Effect of cadmium in drinking water on growth, some haematological and biochemical parameters of chicken

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ABSTRACT

This study was carried out to investigate the effect of cadmium on body weight, haematological and biochemical of domestic chicken. Chicken were divided into two groups. The first group was given a drinking water containing the concentration of 10 mg cadmium /L daily for a period of 30 days and the second group was given tap water and used as a control group. The result revealed decrease in the body weight of treated chicken by 12.7 % compared to control group, whose body weight increased. The haemoglobin (Hb) amount, hematocrit (Hct) value, and the total erythrocyte (RBC) count decreased significantly (P<0.05) in the blood of treated chicken, while mean cell volume (MCV) increased slightly compared to control. The mean cell haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) had no changes in Cd treated chickens when compared to the control group. The plasma glucose concentration, creatinine, aspartate aminotransferase (AST), and alanine aminotransferase (ALT) were increased significantly (P<0.05) in Cd treated chicken in comparison to the control group.

Key words: Cadmium, chicken, haematological and biochemical parameters.

INTRODUCTION

Cadmium can be considered the most toxic heavy metals [1], it is found widely in nature and present in air, all soils and aquatic systems. Considerable amounts of Cd get continuously into the environment as a consequence of human activities. The steel industry, waste disposal, volcanic action, zinc refinery, fossil fuels, and traffic are accounted for the largest part of emissions of atmospheric Cd. Raised concentrations of Cd in soil may be found as a result of industrial activities (e.g. mining) or agricultural activities (e.g. sewage sludge, phosphate fertilizers, and pesticides) containing high concentrations of Cd [2].

Consumption of contaminated water is the major way by which humans are exposed to Cd [3] and the maximum allowable level in drinking-water is 0.005 mg/dL [4].

Animals can be exposed to Cd pollution by: inhalation of polluted air, ingestion of polluted food and drinking of polluted water [5,2,6,7]. It is absorbed from gastrointestinal tract to blood, and cadmium is taken up from the blood into the tissues. The Cd accumulates in human and animals tissues, especially the liver and kidney, causing their damage [2]. Then Cd cause reduced feed intake and weight loss, decreased RBC [red blood cell] and HGB [blood haemoglobin] values [8, 9] and anaemia in Cd exposed animals. Cadmium induced injury to liver and kidney organs has been attributed to its ability to enhance free radical formation in vivo [10, 11].

Cadmium in high doses induces structural and function alterations in various vital organs including liver, kidney,
gill and intestine of fishes. Cadmium accumulates in liver of fishes in high concentrations [12, 13]. It also induces various pathological changes in liver tissues including engorgement of blood vessels, congestion, vacuolar degeneration of hepatocytes, necrosis of pancreatic cells and fatty changes in the peripancreatic hepatocytes [14,15]. Some biochemical characteristic features are associated with Cd-induced kidney and liver damage. Others are marked increase of plasma creatinine or blood urea nitrogen levels [16] as well as altered plasma glucose level [17], and changes in antioxidant enzymes [GOT and GPT] level, which produced in damaged liver tissues.

The objective of this work is to study the effect of cadmium on the changes of weight, and some haematological and biochemical parameters in chicken.

MATERIALS AND METHODS

Six weeks old chickens (n= 12) are collected from their habitat and were housed in cages to acclimatization for one week in laboratory conditions at the room temperature between 30 –35°C. After the acclimatization period, chicken were divided into two groups (n=6) randomly and each group was kept in separate cages, and fed ad libum by the composition of the diet table (1). The chick first group served as control, and the second group as experimental group, whose was exposed to 10mg/L cadmium (CdCl₂) in drinking water for 30 days. Every chicken was weighted before starting the experiment and body weight ranged 250-300 ± gms, then every chicken was weighted after 30 days of experiment period.

The blood samples were collected with heparinized syringe from the wing vein. RBCs were counted after diluting the blood with saline solution (0.75%) by Neubauer haemocytometer slide. The hematocrite (Hct) values were determined by microhaematocrit reader after centrifugation (4000 rpm) of microhaematocrit capillary for 5 min. The haemoglobin [Hb] content was measured according to [18]. Mean cell volume (MCV) and Mean corpuscular haemoglobin concentration (MCHC) were calculated respectively using standard formula [19]. The remaining blood was used to obtain the plasma by centrifugation (5000 rpm) for 5 min.

The plasma glucose, creatinine, ALT and AST were determined using Randox kits.

Statistical analysis: The data is presented as means ± SD. The mean values of the control and test groups were compared using Student’s t-test. The significant level was set at P < 0.05.

Table (1): Composition of the diet

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sesame seed cake</td>
<td>40</td>
</tr>
<tr>
<td>Zea mays bran</td>
<td>30</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>30</td>
</tr>
</tbody>
</table>

RESULTS

Body weight gain:
The result in table [2] shows the body weight of the control group increased by 37 %, whereas the body weight of Cd treated group decreased by 12.7 % after one month. The gain in body weight of the treated group were lowered in relation to the control which was reduced to 43% after 30 days of treatment.

Table (2): Growth performance of chickens exposed to Cd in drinking water (mean ± SD)

<table>
<thead>
<tr>
<th>Items</th>
<th>Initial weight</th>
<th>Weight after 30 days</th>
<th>Weight gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>282 ± 22</td>
<td>388 ± 35.6</td>
<td>+ 108 ± 32.7</td>
</tr>
<tr>
<td>Cadmium treated</td>
<td>290 ± 11.7</td>
<td>228 ± 25.9*</td>
<td>- 62 ± 29</td>
</tr>
</tbody>
</table>

*: P<0.05 comparing with control.

Haematological parameters:
The results of erythrocyte count (RBCs), haemoglobin content (Hb) and haemocrit value (Hct) obtained from Cd treated and control chicken are given in Table (3). Table (3) shows that all the parameters decreased significantly (P<0.05) in chicken exposed to Cd compared to the control after one month of treatment.

The blood indices calculated from the mean values of blood parameters for the aforementioned treatments are given in Table (3). Data shows that the MCV increased slightly in Cd treated chickens, while the MCH and MCHC made no changes in Cd treated chickens when compared to the control.
Table (3): Cadmium effect on some haematological parameters of the chickens (mean ± SD)

<table>
<thead>
<tr>
<th>parameters</th>
<th>control</th>
<th>30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC</td>
<td>2.21 ± 0.23</td>
<td>1.25 ± 0.23*</td>
</tr>
<tr>
<td>Hb</td>
<td>11.12 ± 1.3</td>
<td>6.7 ± 0.66*</td>
</tr>
<tr>
<td>PCV</td>
<td>30.33 ± 4.89</td>
<td>19.34 ± 2*</td>
</tr>
<tr>
<td>MCV</td>
<td>138.6 ± 30.6</td>
<td>154.5 ± 10</td>
</tr>
<tr>
<td>MCH</td>
<td>52.47 ± 8.5</td>
<td>54± 2.7</td>
</tr>
<tr>
<td>MCHC</td>
<td>36.8 ± 2</td>
<td>35 ± 0.5</td>
</tr>
</tbody>
</table>

*: P<0.05 comparing with control.

Biochemical parameters:

Table (4) shows the changes of some biochemical parameters in Cd treated chickens compared to control chickens one month of 10mg/l Cd exposure to drinking water.

The plasma glucose concentration showed higher significant values (P< 0.05) (135±11 mg/dl) in chickens exposed to Cd for one month than the control chicken group value (211±17).

The plasma creatinine increased significantly (P< 0.05) in chickens exposed to Cd for one month when compared to the control group. The changes in AST and ALT activities are used to check liver function in the Cd treated chicken relative to control group. The Results also revealed that cadmium causes significant (P< 0.05) increasing of activity of ALT and AST, as seen in table (4). The plasma ALT and AST level reached (8± 1.7 and 139± 12) in treated chickens comparison to control group (5.2± 1.5 and 105± 9) respectively.

Table [4]: Cadmium effect on blood glucose, AST, ALT and Creatinine in plasma of the chickens [mean ± SD]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>control</th>
<th>30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glucose</td>
<td>135±11</td>
<td>211±17</td>
</tr>
<tr>
<td>AST</td>
<td>105±9</td>
<td>139±12</td>
</tr>
<tr>
<td>ALT</td>
<td>5.2±1.5</td>
<td>8±1.7</td>
</tr>
<tr>
<td>Creatinine</td>
<td>0.45±.11</td>
<td>0.81±0.19</td>
</tr>
</tbody>
</table>

*: P<0.05 comparing with control.

DISCUSSION

The results showed that the chicken exposed to 10 mg/l Cd in drinking water showed a significant lower chicken growth. The final body weight of Cd treated chicken was significantly lower than that of the control group.

In young animals [e.g. calf, swine, rabbit, Japanese quail, chicken, rat], the different Cd salts can reduce feed intake and growth rate [20,21,22].

Furthermore, the present study reveals that the chicken exposed to Cd showed significant reduction in RBCs, Hb and Hct than those compared to control. The reduction of these parameters in Cd treated chicken might be due to the destruction of mature RBCs and the inhibition of erythrocyte production is due to reduction of haemoglobin that was affected by pollutants [23]. The decrease in RBCs count may be attributed to haematopathology or acute haemolytic crisis that results in severe anemia in most vertebrates including chicken species exposed to different environmental pollutants [24] or maybe the decrease in the RBCs may be attributed to reduction of growth and other food utilization parameters which results in sever anemia [25]. [26] found a significant reduction in the RBCs, Hb and Hct in American eel (Anguilla rostrata) after exposure to 150 ug Cd/L.[27] found a significant decrease in total erythrocyte count, haemoglobin content, haematocrit value and mean corpuscular haemoglobin concentration in air breathing fish, Channa punctatus after exposure to sublethal dose of Cd (29 mg Cd/L).

The calculated blood indices MCV, MCH and MCHC have particular importance in anemia diagnosis in most animals [28]. The perturbations in these blood indices (increase MCV, decrease of MCH and MCHC) may be attributed to a defense against Cd toxicity through the stimulation of erythropiosis or may be related to the decrease in RBCs, Hb and Hct due to the exaggerated disturbances that occurred in both metabolic and hemopoietic activities of fish exposed to sublethal concentration of pollutants [29].

Blood glucose is a sensitive reliable indicator of environmental stress in chicken. From the results, it is clear that Cd as shown by the elevated blood glucose level affected as a stress of Cd on chicken. Cd induced hyperglycemia with decreased in liver glycogen in catfish, Heteropneustes fossilis [30]. Soengas et al [31] suggested that hyperglycemia occurred in Atlantic salmon (Salmo salar) after toxicity with cadmium may be due to changes in liver carbohydrate metabolism (activation of liver glycogenolysis and glycolysis) as well as increased levels of
plasma glucose.

The activity of AST and ALT enzymes in blood may also be used as a stress indicator. The significant changes in activities of these enzymes in blood plasma indicates tissue impairment caused by stress [32 and 33]. In the present study, there were significant changes in AST and ALT activities in plasma of chicken exposed to cadmium compared to the control group. The increase in concentration of AST and ALT in blood plasma indicates impairment of liver. In addition, the increase of plasma AST and ALT may be attributed to the hepatocellular damage or cellular degradation by these heavy metal, perhaps in liver, heart or muscle [34]. These results are in agreement with those of [35] who found that sublethal concentration of Cd caused significant increases in AST and ALT of common carp after 7 and 15 days. Also, [36] found that increased activity of serum enzymes ALT and AST in guinea pigs. Similar result demonstrated by [37] who found that the cadmium exposure induced serum AST, ALT increasing of rat.

In the present study, kidney function tests showed elevation in creatinine in the treated group. The results are in agreement with that reported by [37, 38] in guinea pigs and rats.[36] mentioned that the toxic effect of cadmium on the renal tissues was clear as the level of creatinine in serum increased. The elevation in the creatinine was due to nephrotoxic effect of cadmium on renal tubules and glomeruli. Also, [39] found significant elevation in serum creatinine concentration in Cd intoxicated rats. They added that creatinine metabolism was thought to reflect the amount of glomerular filtration.[35] described a significantly increased creatinine level in Cd-treated chickens.

REFERENCES

[18] Khaled Saeed Ali Abdo and Huda Abdulla

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