Physiological Performance of Broiler Chicks Fed on *Medicago sativa* Seeds as Natural Source of Isoflavones

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ABSTRACT

This study was carried out to investigate the effects of *Medicago sativa* seeds as isoflavones (ISF) source on some productive and physiological parameters of broiler chickens. One hundred and twenty day-old Hubbard commercial broiler chicks were randomly divided into 4 experimental groups of 30 chicks each. Groups 2, 3 and 4 were given a diet containing 0.25, 0.5 and 1.0% of *Medicago sativa* seeds while group one served as a control group. Results revealed that live body weight, body weight gain and carcass weight showed a non-significant increase of *Medicago sativa* seeds groups compared to the control group and the 0.5% treated group had the highest mean. As well, all levels of *Medicago sativa* seeds recorded gradually and significantly increased (p<0.01) in feed consumption and that was dose-dependent, whereas, these treatments did not revealed an improvement in feed conversion compared to the control group which had the lowest feed conversion mean. Blood biochemical analysis showed that plasma total protein and albumin concentration were gradually increased in the treated groups compared to the control group but without significant effect, while, plasma total lipids and cholesterol concentrations were gradually and significantly decreased in treated groups compared to the control. Plasma glucose concentration was increased in *Medicago sativa* seeds groups but the significant was with 0.5% treatment only. *Medicago sativa* seeds resulted in decrease the AST and ALT enzymes activities in treated groups and this effect was non-significant. Similarity, lipid peroxidation activity (Malondialdehyde) was significantly decreased due to treated chicks with *Medicago sativa* seeds and this effect was dose-dependent. It could be concluded that *Medicago sativa* seeds has some physiological effects on broiler chicks that feed on *Medicago sativa* inclusion diet.

Key words: Antioxidant, broiler, isoflavones, lipid peroxidation

INTRODUCTION

Isoflavanoids (ISF) are a diverse group of natural products that are found primarily in leguminous plants and the bioactivities of isoflavonoids impact plant, animal and human health (Shao et al., 2007). Isoflavones are potential additives in improving meat quality; they have been shown to possess antioxidant activity (Wei et al., 1995; Ruiz-Larrea et al., 1997) which might be related to their anticancer, anti-inflammatory and cardio-protective effects. It has been demonstrated that ISF decrease the production of free radicals in plasma, liver, brain, testes and kidney of male rabbits (Yousef et al., 2004). Yilmaz et al. (2008) reported that ISF showed strong
antioxidant effects in preventing lipid peroxidation and reduce the level of Low Density Lipoprotein (LDL). In addition, ISF as antioxidants reduce the formation of free radicals and reactive oxygen (Fran et al., 2000).

Isoflavones are primarily ingested in the form of glycosides which hydrolyzed in the gastrointestinal tract to obtain free glycones (such as daidzin, genistin and glycitein). These compounds influence cell growth, regulate lipid metabolism and lower blood cholesterol (Pakalapati et al., 2009). Genistein and daidzein, have shown antioxidant properties in vitro; the antioxidant effects were predominantly directed against oxidative damage to membrane lipids and lipoprotein particles (Hodgson et al., 1996) and also against oxidative DNA damage (Giles and Wei, 1997). As well, oxidative damage to LDL was implicated in atherogenesis (Steinberg et al., 1989; Steinberg and Lewis, 1997).

In recent years, considerable interest has been generated on a leguminous plant Medicago sativa (MS) (Leguminosae) which is one of the most reputed medicinal plant traditionally used to improve the memory, to cure kidney pain, cough, sore muscles (Finkler, 1985). Medicago sativa commonly known as Lucerne or alfalfa has pharmacological active substances that include acids, alkaloids, amino acids, isoflavonoids, vitamins, pectin and minerals (EMEA, 1998). Phytochemical reports on Medicago sativa seeds (MS) indicate that the plant contains flavonoids (Bickoff et al., 1964), alkaloids (Duke, 2001; Mills, 1994), phytosterogens, coumarins, digestive enzymes, triterpenes (Reilly, 1989), saponins (Oleszek et al., 1990); phytosterols (Reilly, 1989; Timbekova et al., 1996). Several clinical and animal studies indicate that the ingestion of MS reduces cholesterol absorption and atherosclerotic plaque formation in the arteries (Cohen et al., 1990; Molgaard et al., 1987). Diets containing isoflavones (150 and 250 mg kg⁻¹) obviously elevated antioxidant enzymatic levels in various organs of rats fed diets containing partially oxidized oil (Liu et al., 2005). Cai and Wei (1996) suggested that dietary genistein (1 of the 2 major component of ISF enhances the activities of antioxidant enzymes in various organs in SENCAR mice. Jiang et al. (2011) studied the effect of red clover isoflavone on antioxidant and immune performance of chicken under heat stress conditions. Results indicated that red clover isoflavone could increase the activity of GSH-PX and SOD in serum and liver, reduced the content of MDA and lessen the impairing of heat stress on chicken.

The main objective of this study was to investigate the physiological effects and efficacy of adding Medicago sativa seeds as a natural source of isoflavones (ISF) on productive performance and some physiological parameters in broiler chicks.

**MATERIALS AND METHODS**

One-day-old 120 unsexed Hubbard commercial broiler chicks were randomly divided into 4 groups of 30 chicks with 3 replicates of 10 chicks each. All experimental groups have commenced with a nearly similar initial Live Body Weight (LBW) which average weight 50.94-51.56 g (with insignificant differences).

Chicks were maintained in caged wire floor batteries in a controlled environmental house with 23 h light/day, during six weeks experimental period. Groups 2, 3 and 4 were fed diet containing Medicago sativa seeds (MS) (in mash form) as a source of IF with levels 0.25, 0.5 or 1.0%. Whereas, group one served as a control group. Experimental diets were formulated to be isocaloric, iso-nitrogenous which provide chicks with 22.4% protein and 3160 kcal kg⁻¹. Feed and water were provided ad libitum throughout the experimental period (0-42 days of age).
Individual Live Body Weight (LBW) and Body Weight Gain (BWG) as (g) (for each bird) were recorded weekly per treatment group. As well, Feed Intake (FI) as (g feed) and Feed Conversion (FC) as (g feed/g body weight gain) (for each replicate under each treated group) were recorded weekly and over all experimental period (0-6 weeks).

**Blood samples:** At the 42 days of age, Blood samples were collected (during slaughter) from five birds (randomly chosen) from each treatment group into dry clean centrifuge tubes containing drops of heparin and centrifuged for 15 min (3500 rpm) to obtain plasma which stored at -20°C for later analysis. Plasma concentration of total protein (Armstrong and Carr, 1964), albumin (Doumas et al., 1971), globulin (which calculated as the difference between total protein and albumin concentration), triglycerides (Fossati and Prencipe, 1982), glucose (Trinder, 1969), cholesterol (Richmond, 1973) and High Density Lipoprotein (HDL) was determined according to Warnick et al. (1983). Low Dnsity Lipoprotein (LDL) was calculated by subtract the HDL from total cholesterol. Aspartate amino transaminase (AST) and alanine amino transaminase (ALT) enzymes activities (Reitman and Frankel, 1957), lipid peroxide and total antioxidant capacity were assayed.

**Slaughter traits:** At the end of experimental period, 3 chicks from each treatment were randomly chosen for slaughter. Chicks were fasted for over-night before slaughter and were individually weighed. After scalding, feather picking and evisceration carcass, organs (pancreas, spleen, bursa, thymus, thyroid gland and adrenal gland) and abdominal fat were weighted. Percentage of carcass and organs were calculated based on live body weights.

**Statistical analysis:** Data were analyzed by analysis of variance using the general linear model procedure (Statistical Analysis System (SAS), 2001). Differences among means were determined using Duncan test (Duncan, 1955).

**RESULTS AND DISCUSSION**

Results of Live Body Weight (LBW) and Body Weight Gain (BWG), at 42 days of age, (Table 1) showed that adding *Medicago sativa* seeds (MS) as a natural ISF source to broiler rations (from 1-42 days of age) did not have a positive effect on LBW and BWG compared to the control group, except that the 0.5% level had slightly increase in these two parameters but the differences was not significant (1791.44 of 0.5% treated group vs. 1666.28 of control group). Data of Feed Consumption (FC) (from 1-42 days of age) (Table 1) revealed that inclusion *Medicago sativa* seeds (MS) at any studied levels resulted in the chicks consumed more feed than the control group and these differences were significant (p<0.05) which reached 111.10, 111.35 and 112.50 from the control group mean, respectively, on the other side, within MS groups no significant differences were showed due to inclusion MS seeds in chicks’ rations on FC. Increasing Feed Consumption (FC)

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Treatments (%)</th>
<th>Control 0</th>
<th>0.25</th>
<th>0.5</th>
<th>1.0</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW week 6</td>
<td></td>
<td>1717.22±59.81</td>
<td>1727.22±42.48</td>
<td>1842.78±38.41</td>
<td>1723.33±40.03</td>
<td>0.1618</td>
</tr>
<tr>
<td>BWG week 0-6</td>
<td></td>
<td>1666.38±59.62</td>
<td>1675.67±42.18</td>
<td>1791.44±38.18</td>
<td>1672.11±40.42</td>
<td>0.1606</td>
</tr>
<tr>
<td>FC week 0-6</td>
<td></td>
<td>2949.53±66.79</td>
<td>3267.20±17.20</td>
<td>3274.43±48.02</td>
<td>3308.39±77.56</td>
<td>0.0154</td>
</tr>
<tr>
<td>FCR week 0-6</td>
<td></td>
<td>1.77±0.06</td>
<td>1.95±0.05</td>
<td>1.83±0.09</td>
<td>1.94±0.04</td>
<td>0.1708</td>
</tr>
</tbody>
</table>

*Means in the same row having different superscripts are significantly different (p<0.05), Body Weight (BW), Body Weight Gain (BWG), Feed Consumption (FC) and Feed Conversion Ratio (FCR)*
in the MS seeds treated groups reflected on Feed Conversion Ratio (FCR) (as kg BWG/kg FC) from 1-42 days of age, whereas, inclusion MS seeds in chicks’ rations resulted in a non-significant increase (Table 1) of FCR in all three treated groups compared to the control, while, increase BWG in 0.5% group relived this effect compared to the other two treated groups (0.25 or 1.0%). The previous study of Wilhelms et al. (2006) mentioned that ISF supplemented into the diet at 1 and 5% did not influence the growth performance of the Japanese quail. As well, Payne et al. (2001) reported that ISF supplementation in a typical Corn-Soybean meal diet did not affect growth performance in growing-finishing gilts. On the other hand, adding 0, 10, 20, 40 or 80 mg of ISF/kg to the broiler chicken for a period of 3 weeks, the results showed that dietary supplementation with 10 or 20 mg of ISF/kg increased weight gain by 13.6 and 16.2% and elevated feed intake by 7.37 and 11.2% (Jiang et al., 2007). On the other hand, decreasing live body weight in 1.0% MS group than the other treated groups (0.25 and 0.5%) may be due the inhibitor material that found in MS seeds, whereas, Reshef et al. (1976) reported that extent of growth inhibition of mice was related to the level of medicagenic acid in the MS seeds.

Data of slaughter traits (as a relative to live body weight) and their statistical analysis are shown in Table 2. Relative carcass weight means not significantly differ between the control group and MS seeds tested groups with slightly increase in this point for MS seeds groups. Increasing relative carcass weight that observed in MS seeds groups may be due to the increase BW in those groups, also, inclusion MS seeds as ISF source in chicks’ diet may be resulted in enhance the nutrient digestibility and absorption through digestive tract which reflected on increase protein deposit in tissue. Data concerning relative gizzard weight of broilers at 42 days of age showed that MS seeds at any inclusion levels had a non-significant increase in relative gizzard weight compared to the control group and this increase was MS dose dependent manner. Meanwhile, a tendency to increase values of gizzard as increasing tested material in diets; it may be due to increase the mechanical effect of gizzard to grind the hardness MS seeds which stimulate growth the gizzard tissues. Data of pancreatic relative weight showed no effect due to adding MS seeds as ISF source at any level in chicks’ diet except that 0.5% MS seeds level increased pancreatic relative weight by a proximately 6.45% over than the control mean and this increase was not significant. Increasing pancreatic relative weight that observed with 0.5% MS seeds level may be attributed to increase plasma glucose level in this group which stimulate pancreatic insulin secretion which are intimately involved in glucose metabolism activity (Bell and Freeman, 1971). Data concerning relative spleen, bursa and thymus weights of chicks at 42 days of age showed that fed chicks on diets containing different levels of MS seeds conducted to increase chicks’ spleen, bursa and thymus relative weight compared to the control means and this increase was significant (p<0.05) for bursa and thymus.

Table 2: *Medicago sativa* seeds (MS) as isoflavones (ISF) source and its effect on broilers’ percentage carcass weight, gizzard, pancreas, spleen, bursa, thymus and abdominal fat (as a relative to live body weight)

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Treatments (%)</th>
<th>0.25</th>
<th>0.5</th>
<th>1.0</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass</td>
<td>67.30±1.31</td>
<td>68.53±1.06</td>
<td>69.30±0.89</td>
<td>68.78±0.56</td>
<td>0.6461</td>
</tr>
<tr>
<td>Gizzard</td>
<td>2.30±0.21</td>
<td>2.50±0.49</td>
<td>2.52±0.08</td>
<td>2.59±0.15</td>
<td>0.9203</td>
</tr>
<tr>
<td>Pancreas</td>
<td>0.31±0.08</td>
<td>0.30±0.03</td>
<td>0.31±0.05</td>
<td>0.33±0.01</td>
<td>0.8897</td>
</tr>
<tr>
<td>Spleen</td>
<td>0.15±0.02</td>
<td>0.15±0.01</td>
<td>0.17±0.02</td>
<td>0.17±0.04</td>
<td>0.9963</td>
</tr>
<tr>
<td>Bursa</td>
<td>0.07±0.01*</td>
<td>0.08±0.00*</td>
<td>0.10±0.01*</td>
<td>0.09±0.01*</td>
<td>0.0429</td>
</tr>
<tr>
<td>Thymus</td>
<td>0.12±0.03*</td>
<td>0.22±0.01*</td>
<td>0.22±0.03*</td>
<td>0.23±0.01*</td>
<td>0.0006</td>
</tr>
<tr>
<td>Abdominal fat</td>
<td>1.47±0.05</td>
<td>1.26±0.16</td>
<td>1.17±0.14</td>
<td>0.97±0.19</td>
<td>0.2761</td>
</tr>
</tbody>
</table>

*Means in the same row having different superscripts are significantly different (p<0.05)
Table 3: Medicago sativa seeds (MS) as isoflavones (ISF) source and its effect on some broilers' blood biochemical constituents

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Control 0</th>
<th>0.25</th>
<th>0.5</th>
<th>1.0</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>239.33±12.99ab</td>
<td>240.67±12.91ab</td>
<td>242.00±8.86ab</td>
<td>290.33±4.63ab</td>
<td>0.1417</td>
</tr>
<tr>
<td>Total protein (g dL⁻¹)</td>
<td>0.47±0.27</td>
<td>0.39±0.44</td>
<td>0.37±0.40</td>
<td>3.90±0.20</td>
<td>0.7430</td>
</tr>
<tr>
<td>Albumin (g dL⁻¹)</td>
<td>2.22±0.07</td>
<td>2.30±0.36</td>
<td>2.59±0.23</td>
<td>2.60±0.19</td>
<td>0.4496</td>
</tr>
<tr>
<td>Globulin (g dL⁻¹)</td>
<td>1.11±0.21</td>
<td>1.35±0.25</td>
<td>1.33±0.10</td>
<td>1.20±0.08</td>
<td>0.8109</td>
</tr>
<tr>
<td>Cholesterol (mg dL⁻¹)</td>
<td>132.33±3.18a</td>
<td>129.90±3.61a</td>
<td>128.00±3.31a</td>
<td>91.67±9.17a</td>
<td>0.0057</td>
</tr>
<tr>
<td>HDL (mg dL⁻¹)</td>
<td>36.00±4.73</td>
<td>43.57±11.68</td>
<td>42.00±4.00</td>
<td>38.33±1.76</td>
<td>0.5009</td>
</tr>
<tr>
<td>LDL (mg dL⁻¹)</td>
<td>91.33±2.54a</td>
<td>81.90±12.19a</td>
<td>72.33±4.59a</td>
<td>52.90±13.59a</td>
<td>0.0670</td>
</tr>
<tr>
<td>Total lipids (g dL⁻¹)</td>
<td>350.66±2.66a</td>
<td>350.38±0.37a</td>
<td>310.17±1.34a</td>
<td>300.28±1.06a</td>
<td>0.010</td>
</tr>
<tr>
<td>Triglyceride (mg dL⁻¹)</td>
<td>60.67±3.18</td>
<td>52.00±4.16</td>
<td>58.00±6.08</td>
<td>58.33±3.33</td>
<td>0.3940</td>
</tr>
<tr>
<td>ALT (IU L⁻¹)</td>
<td>20.00±4.16</td>
<td>14.00±1.15</td>
<td>16.33±1.45</td>
<td>16.00±2.08</td>
<td>0.5045</td>
</tr>
<tr>
<td>AST (IU L⁻¹)</td>
<td>95.33±6.64</td>
<td>65.00±13.86</td>
<td>72.33±3.76</td>
<td>81.67±9.53</td>
<td>0.2359</td>
</tr>
<tr>
<td>MDA (mg dL⁻¹)</td>
<td>1.83±0.04</td>
<td>1.11±0.01</td>
<td>1.13±0.03</td>
<td>1.10±0.02</td>
<td>0.0001</td>
</tr>
<tr>
<td>TAC (mm L⁻¹)</td>
<td>140.33±8.99</td>
<td>145.00±11.50</td>
<td>161.33±15.45</td>
<td>230.33±14.86</td>
<td>0.010</td>
</tr>
</tbody>
</table>

* Means in the same row having different superscripts are significantly different (p<0.05). HDL: High density lipoprotein, LDL: Low density lipoprotein, ALT and AST: Alanine amino transaminase and Aspartate amino transaminase, MDA: Malondialdehyde, TAC: Total antioxidant capacity.

only. Adding ISF from MS seeds to chicks' rations may enhanced the immune response in secondary lymphoid organs. ISF from MS seeds in chicks' rations resulted in a gradual and non-significant decrease in abdominal fat deposit tissues by -14.96, -20.40 and -34.01% for 0.25, 0.5 and 1.0% MS seeds treated groups, respectively, compared to the control group and this effect was MS seeds-dependent manner. The reduction in abdominal fat deposit tissue that found with MS seeds groups was attributed to the reduction in plasma total lipids and triglycerides concentrations due to feed chicks on MS seeds inclusion diets. Chapman (1980) reported that most fat deposited in chickens and turkeys is synthesized in the liver and transported with the blood to the various adipose tissue depot as triglyceride-rich Very Low Density Lipoprotein (VLDL). Lipids synthesized de novo is transported from its origin site in the liver to site of utilization in the form of VLDL (Bensadoun and Kompiang, 1979). Elkomy (1995) mentioned that there was a relationship between increase relative abdominal fat weight and increase triglycerides level in blood.

Plasma glucose concentration (Table 3) in MS seeds groups was gradually increased compared to the control group and this effect was significant (p<0.05) with the high MS level (1.0% MS seeds) only which increased by 12% above the control level. This finding was in contrast with that found by Yousef et al. (2003) reported that treated male rabbits orally with ISF for 12 weeks did not influence blood glucose level but it alleviated the negative effect of cypermethrin pesticide when given in a combination with ISF. Inclusion MS seeds as a natural ISF source resulted in a non-significant increase in plasma total protein concentration which was MS seeds-level dependent manner (Table 3). The same trend was observed with plasma albumin and globulin concentrations which showed a gradual and non-significant increase compared to the control group. Cho et al. (2009) found a minimal increase of serum total protein and albumin when rats were given 0, 1.25, 2.5 and 5% of soybean extract containing 6% ISF for 13 weeks. On the other hand Yousef et al. (2003) reported that treated rabbits orally by ISF did not cause any significant change in plasma total protein, albumin and globulin. The low and medium levels of MS seeds (0.25 and 0.5%) caused slightly decreased in plasma total cholesterol concentration (Table 3) by -2.51 and -3.27% from the control group, respectively, while, the high MS seeds level
had highly significant effect on decreasing plasma cholesterol level which reached -30.72% from the control value. Low density lipoprotein concentration (LDL) had the same trend of total cholesterol concentration, whereas, LDL level was gradually decreased in MS seeds groups than the control group and this effect was significant with the high level of MS only. LDL level was decreased by -10.28, -14.27 and -42.10% for 0.25, 0.5 and 1.0% MS seeds levels than the control mean, respectively. In spite of, the total cholesterol level was decreased due to fed chicks on ration containing different levels of MS seeds the High Density Lipoprotein (HDL) concentration (Table 3) was increased in treated group compared to the control group which reached 121.30, 133.33 and 105.47% over than the control mean and this increase was not significant. Isoflavones influence lipid metabolism and lower blood cholesterol (Pakalapati et al., 2009). As well, oxidative damage to LDL was implicated in atherogenesis (Steinberg and Lewis, 1997). Also, Pakalapati et al. (2009) demonstrated that total cholesterol and HDL unchanged while LDL decreased when ovariectomized rats were treated with 450 mg red clover ISF/kg body weight/day for four days. Also, blood total cholesterol of rabbits treated orally with ISF for 12 weeks was significantly decreased (Yousef et al., 2003). In addition, Taku et al. (2007) reported that soy isoflavones significantly lowered serum total and LDL cholesterol but did not change HDL cholesterol. Plasma total lipids concentrations of groups that put on MS seeds treatment showed a gradually decreasing compared to the control group and this effect was significant with 0.5 and 1% MS seeds levels only. Feeding chicks on MS seeds rations at any levels resulted in a non-significant reduction in plasma triglycerides concentration and the main effect was obtained with the low MS seeds level (0.25%). Our findings was identical with Anderson et al. (1995) who demonstrated that triglycerides were reduced by 10.5% in controlled clinical trials which consumed soy protein containing ISF. The same results were found by Yousef et al. (2003) when treated male rabbits with ISF for 12 weeks. Results of liver function enzymes activities AST and ALT (Table 3) showed a non-significant reduction in the MS seeds tested groups compared to the control group and the high impact was observed with the low level of MS seed (0.25%). Lipid peroxidation, determined as the concentration of Malondialdehyde (MDA) and Total Antioxidant Capacity (TAC) were postulated in Table 3. The present results showed that adding MS seeds as a source of ISF at any tested levels to chicks’ rations resulted in a highly significant decrease (p≤0.01) in plasma MDA which decreased by 39.34, 38.52 and 39.89%, respectively, below than the control group, while, no differences were found between MS seeds groups in this point. ISF had effect on Total Antioxidant Capacity (TAC) which gradually increased in MS seeds groups compared to the control group and this increase was highly significant (p<0.1) with 1% MS seeds level only, while, no significant differences were found between the low and medium MS seeds levels and the control group. The TAC means of MS seeds levels were 3.32, 14.96 and 64.13%, respectively, above than the control mean and this effect was MS seeds-levels dependent manner. Recent studies reported that ISF could improve growth performance by decreasing lipid peroxidation and improving antioxidative status in male broilers. In addition, the improved antioxidative status protected against lipid oxidation in animals (Cai and Wei, 1996) and ISF shows good potential as an antioxidant in male broilers (Jiang et al., 2007). The extent of lipid peroxidation by reactive oxygen species can be monitored by MDA levels (Satoshi et al., 1989). Yilmaz et al. (2008) reported that isoflavones (ISF) show strong antioxidant effects in preventing lipid peroxidation and reduce the rate of Low Density Lipoprotein (LDL). In addition, ISF as antioxidants reduce the formation of free radicals and reactive oxygen (Fran et al., 2000). The results of Jiang et al. (2011) indicated that red clover isoflavone could increase the activity of GSH-PX and SOD in serum and liver, reduced the content of MDA and lessen the impairing of heat stress on chicken.
CONCLUSION
The results of this study have shown that *Medicago sativa* seeds as isoflavones (ISF) source in broiler chick’s diet did not influence body weight, body weight gain or carcass weight, while, it has clear impact on blood biochemical analysis. Plasma total protein and albumin concentration were gradually increased while, plasma total lipids and cholesterol concentrations were gradually and significantly decreased in treated groups compared to the control. *Medicago sativa* seeds resulted in decrease the AST and ALT enzymes activities. Similarity, lipid peroxidation activity (Malondialdehyde) was significantly decreased due to treated chicks with *medicago sativa* seeds. Total Antioxidant Capacity (TAC) gradually increased in MS seeds groups compared to the control group and this increase was highly significant with MS seeds high dose only.

REFERENCES


