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Effect of Dietary Inclusion of Phytogenic Feed Additives on Haemato-Biochemical Parameters of Broilers in Konkan Climatic Conditions, India

V. Y. Bharambe[1] and Y. A. Garde[2]*

[1]Senior Research Fellow (AH), OFRTC Project, Department of Agronomy, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Ratnagiri, Maharashtra, INDIA
[2]Assistant Professor, Department of Agricultural Statistics, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat, INDIA

*Corresponding Author: y.garde@yahoo.co.in

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Abstract

The present study was conducted to examine the effect of supplementation of phytogenic feed additives (PFA) like Fenugreek seed powder (FSP) and Guduchi stem powder (GSP) on the haemato-biochemical parameters of broiler birds in Konkan climatic conditions, Maharashtra, India. A total of 162-day-old Vencobb-400 chicks were randomly divided into nine dietary treatments with three replicates. Each replicate has six birds in each treatment. The control group was fed with a commercial starter and finisher diet. The remaining groups were supplemented with 0.1 and 0.2 per cent of FSP and GSP and its combinations, respectively. In order to evaluate the effect of seasons, birds were reared in main three seasons of Konkan region viz. summer (S1), rainy (S2) and winter (S3). At the 6th weeks of age, the blood samples were collected from wing vein of three birds per replicate. In the study, haemato-biochemical parameters like total cholesterol (COL), serum glucose (G), haemoglobin (H), serum total protein (TP), triglycerides (TG), low density lipoprotein (LDL) and high-density lipoprotein (HDL) levels were determined. The results of the study showed that supplementation of FSP and GSP alone and its combinations significantly (P<0.05) decreased the cholesterol, triglycerides and low-density lipoproteins, while significantly (P<0.05) increased the glucose, haemoglobin, total protein, and high-density lipoprotein in broilers fed with FSP and GSP compared to control birds. It can be concluded that supplementation of 0.2 per cent FSP and GSP could be used to improve the haemato-biochemical parameters of broilers in Konkan climatic conditions.

Keywords: Broilers, Phytogenic Feed Additives (Fenugreek Seed and Guduchi Stem Powder), Seasons and Blood Parameters

Introduction

Indian poultry sector has been growing at a rate of 8-10% annually with broiler meat volumes growing up at a rate of 10% due to increased domestic consumption. (Singh *et al.,* 2020). Antibiotic feed additives have long been used as growth promoters in poultry nutrition. However, concern has been expressed about the potential development of antibiotic resistant bacteria. Consequently, the animal feed industry, exposed to increasing consumer pressure to reduce the use of antibiotic growth promoters (AGPs) in poultry diets has to find alternative feed additives. The utilization of growth promoters of natural origin has been a topic of interest in recent years (Humphrey *et al*., 2002). Phytogenic feed additives are usually defined as products derived from plants and added to animal feed for fattening, to increase productivity, improving the quality of feed and animal hygiene conditions and to improve the quality of produced food. Feed additive produced from plants have often a significant anti-bacterial effect, thereby suppressing pathogenic microflora in the gastrointestinal tract of animals and thus reducing mortality during the fattening period, especially in stress period. Plant additives are often added into feedstuff as they improve the taste and smell of feed and thus improve intake and growth of animals. Supplementation of feed or drinking water with plant aromatic oils increases body weight of chickens and favorably has an effect on feed conversion. For a wider range of action, the most suitable combination of extracts is researched. The role of research is to find the most effective concentrations and combinations of plants and essential oils. According to Ertas *et al.* (2005), the combination of some plants extract has a better effect on the growth performance in poultry than their individual supplementations (Hernandez *et al*., 2004).

Some studies have indicated that various plants extracts can improve feed conversion ratio, increase carcass quality, decrease the market age of broiler and reduced their rearing cost (Javed *et al*., 2009). Fenugreek (*Trigonella foenum-graecum* L.) is a well-known medicinal plant that grows in nature and mainly cultivated in India, Pakistan and China. Fenugreek seeds have many therapeutic effects like hypoglycemic, anthelmintic, antibacterial, anti-inflammatory, antipyretic, and antimicrobial (Bash *et al.,* 2003). It contains neurin, biotin, trimethylamine which tends to stimulate the appetite by their action on the nervous system (Al Habori and Roman, 2002). Another herb, Guduchi (*Tinospora cordifolia*) belongs to a group of medicinal plants that grow in the tropical and subtropical regions of India (Sengupta *et al*., 2011). It is also well known for its immunomodulatory, antioxidant, antibacterial and antiviral properties (Srinivasan *et al*., 2008). In view of this, the present investigation was carried out to study the effect of supplementation of phytogenic feed additives on haemato-biochemical parameters of broilers in Konkan climatic conditions.

Materials and Methods

A total one hundred sixty-two Vencobb-400 broiler chicks of day-old age belonging to the same hatch and uniform body size were randomly assigned to nine dietary treatments with three replicates in a randomized complete block (RCBD) design (factorial). The broilers chicks were vaccinated with Lassota strain and Gumboro at the end of first week and third week. The treatment detail for conducting experimental design is shown in Table 1.

Table 1: Treatment details

Treatment	Particulars
T_0	Control- Basal diet
T_1	Control + 0.1 % FSP of basal diet
T_2	Control + 0.2 % FSP of basal diet
T_3	Control + 0.1 % GSP of basal diet
T_4	Control + 0.2 % GSP of basal diet
T_5	Control + 0.1 % FSP + 0.1 % GSP of basal diet
T_6	Control + 0.1 % FSP + 0.2 % GSP of basal diet
T_7	Control + 0.2 % FSP + 0.1 % GSP of basal diet
T_8	Control + 0.2 % FSP + 0.2 % GSP of basal diet

Basal diet, commercial starter and finisher

The birds were fed as per recommendation of BIS (1992) feeding standard to meet the energy and protein requirements during first phase with maize crumbles (0-4 days), starters phase (5-21 days) and finisher phase (21-42 days). All the birds under control and treatment groups were offered *ad libitum* drinking water and feed

throughout the experimental period of six weeks under uniform managemental conditions. The blood samples from three birds per replicate were collected at the 6th weeks of age from wing vein for determination of haemato-biochemical parameters like total cholesterol (COL), serum glucose (G), haemoglobin (H), serum total protein (TP), triglycerides (TG), low density lipoprotein (LDL) and high-density lipoprotein (HDL) of broilers in three seasons. Serum samples from blood were separated by low-speed centrifugation (1500g for 15min at 20°C), the commercially available kits (M/S. Omsai Clinical Laboratory, Dapoli, Dist-Ratnagiri, Maharashtra, India) were used for determination of haemato-biochemical parameters.

Statistical Analysis

The data were subjected to two-way analysis of variance (RCBD-factorial) to observe the effect of treatments (Snedecor and Cochran, 1994). Data were tested for homogeneity of variances, and comparison of means was performed by least significance difference (LSD) test. The significance level was set at $P<0.05$.

Results

A critical look on haemato-biochemical parameters data showed that both phytogenic feed additives used in this experiment have noteworthy effect on lipid metabolism of broiler birds in all seasons of Konkan region. Both the additives were quite impressive in improving the circulating lipid profile in birds due to dietary treatments in three seasons. The average values for lipid profile and blood parameters are presented in Table 2.

Table 2: Effect of phytogenic feed additives on blood parameters of broiler birds

	Total cholesterol (mg/dl)	Serum glucose (mg/dl)	Haemoglobin (g/dl)	Serum total protein (g/dl)	Triglycerides (mg/dl)	Low density lipoprotein (mg/dl)	High density lipoprotein (mg/dl)
Seasons							
S_1 (Summer)	$113.21^{a} \pm 19.40$	$207.26^{ab} \pm 19.05$	$8.71^{c} \pm 1.89$	$3.41^{b} \pm 0.38$	$72.82^{a} \pm 18.33$	$64.58^{a} \pm 15.27$	$30.66^{b} \pm 6.02$
S_2 (Rainy)	$99.39^{b} \pm 15.72$	$215.73^{a} \pm 20.50$	$12.42^{b} \pm 1.57$	$3.65^{a} \pm 0.48$	$75.53^{a} \pm 15.05$	$35.66^{c} \pm 11.27$	$43.29^{a} \pm 4.83$
S_3 (Winter)	$88.62^{c} \pm 21.91$	$197.74^{b} \pm 29.35$	$13.53^{a} \pm 1.24$	$3.59^{a} \pm 0.32$	$64.00^{b} \pm 13.46$	$45.98^{b} \pm 12.84$	$25.26^{c} \pm 7.25$
SEM±	2.54	4.31	0.22	0.05	2.18	1.77	0.76
CD (P<0.05)	7.22	12.22	0.63	0.14	6.19	5.04	2.17
Treatments							
T_0 (Control)	$134.75^{a} \pm 26.94$	$188.78^{c} \pm 23.96$	$10.42^{d} \pm 2.77$	$3.08^{e} \pm 0.31$	$93.04^{a} \pm 12.04$	$68.99^{a} \pm 17.34$	$22.77^{c} \pm 11.04$
T_1	$99.96^{bcd} \pm 13.06$	$204.16^{bc} \pm 19.74$	$11.63^{bc} \pm 2.58$	$3.41^{cd} \pm 0.14$	$74.45^{b} \pm 9.79$	$51.99^{bc} \pm 12.15$	$32.28^{b} \pm 8.74$
T_2	$96.87^{bcd} \pm 11.79$	$212.41^{ab} \pm 34.44$	$11.49^{bcd} \pm 2.99$	$3.63^{bc} \pm 0.25$	$55.34^{d} \pm 10.90$	$48.19^{cd} \pm 16.04$	$36.60^{a} \pm 10.93$
T_3	$108.26^{b} \pm 10.25$	$201.71^{bc} \pm 14.12$	$11.62^{bc} \pm 2.40$	$3.29^{de} \pm 0.35$	$77.95^{b} \pm 11.08$	$57.34^{b} \pm 20.39$	$31.14^{b} \pm 10.28$
T_4	$101.72^{bc} \pm 11.84$	$203.40^{bc} \pm 14.17$	$10.90^{cd} \pm 2.08$	$3.49^{cd} \pm 0.36$	$68.23^{bc} \pm 7.51$	$47.69^{cd} \pm 15.99$	$33.33^{ab} \pm 6.13$
T_5	$94.38^{cd} \pm 15.33$	$210.49^{ab} \pm 7.55$	$10.42^{d} \pm 3.02$	$3.57^{bc} \pm 0.21$	$74.31^{b} \pm 14.31$	$42.10^{de} \pm 7.60$	$32.12^{b} \pm 10.29$
T_6	$98.02^{bcd} \pm 22.54$	$205.72^{abc} \pm 7.82$	$11.14^{bcd} \pm 1.77$	$3.59^{bc} \pm 0.28$	$69.81^{bc} \pm 18.95$	$44.34^{cd} \pm 16.70$	$36.71^{a} \pm 6.70$
T_7	$88.93^{de} \pm 18.58$	$209.28^{abc} \pm 22.19$	$12.23^{b} \pm 2.31$	$3.75^{b} \pm 0.36$	$62.23^{cd} \pm 18.80$	$43.48^{cd} \pm 18.09$	$36.30^{a} \pm 8.11$
T_8	$80.76^{e} \pm 14.11$	$226.23^{a} \pm 42.81$	$14.12^{a} \pm 2.25$	$4.16^{a} \pm 0.42$	$61.70^{cd} \pm 10.53$	$34.53^{e} \pm 15.07$	$36.40^{a} \pm 9.27$
SEM±	4.4	7.46	0.39	0.09	3.78	3.07	1.32
CD (P<0.05)	12.5	NS	1.1	0.25	10.72	8.72	3.75
S x T interaction							
SEM±	7.63	12.92	0.67	0.15	6.55	5.32	2.29
CD (P<0.05)	NS	NS	NS	NS	NS	NS	NS

abcd Mean values with different superscripts in column differ significantly (P<0.05), NS-Non-significant (P>0.05)

The statistical analysis of data revealed that fenugreek seed and guduchi stem powder alone and in combination showed the significant (P<0.05) effect on total cholesterol, haemoglobin, total protein, triglycerides, low density lipoprotein and high-density lipoprotein levels. However, phytogenic feed additives supplementation was not

significantly (P>0.05) effective in alteration of serum glucose content of broiler birds.

Haemato-biochemical Parameters

Total Cholesterol

The table 2 Showed that significantly (P<0.05) lower serum cholesterol was observed in winter season (88.62 mg/dl) followed by rainy (99.39 mg/dl) and summer season (113.21 mg/dl) in experimental broiler birds.

Significantly lower level of serum cholesterol was observed in treatment T_8 (80.76 mg/dl) followed by T_7 (88.93 mg/dl), T_5 (94.38 mg/dl), T_2 (96.87 mg/dl), T_6 (98.02 mg/dl), T_1 (99.96 mg/dl), T_4 (101.72 mg/dl), T_3 (108.26 mg/dl) and T_0 (134.75 mg/dl). The average serum cholesterol value for T_8 (80.76 mg/dl) was significantly (P<0.05) lower than other dietary treatment but was at par with T_7 (88.93 mg/dl). The average serum cholesterol content in experimental broiler birds was found lower in T_5 (94.38 mg/dl) which was at par with T_1, T_2, T_4 and T_6, respectively.

Serum Glucose

The statistical data on serum glucose for broiler chicks was significantly (P<0.05) higher in rainy season (215.73 mg/dl) followed by summer (207.26 mg/dl) and winter season (197.74 mg/dl). The mean serum glucose (Table 2) content of broiler chicks was significantly (P<0.05) higher in rainy season which was at par with summer season.

The average serum glucose concentration in broiler birds showed increasing trend with inclusion at the different level of phytogenic feed additives in broilers diet. The average serum glucose content was significantly (P<0.05) higher in treatment T_8 (226.23 mg/dl) followed by T_2 (212.41 mg/dl), T_5 (210.49 mg/dl), T_7 (209.28 mg/dl), T_6 (205.72 mg/dl), T_1 (204.16 mg/dl), T_4 (203.40 mg/dl), T_3 (201.71 mg/dl) and T_0 (188.78 mg/dl), respectively. The mean serum glucose content was significantly (P<0.05) higher in T_8 (0.2% FSP and GSP) treatment than other dietary treatments but was at par with T_2, T_5, T_6 and T_7, respectively. There were no significant (P>0.05) differences in serum glucose (mg/dl) concentration of experiment broiler birds in interactive effect of season vs treatments.

Haemoglobin

The significantly (P<0.05) higher haemoglobin (g/dl) concentration in blood of broiler birds was found in winter season of experiment (S_3-13.53 g/dl) followed by rainy (S_2-12.42 g/dl) and summer season (S_1-8.71 g/dl).

The significantly higher (P<0.05) haemoglobin level in experimental broiler birds was observed in T_8 (14.12 g/dl) followed by T_7 (12.23 g/dl), T_1 (11.63 g/dl), T_3 (11.62 g/dl), T_2 (11.49 g/dl), T_6 (11.14 g/dl), T_4 (10.90 g/dl), T_5 (10.42 g/dl) and T_0 (10.42 g/dl). The lowest value of haemoglobin in T_0 (10.42 g/dl) was at par with T_2, T_4, T_5 and T_6. It was observed that increasing trend was found in haemoglobin in broilers supplementation of different levels of FSP and GSP as phytogenic feed additives. There were no significant differences (P>0.05) due to interaction of season on treatments. The average mean haemoglobin concentration was higher in S_2T_8 (15.08 g/dl) than other interactions during experimental period.

Serum Total Protein

The average value of serum total protein was significantly (P<0.05) higher in rainy season (3.65 g/dl) followed by winter (3.59 g/dl) and summer season (3.41 g/dl). However, the serum total protein content in rainy season which was at par with average value of serum total protein content found in winter season. The highest serum total protein was found in treatment T_8 (4.16 g/dl) supplemented with 0.2 per cent FSP and GSP and the lowest amount of total protein was recorded in control treatment (T_0). The statistical data also showed that treatment contained more protein but at par with T_2 (3.63 g/dl), T_5 (3.57 g/dl) and T_6 (3.59 g/dl), respectively.

Serum Triglycerides

The table 2 proved that average triglycerides content was significantly higher (P<0.05) in rainy season (75.53 mg/dl) which was at par with summer season (72.82 mg/dl). The significant lowest value of serum triglycerides was found in winter season (64.00 mg/dl). The data showed significantly decreasing trend with level of inclusion of FSP and GSP. The significantly lowest value of triglycerides was observed in T_2 (55.34 mg/dl) followed by T_8 (61.70 mg/dl),

T_7 (62.23 mg/dl), T_4 (68.23 mg/dl), T_6 (69.81 mg/dl), T_1 (74.45 mg/dl), T_5 (74.31 mg/dl), T_3 (77.95 mg/dl) and T_0 (93.04 mg/dl). The interaction effect of season vs. dietary treatment was not significant (P>0.05).

Low Density Lipoprotein

The mean LDL value was significantly (P<0.05) less in rainy season (35.66 mg/dl) followed by winter (45.98 mg/dl) and summer season (64.58 mg/dl).

The statistical analysis revealed significant (P<0.05) difference between treatment groups in mean serum low density lipoprotein level in experimental broilers (Table 2) at the end of experiment due to dietary supplementation of FSP and GSP alone and in its combinations. Significantly lowest value of LDL (mg/dl) was observed in treatment T_8 (34.53 mg/dl) followed by T_5 (42.10 mg/dl), T_7 (43.48 mg/dl), T_6 (44.34 mg/dl), T_4 (47.69 mg/dl), T_2 (48.19 mg/dl), T_1 (51.99 mg/dl), T_3 (57.34 mg/dl) and T_0 (68.99 mg/dl). The results showed reduction of LDL level in broiler birds with inclusion level of FSP and GSP in broiler diets. However, treatment T_7 (0.2% FSP and 0.1% GSP) showed lowest LDL level but it was at par with T_2, T_4, T_5 and T_6, respectively. The statistical analysis showed that LDL content in broilers fed with different dietary treatments was not season dependent.

High Density Lipoprotein

It was observed from data that significant difference (P<0.05) was observed among the seasons. The significantly (P<0.05) higher HDL content was observed in rainy season (43.29 mg/dl) followed by summer (30.66 mg/dl) and winter season (25.26 mg/dl), respectively. Data in respect of HDL content in experimental broiler birds (mg/dl) as influenced by various treatment and its combinations are presented in Table 2. The inclusion of 0.1 per cent FSP and 0.2 per cent GSP (T_6) recorded significantly (P<0.05) higher HDL content (36.71 mg/dl) in experimental broiler birds followed by T_2 (36.60 mg/dl), T_8 (36.40 mg/dl), T_7 (36.30 mg/dl), T_4 (33.33 mg/dl), T_1 (32.28 mg/dl), T_5 (32.12 mg/dl), T_3 (31.14 mg/dl) and T_0 (22.77 mg/dl). The interaction effect of season vs. treatments was not significant (P>0.05).

Discussion

Haemato-biochemical Parameters

Total Cholesterol

The lower serum cholesterol was observed in winter season, which proved that dietary treatments were effective more in winter season than other seasons. Significant reduction in total cholesterol level on supplementation of FSP and GSP alone and its combinations was probably due to possible mechanism of hypocholesterolaemic and hypolipidemic action of fenugreek and guduchi products which depresses the hepatic activities of lipogenic and cholesterogenic enzymes such as malic enzyme, fatty acid synthatase and glucose-6-phosphatase dehydrogenase. These findings are in agreement with the results obtained by (Khadr and Abdel Fattah, 2007, Rabia, 2010 and Yattoo *et al.*, 2012). Such effect in total cholesterol level of fenugreek supplemented group may be due to the mode of action of fenugreek in bird metabolism, which includes competition with cholesterol at binding sites or interfere with the cholesterol biosynthesis in the liver. The low average serum cholesterol observed proved that dietary inclusion of fenugreek and guduchi in combination in broiler diets improved the lipid profile of broiler chickens may be due to mode of action of fenugreek and guduchi in bird mechanism, which includes competition with cholesterol biosynthesis in the liver. Hypo-cholesterolaemic effects of fenugreek are owing to increased conversion of hepatic cholesterol to bile salts due to loss in faeces and complexes of these substances with fenugreek fibres and saponins (Duru *et al.*, 2013, Mamoun *et al.*, 2014). Joshi and Kumar (1987) observed that the total serum cholesterol decreased in Liv-52. (*Tinospora cordifolia* constituents) supplemented group in Japanese quails than control. Abdul Rahman (2012), Mamoun *et al.* (2014), Sonia *et al.* (2014) and Adil *et al.* (2015) showed the reduction of serum cholesterol when broiler birds supplemented with fenugreek. It was found that the reduction in the serum cholesterol level in broiler blood may be due to the presence of saponins in fenugreek which inhibit cholesterol absorption from intestine in broilers. It was proved from the results that the supplementation of 0.2 per cent FSP and GSP is most efficient for reduction of serum total cholesterol than the rest of the treatments.

Serum Glucose

The findings in the present study are in accordance with those of Devi *et al.* (2016). Kusnadi and Djulardi (2011) recorded that at high temperature glucose concentration increased which might be indicative of stimulation of gluconeogenic process. In contrast, Mohammed (2012) reported that at high temperature glucose concentration decreased which might be due to reduced feed intake and increased water consumption accompanied by haemodilution in response to thermal stress. A critical look on blood biochemical data like serum glucose content showed that both the phytogenic feed additives used in this experiment have noteworthy effect on serum glucose metabolism of broiler birds. Addition of FSP and GSP in broiler diet was found to be improving the lipid profile in experimental birds. The present findings is in agreement with Rekhate *et al.* (2010) who reported that significantly increasing trend in serum glucose content in broiler birds fed with shatavari root powder as phytogenic feed additive. In contrast Rabia (2010) proved that a significant ($P<0.05$) decrease in glucose level indicating the hypoglycemic effect of fenugreek seeds in broiler diets.

Haemoglobin

According to the results of this study, the haemoglobin level in the experimental treatment was significantly different ($P<0.05$). Findings of Muhammad *et al*. (2009) showed that use of plant aqueous extract of ginger, fenugreek, garlic, ashwagandha was added over the basal ration at 5, 10 and 15 ml/liter in drinking water which showed a significant ($P<0.05$) increased in the haemoglobin level in broilers blood. Also studies of Saleh *et al.* (2014) showed that the Hb level was higher in broiler birds fed with ginger and thyme as herbal feed. These results are in line with Kulkarni *et al.* (2011) who reported higher level of haemoglobin in broiler birds which may be due to anti-parasitic activities of levamisole in guduchi allowing better absorption of food particles in intestinal lumen.

Serum Total Protein

The statistical analysis of data revealed significant ($P<0.05$) effect of FSP and GSP alone and in combinations in different seasons. The present results are in agreement with Devi *et al.* (2016) who reported the concentration of total protein was higher during winter than the summer season.

According to the results of this study, the serum total protein content in experimental treatments were significantly different ($P<0.05$). The results agreed with the findings of Samarth *et al.* (2003), who found that dietary ashwagandha as herbal additive in broiler birds significantly increased blood protein than the control birds. On the contrary, the results obtained by Rabia (2010) reported that feeding fenugreek, parsley and basil seeds did not affect the total protein content in broiler chickens.

Serum Triglycerides

The lower triglycerides was observed in winter season, which proved that dietary treatments were more effective in winter season than other seasons. The reduction ($P<0.05$) in level of triglycerides by fenugreek supplementation may be attributed to the reduction in the level of the M-RNA of microsomal triglycerides transferase protein which is necessary for the secretion of triglycerides synthesized in liver and through the blockage of fatty acid synthesis (Patel *et al.*, 2014). Duru *et al.* (2013), Sonia *et al.* (2014) and Yadav *et al.* (2017) reported carvacrol, fenugreek and *Aloe vera* in broiler diet significantly reduces the triglycerides and suggested that fenugreek may have more impact on lipogenesis than cholesterol biosynthesis. Similar results reported by Kulkarni *et al.* (2011). On the contrary, increased triglycerides concentration in broiler birds supplemented with higher level of fenugreek (1, 2, and 3 per cent) in broiler diets as compared to control group (Mamoun *et al.* 2014).

Low Density Lipoprotein

Significant effect ($P<0.05$) of dietary treatment was observed with FSP and GSP in broiler birds in different seasons on blood LDL concentration. The results also revealed that significant reduction in LDL content (mg/dl) in broiler birds supplemented with 0.2 per cent FSP and GSP. Similar results was reported by Issa and Omar (2012) who found significant ($P<0.05$) decrease in serum low density lipoprotein concentration in garlic powder supplemented groups (116.9 and 113.9 mg/dl) than control group (194.0 mg/dl). The levels of garlic powder decreased LDL levels compared to levels in broiler birds of the control groups. This effect can be explained by the possible mechanism of

antioxidant and anti-peroxide lowering action of garlic powder on LDL or the decrease in hepatic production of serum LDL which serves as the pressure of blood circulation. Similar results was obtained by Safaei *et al.* (2013) and Saleh *et al.* (2014) which might be due to the presence of herbal additives in broiler diets. In contrary, increased LDL content in broiler blood was reported with higher level of fenugreek incorporation in broiler diets (Duru *et al.*, 2013).

High Density Lipoprotein

The results of present study are in line with previous reports of Zhang *et al.* (2013) and Goodarzi *et al.* (2013). Weerasingha and Attapattu (2013) reported that fenugreek seed have therapeutic effects such as hypoglycemic, hypo-cholesterolaemic, anthelminstic, antibacterial, anti-inflammatory, antipyretic and anti-microbial properties. In contrary, there was no significant effect on blood HDL of broilers fed with 200 ppm carvacrol (the active ingredient in savary). The results agreed with findings obtained by Patel *et al.* (2014). It was observed from the data that dietary treatments of FSP and GSP and its combinations significantly ($P<0.05$) increased the level of HDL (mg/dl) in experimental broiler birds.

Conclusion

The results of the study showed that supplementation of FSP and GSP alone and in combinations significantly ($P<0.05$) decreased the blood cholesterol, triglycerides and low-density lipoproteins, while significantly ($P<0.05$) increased the glucose, haemoglobin total protein and high-density lipoprotein in broilers fed with FSP and GSP compared to control birds. It can be concluded that supplementation of 0.2 per cent FSP and GSP can be used to improve the haemato-biochemical parameters of broilers in Konkan climatic conditions.

Conflict of Interests

There is no conflict of interest.

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