and zinc or commercial fenugreek supplementations. *Egypt Poult Sci; 23(III): 523-540.*
- Gershwin M., Beach R and Hurley L (1985). The potent impact of nutritional factors on immune response. In Nutrition and Immunity. *Academic Press, New York;* pp.1-7.

- Darshana B., Bhaisare D., Thyagarajan R., Richard Churchil and Punniamurthy N. (2014). Effect of dietary supplementation of herbal seeds on carcass traits of turkey poults. *Veterinary world*; Vol.7 : (5-7).
- Tariq Mamoun, Mukhtar Ahmed Mukhtar and Mohamed H. Tabidi (2014). Effect of fenugreek seed powder on the performance, carcass Characteristics and some blood serum attributes. *Adv. Res. Agri. Vet. Sci.* Vol. 1, No. 1:6-11.
- Gogary E.I., Ismail M. R., El-Nadi F. S. A, M. I. (2015). Effect of vitamin E supplementation and stocking density on broiler performance, carcass traits and histological responses of lymphoid organs, *Asian Journal of Poultry Science*; 9 (2):70-84.
- Shashi Kant, Nazim Ali, Gulab Chandra and Rakesh Kumar Singh (2015). Effect of shatavari and vitamin E on growth performance, biochemical profile and dressing percentage of broilers during winter season. *Indian Journal of Poultry Science*, 50(2): 158-162.
- Nadir Alloui, S. Ben Aksa, M.N. Alloui and F. IBRIR (2012). (Animal Production Division, INSVSA, University of Batna, Algeria). Utilization of Fenugreek (*Trigonella Foenum-Graecum*) as Growth Promoter for Broiler Chickens. *J. World's Poult. Res.* 2(2): 25-27.
- Weerasingha A.S. and N.S.B.M. Atapattu (2013). Effects of fenugreek (*trigonella foenum-graecum l.*) Seed powder on growth performance, visceral organ weight, serum cholesterol levels and the nitrogen retention of broiler chicken. *Tropical Agricultural Research Vol. 24 (3): 289 – 295.*
- Patel R.M, Garg D.D, Patel V.R., Vahora S.G, Katariya M.A and Choubey M. (2014). Effect of Dietary Supplementation of Garlic (*Allium sativum*) and Fenugreek (*Trigonella foenum-graecum L.*) Seed Powder on Growth Performance, Carcass Characteristics and Economics of Feeding in Broilers, *J. of Animal Research*; v.7 n.2: 313-318.
- Singh V.S., Jyoti Palod, Stuti Vatsya and S.K. Shukla (2013). Effect of herbal vitamin E selenium with organic chromium on growth, haematological and parasitological parameters of broiler chicken during mixed *Eimeria* infection. *Veterinary Research International. Vol. 1, 25-30.*
- Safarizadeh A. and Zakeri A. (2013). The effect of vitamin A and complex of vitamin E and selenium on growth factors and Humoral immunity in broiler chickens *European Journal of Experimental Biology*;3(4):99-102.
- Safaei. A, S. M., Rahanjam and M. Gharajanlu (2013). Effect of *foenum-graecum* on immune response and some blood parameters of broilers. *Scholarly J. of Agricultural Science*, Vol. 3(4), pp. 117-120.
- Rodica D.C., Tatiana P., Anca B., Iulia Varzaru, Mariana R. and Gabriela M. C. (2013). Study on the use of fenugreek in laying hens diet on egg quality. National Research and Development Institute for Biology and Animal Nutrition, Page (1-5).
- Farman Ullah Khan, Assad Ullah, Sajid-ur-Rehman, Shabana Naz and Naureen Rana (2011). Fenugreek (*Trigonella foenum-graecum L.*) effect on muscle growth of broiler Chicks, *ROAVS*; Vol, 1(1): 1-3
- Rabia J. Abbas (2010). Effect of Using Fenugreek, Parsley and Sweet Basil Seeds as Feed Additives on the Performance of Broiler Chickens, *International Journal of Poultry Science*; 9 (3): 278-282.
- Omar J. Abo, A. Hejazi and R. Badran (2016). Performance of Broilers Supplemented with Natural Herb Extract. *Open Journal of Animal Sciences, Vol, 6. 68-74.*
- Yesuf K.Y., Mersso B.T. and Bekele, T.E. (2017). Effects of different levels of turmeric, fenugreek and black cumin on carcass characteristics of broiler chicken, *J. Livestock Sci.* 8: 11-17.
- Yonatan Kassu, Berhan Tamir and Etalem Tesfaye (2016). Effect of Supplementing Natural Feed Additives: Black Cumin, Fenugreek and Turmeric on the Growth Performance and Economic Efficiency of Broiler Chickens. *Advances in Biological Res.* 10 (5): 335-344.
- Ihsan T. Tayeb and Gelawesh Khelil Qader (2012). Effect of Feed Supplementation of Selenium and Vitamin E on Production Performance and Some Hematological Parameters in Broiler, *KSU J. Nat. Sci.*; 15(3), 46-56.
- Jafari R. A., Kiani R., Shahriyari A., Asadi F. and Hamidinejat, H. (2012). Effect of dietary vitamin E on plasma oxidative stress in broiler chicks infected with *Eimeriatenella*, *Comparative Clinical Pathology*; 21(5):895-899.
- Gamel A.I., Abdelrahman M. A., Gihan A. S, Arafa H. E, M. M. and El-Shafei, A. A. (2013). Study the impact of EDTA and vitamin E supplementation in diet on physiological, biochemical and histo-pathological pictures of broiler chicks, *The Journal of American Science*; 9(4):543-562.
- Patel R.M., Garg D.D., Patel V.R., Vahora S.G, Raval A.P. and Choubey M. (2017). Effect of Dietary Supplementation of Garlic (*Allium sativum*) and Fenugreek (*Trigonella foenum graecum L.*) Seed powder on growth performance, carcass characteristics and economics of feeding in broilers, *Journal of Animal Research*; V.7 (2): 313-318.