Hematological and Biochemical evaluation after different orally doses of Copper sulfate in rats

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Summary

Objectives of this study were to evaluate hematological and biochemical parameters in rats ingested toxic doses of CuSO4.5H2O. Thirty six rats divided into 3 equal groups. First group ingested orally distilled water / day for 3 months and considered as control group , second group was drenched 8 mg /kg B.W /day of CuSO4.5H2O for 3 months and considered as Treated group1 (T1). Third group was drenched 40 mg /kg B.W /day of CuSO4.5H2O for 3 months and considered as Treated group2 (T2). Blood collection was done by direct cardiac puncture every month for hematological and biochemical examinations. Hematological parameters showed that anemia caused by CuSO4.5H2O toxicity was of microcytic hypochromic type with significant increase of neutrophils and decrease of lymphocytes and blood platelets. There was significant increase in biochemical parameters , liver enzymes (GOT,GPT,ALP) and total serum protein . It concluded that CuSO4.5H2O poisoning in rats causes significant changes in blood picture and clinical enzyme.
Key words: Hematological, Biochemical, Copper sulfate, Rats.

Introduction

Cupper (Cu) is a mineral found in trace amount in all tissues in the body. It has been known, mined, and used by humans for more than 7000 years (1). Numerous metalloprotein enzymes and non – enzymes metalloprotein in animal that require Cu to be biologically active, it has been shown that Cu is one of the key trace minerals required for an effective immune response (2). The total body content of Cu is 150 mg (3). Approximately 30% absorbed from gastrointestinal (gI) tract (4).The kinetics of Cu during over dose differs from that during the normal. In acute poisoning, albumin rather than ceruloplasmin, binds the excess Cu. liver is the major site of deposition of Cu following large ingestion (5). In humans acute Cu poisoning has occurred through the contamination of beverages by storage in Cu containing containers as well as from contaminated water supplies (6). In animals acute responses to Cu vary with species and Cu compound. Hemolytic anemia is a common complication of CuSO4 intoxication (7 and 8). And may cause by direct erythrocyte membrane damage (9) or indirectly by Cu- mediated inhibition of enzymes important in protecting against oxidative agent stress, including G-6-P dehydrogenase and glutathione reductase (10-12). The study of the serum enzymes is very important in Cu poisoning to evaluate the liver function tests. Elevated levels of liver enzymes are seen in all patients except mild cases of Cu poisoning. In one series where biochemical changes in blood were studied in CuSO4 poisoning, the authors suggested a prognostic significance for estimations of levels of serum transaminases along with blood urea estimation with higher levels seen in more seriously ill patient (5and 13). Plasma proteins are formed in liver and lymphatic tissues, any damage or disease affected these organs had a direct effect on the process of formation of these proteins (14). This study was designed to evaluate the effects of different toxic doses of this element on hematological and biochemical parameters.

Materials and Methods

Experimental design: Thirty six female rats were divided equally into three groups after a period of accommodation. Control group (C) drenched daily with distilled water for three months via gavage needle. Treated one group (T1) drenched daily for three months with CuSO4.5H2O at a dose of 8 mg/Kg B.W. The selected dose was less than the reported NOAEL dose in rats (15). Treated two groups (T2) drenched daily for three months with CuSO4.5H2O at a dose of 40mg/Kg B.W. This

dose was the same as the reported LOAEL dose in rats (15).

Blood collection were done at (30, 60 and 90) days of experiment via cardiac puncture technique. 1st part of blood samples were collected in tubes containing anticoagulant (EDTA) , for hematological tests while the 2nd part of blood were collected in plain tubes and used to separate serum which stored at(-20c◦), then used for measurement of biochemical parameters.

Hemoglobin test done according to the method mentioned by (16). Packed cell volume (Pcv), Red blood cells count, White Blood cell count and Platelets counting measured according to the method mentioned by (17). While differential counting of WBC`s according to (18). And Reticulocytes according to the method mentioned by (19).

Serum Glutamate oxaloacetic Transaminase (SGOT) and Serum Glutamate pyruvic transaminase (SGPT): This tests is done according to the method mentioned by (20 and 21). Serum ALP concentration was enzymatically measured using standard assay (ALP-Kit). Alkaline phosphatase activity in serum samples was estimated spectrophoto -metrically by employing king and Armstrong method, in which the disodium phenyl phosphate is hydrolysed with liberation of phenol and formation of sodium phosphate. The amount of phenol formed is estimated colorimetrically. Readied immediately at 510 nm. Serum total protein concentration was enzymatically measured using standard assay (Serum total protein –Kit). Curpic ions, in an alkaline medium interact with protein peptide bounds resulting in the formation of a colored complex, incubate exactly for 10 min. at 37C° and read at 520 nm.

Statistical analysis: Factorial experiment applied in completely randomized design (CRD) was used to study the effect of treatment and month in different trails . Least significant difference (L.S.D) was used to compare the significant difference between means at ($p<0.05$). Data were analyzed using statistical analysis system (SAS) (2001) program.

Results and Discussion

The results of hemoglobin (Hb) g / dl showed in (Table, 1), there were significant decrease in values in both treated groups along the period of experiment in comparison with control, and significant decrease between T1 and T2 along the period of experiment.T2 group showed significant decrease through the three intervals.

The results of PCV (%) showed in (Table, 2). The values of PCV are significantly decreased in both treated group along the period of experiment compared with controls, with no significant difference between T1 and T2 group at the 1st month while the 2nd and 3rd month showed significant decrease in their values respectively .In addition to that T1 group showed that no significant decrease in values between the 1st and 2nd month, with significant decrease between the 1st and 3rd month and the 2nd and 3rd month.T2 group showed significant decrease between all intervals of experiment. Control groups showed no significant decrease in their values along the period of experiment.

The results of RBC count (Cells * 10^3 /Cm^3) were showed in (Table, 3). There is significant decrease in values in both treated groups along the period of experiment compared with controls, also there was significant decrease between T1 and T2 group along the period of experiment. There is no significant decrease between the 1st and 2nd month of T1 group with significant decrease between the 1st and 3rd month and the 2nd and 3rd month.T2 group showed significant decrease along the intervals of the experiment. The control groups showed no significant decrease along the period of experiment.

The result of WBC count (cells*50 /cm^3) are listed in (Table, 4). It showed a significant increase in both T1 and T2 group compared with controls, with no significant increase between them at the 1st and 2nd month, with significant increase at the 3rd month T1 group showed significant increase between 1st and 3rd month with no significant increase between 2nd and 3rd month while T2 group showed significant increase between all intervals. Control group showed no significant increase along the period of experiment.

The results of neutrophils (%) count are shown in (Table, 5) which showed significant increase in both treated group along the period of experiment compared with control, also there are significant increase between treated group along the three months of the experiment .The study showed that there are significant increase in values of both treated groups for different intervals .Control groups showed no significant increase in their values.

The results of lymphocytes (%) count are shown in (Table, 6). The study showed a significant decrease in values of both treated groups along the period of experiment compared with control. In addition to that there was significant decrease between the treated group along the intervals of test, also the results showed no significant decrease in values of T1 between the 1st and 2nd month with significant decrease in count between 1st and 3rd month and 2nd and 3rd month.T2 group showed significant decrease along the intervals of experiment. Control groups showed no significant decrease in their values.

The results of platelets count (cells*10^3/cm^3) showed in (Table,7). The values showed significant decrease in both treated groups along the period of experiment compared with control, with significant decrease between T1 and T2 along the interval of experiment. The treated group showed no significant decrease between the 1st and 2nd month in both treated groups, and significant decrease between the 1st and 3rd month and 2nd and 3rd month. Control groups showed no significant decrease along the period of experiment.

The values of reticulocytes (%) are listed in (Table, 8). Results showed that there are no significant increase in count at the 1st and 2nd month in T1 group compared with control with significant increase in T2 group for the same period while at the 3rd month the values showed significant decrease compared with control, with significant increase between T1 and T2 at the 1st and 2nd month and significant decrease between them at the 3rd month. T1 group showed no significant increase between the 1st and 2nd month with a significant decrease between the 1st and 3rd month and 2nd and 3rd month. Results of T2 group showed significant increase between the 1st and 2nd month and significant decrease between the 1st and 3rd month and 2nd and 3rd month. Control groups showed no significant increase or decrease along the period of experiment.

Various hematological tests have been applied to determine anemia in chronic CuSO4.5H2O treatment .The results showed a significant decrease in RBC counts, PCV values with marked decrease in Hb concentration especially in later month of treatment which is suggestive of chronic blood loss due to hemolytic anemia .In studies on the possible mechanisms by which Cu produces destruction of RBCs, (22) observed a marked reduction in the deformability of the RBCs as well as marked increases in membrane permeability and osmotic fragility .More recently, (23) reported that Cu- induced formation and subsequent degradation of peroxides from the membrane lipids of the RBCs this may be a critical factors in altering membrane integrity that leads to hemolysis .

In addition to that, the results showed that increase in the severity of hemolytic anemia which to stimulate bone marrow to increase the production of blood cells with immature forms (reticulocytes) (1st and 2nd months). At this stage anemia was considered of responsive type .At the 3rd month there were a significant decrease in their numbers and that may be attributed to the suppression of hemopoietic tissue due to toxic effects of CuSO4.5H2O and exhaustion of bone marrow. These results agreed with (24), but not agreed with (25), who noticed that there is continuous increase in the numbers of reticulocytes until the death of the animal.

When studying the blood picture of experimental animals, WBCs count showed a significant increase compared with control .The increased in WBCs count was due to neutrophilia. The latter may well be produced by stimuli coming from the damaged liver cells. Lymphocyte showed significant decrease in treated groups because of rapid migration from circulatory system to the areas of tissue injury especially liver, kidney and lung in which they adhere to the endothelium and immigrated to the perivascular areas.

Secondary thrombocytopenia resulting from poisoning cause interference with clotting and hemorrhage (26).

The results of GOT (U/L) are listed in (Table, 9) .The results showed that there are a significant increase (P<0.05) in the values along the period of experiment in addition to a significant increase (P< 0.05) in values between T1 and T2 along the period of experiment, compared with control . There is a significant increase (P<0.05) in (GOT) in T1 between the 1st and 2nd month; and between the 1st and 3rd month. Concerning the T2 group there are significant increase (P<0.05) between the 1st and 3rd month and the 2nd and 3rd month.

The results of GPT (U/L) are listed in (Table, 10). The results showed a significant increase (P<0.05) along the period of experiment of treated groups in comparison with control, also there are significant increase (p<0.05) between the values of T1 and T2 group along the period of experiment .Furthermore there are no significant increase in values of (GPT) in T1 group between the 1st and 2nd month with significant increase (p<0.05) between the 1st and 3rd month. Concerning the T2 group there is a significant increase (p<0.05) between all intervals .Control group showed no significant increase along the period of experiment.

The results of ALP (U/L) are listed in (Table, 11). The results showed that there is significant increase (p< 0.05) in the values in both treated groups along the period of experiment in comparison with the control. In addition to that there is significant increase (p<0.05) between T1 and T2 along the period of experiment. The values of (ALP) of T1 group showed that there is a significant increase (p< 0.05) between 1st and 2nd month and the 1st and 3rd month while there are no significant changes between the 2nd and 3rd month . The result of T2 group showed that that there are no significant increase in values between the 1st and 2nd month, with significant increase (p<0.05) in values between 1st and 3rd month, and 2nd and 3rd month. Control group showed no significant increase along the period of experiment.

The results of serum total protein (g/dl) are listed in (Table, 12) showed that there are no significant increase in values of the 1st month compared with control ,while at the 2nd and 3rd months there are significant increase (p< 0.05) in values compared with control,T2 group showed significant increase (p< 0.05) along the period of experiment in comparison with the control , also the results of T2 group showed that there are significant increase (p<0.05) between all intervals of experiment .T2 group showed significant increase (p< 0.05) between 1st and 2nd month .1st and 3rd month, with no significant increase between the 2nd and 3rd month control group showed no significant increase in values.

Biochemical analysis of rat blood serum was done during the period of experiment. This included GOT, GPT, ALP and total serum protein.

Our study showed that there were significant elevations of the enzymes (GOT, GPT, ALP) of treated groups which further increased along the periods of the experiments in comparison with controls. The elevation of these enzymes are indicative of severe damage of liver and other tissues parenchyma , these results agreed with (15).They observed that a dose –related increase in liver damage was apparent in the rats ,which was indicative of hepatocellular damage and cholestasis.

Similarly (27) showed that hemolysis of RBCs would not explain the dramatic increase in serum activities, and since necrosis of liver lobules is a constant feature of chronic Cu poisoning cases .It would seem reasonable to assume that the destruction of liver tissue was the major cause of the increase in enzymes levels. However necrosis of kidney tubules is also a features of Cu poisoning in sheep and it is possible that the kidney damage contributes to the increased serum levels , since kidney contain similar or greater amounts of GOT,GPT than liver (28), Our results showed also increase in the level of ALP. According to (28). ALP activity increase in hepatocelluar damage,but the level that occurs in obstructive icterus is usually much higher. Furthermore (11) stated that hepatic enzyme activities, together with Cu concentration in blood, liver and kidney, are among the most widely used

clinical tools for diagnosis of chronic Cu toxicosis because hepatic necrosis leads to a sudden release of hepatic enzymes to the blood during the terminal stages of Cu poisoning . Several authors (29 and 30), postulated that hepatic enzymes may also be useful early markers during the long –term , subclinical phase of hepatic Cu accumulation on the basis of the fact that , during this silent phase , some cells undergo necrosis , leading to increases in enzyme activities in the blood. This was noticed in our results that showed significant increase in most biochemical marker from the first month of treatment till the end of treatment periods.

Table, 1: Values of Hb (g/dl) in blood of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	Hb 1 month	Hb 2 month	Hb 3 month	L.S.D
C	14.52 ± 0.07 a A	14.87 ± 0.33 a A	14.82 ± 0.25 a A	0.72
T1 8 mg/kg.bw	11.65 ± 0.08 a B	11.12 ± 0.09 a B	10.20 ± 0.3 b B	0.64
T2 40 mg/kg.bw	10.31 ± 0.19 a C	9.40 ± 0.08 b C	8.71 ± 0.08 c C	0.49
L.S.D	0.39	0.42	0.37	

Different small letters means significant (P<0.05) results within groups VS
Different big letters means significant (P<0.05) results between groups VS. control

Table, 2: Values of PCV(%) in Blood of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	PCV 1 month	PCV 2 month	PCV 3 month	L.S.D
C	43.71 ± 0.42 a A	43.73 ± 0.21 a A	44.10 ± 0.15 a A	1.89
T1 8 mg/kg.bw	41.30 ± 0.57 a B	41.16± 0.63 a B	38.52 ± 0.43 b B	1.05
T2 40 mg/kg.bw	40.55 ± 0.2 a B	38.60 ± 0.82 b C	37.10 ± 0.85 c C	1.02
L.S.D	1.03	1.04	0.37	

Table, 3: Values of RBC (Cells * 10^3 /Cm^3) in blood of rats treated with different doses of CuSO4. 5H2O

Parameters and period / Group	RBC 1 month	RBC 2 month	RBC 3 month	L.S.D
C	57.33 ± 0.06 a A	56.90 ± 0.33 a A	57.42 ± 0.23 a A	0.94
T1 8 mg/kg.bw	47.82 ± 0.15 a B	47.34 ± 0.80 a B	45.91 ± 0.54 b B	0.53
T2 40 mg/kg.bw	42.51 ± 0.13 a C	41.22 ± 0.30 b C	40.12 ± 0.11 c C	0.36
L.S.D	0.33	0.40	0.38	

Table, 4: Values of WBCs (cells*50 /cm³) in blood of rats treated with different doses of CuSO4. 5H2O

Parameters and period / Group	WBC 1 month	WBC 2 month	WBC 3 month	L.S.D
C	4.22 ± 0.13 a B	4.60 ± 0.21 a B	4.63 ± 0.13 a C	1.62
T1 8 mg.kg.bw	55.50 ± 0.20 b A	6.63 ±0.80 a A	7.02± 1.52 a B	0.98
T2 40 mg.kg.bw	5.81 ± 0.05 c A	7.52± 0.23 b A	9.04 ± 0.32 a A	1.01
L.S.D	0.97	1.02	0.64	

Different small letters means significant (P<0.05) results between months
Different big letters means significant (P<0.05) results between groups.

Table, 5: Values of Neutrophils (%) in blood of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	Neutrophils 1 month	Neutrophils 2 month	Neutrophils 3 month	L.S.D
C	24.80 ± 0.32 a C	24.50 ± 0.50 a C	25.31 ± 0.50 a C	1.66
T1 8 mg/kg.bw	27.51 ± 0.60 c B	30.25 ± 0.61 b B	32.81 ± 0.90 a B	1.02
T2 40 mg/kg.bw	29.80 ± 0.34 c A	34.80 ± 0.85 b A	39.32 ± 0.85 a A	1.40
L.S.D	1.39	1.31	1.42	

Table, 6: Values of Lymphocytes (%) in blood of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	Lymphocytes 1 month	Lymphocytes 2 month	Lymphocytes 3 month	L.S.D
C	69.31 ± 0.60 a A	69.30 ± 0.30 a A	70.00 ± 0.40 a A	1.53
T1 8 mg/kg.bw	67.22 ± 0.82 a B	65.91 ± 0.52 a B	64.31 ± 0.62 b B	1.38
T2 40 mg/kg.bw	64.80± 0.50 a C	63.00 ± 0.40 b C	60.80± 0.50 c C	1.25
L.S.D	1.03	1.20	1.19	

Table, 7: Values of Platelets count (cells*10³/cm³) in blood of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	Platelets count 1 month	Platelets count 2 month	Platelets count 3 month	L.S.D
C	582.81 ± 3.90 a A	584.03 ± 5.04 a A	591.31 ± 1.90 a A	27.01
T1 8 mg/kg .bw	449.80 ± 18.93 a B	438.80 ± 20.20 a B	402.33 ± 21.30 b B	24.86
T2 40 mg/kg.bw	368.05 ± 6.32 a C	354.51 ± 7.90 a C	337.03 ± 2.30 b C	24.06
L.S.D	20.90	16.51	21.08	

Different small letters means significant (P<0.05) results between months
Different big letters means significant (P<0.05) results between groups.

Table, 8: Values of Reticulocytes (%) in blood of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	Reticulocyte 1 month	Reticulocyte 2 month	Reticulocyte 3 month	L.S.D
C	2.75 ± 0.25 a B	2.75 ± 0.25 a B	2.51 ± 0.29 a A	0.86
T1 8 mg./kg.bw	2.75 ± 0.50 a B	3.25 ± 0.25 a B	1 .00± 0.00 b C	0.62
T2 40 mg/kg.bw	3.02 ± 0.00 b A	4.75 ± 0.25 a A	± 0.29 c B	0.42
L.S.D	0.46	0.52	0.44	

Table, 9: Values of GOT (U/L) in serum of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	GOT 1 month	GOT 2 month	GOT 3 month	L.S.D
C	201.51 ± 1.10 a C	203.43 ± 0.70 a C	203 .70 ± 0.42 a C	6.03
T1 8 mg/kg .bw	208.03 ± 1.31 b B	244.70 ± 16.21 a B	247.90 ± 16.60 a B	4.73
T2 40 mg/kg.bw	293.50 ± 2.60 b A	295.80 ± 4.02 b A	339.40 ± 6.51 a A	5.01
L.S.D	3.99	3.08	4.30	

Table, 10: Values of GPT (U/ L) in serum of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	GPT 1 month	GPT 2 month	GPT 3 month	L.S.D
C	73.80 ± 1.81 a C	75.12 ± 1.21 a C	75.14 ±1.20 a C	5.03
T1 8 mg/kg.bw	87.41± 4.13 b B	89.03± 2.6 b B	96.90 ± 1.90 a B	4.51
T2 40 mg /kg .bw	96.10 ± 1.13 c A	102.03 ± 0.30 b A	116.90 ± 1.02 a A	4.06
L.S.D	3.88	3.19	4.04	

Different small letters means significant (P<0.05) results between months
Different big letters means significant (P<0.05) results between groups.

Table, 11: Values of ALP (U/ L) in serum of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	ALP 1 month	ALP 2 month	ALP 3 month	L.S.D
C	68.72 ± 1.30 a C	68.90 ± 6.90 a C	69.40 ± 0.90 a C	4.03
T1 8 mg/ kg .bw	78.90 ±1.82 b B	89.21 ± 0.30 a B	93.00 ± 1.40 a B	3.80
T2 40 mg /kg.bw	93.61 ± 1.73 b A	96.12 ± 9.22 b A	100.41 ± 2.60 a A	3.91
L.S.D	4.84	6.89	6.61	

Table, 12: Values of Total protein (g/dl) in serum of rats treated with different doses of CuSO4.5H2O

Parameters and period / Group	Total protein 1 month	Total protein 2 month	Total protein 3 month	L.S.D
C	5.10 ± 0.10 a B	5.21 ± 0.09 a C	5.40 ± 0.22 a C	0.89
T1 8 mg/kg.bw	5.60 ± 0.33 c B	6.70 ± 0.30 b B	8.02 ± 0.44 a B	0.58
T2 40 mg/kg.bw	8.02 ± 0.41 b A	9.10 ± 0.21 a A	9.61 ± 0.20 a A	0.60
L.S.D	0.52	0.53	0.48	

Different small letters means significant (P<0.05) results between months
Different big letters means significant (P<0.05) results between group.

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التقييمات الدموية والكيميائية الحياتية بعد إعطاء جرعات سميه فموية مختلفة من كبريتات النحاس المائية في الجرذان

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الخلاصة

هدفت الدراسة الى بيان تأثير الجرعات السمية لمحلول كبريتات النحاس المائية وذلك من خلال دراسة التغيرات الدموية والكيميائية الحياتية في الجرذان المجرعة تجريبيا. أجريت التجربة على 36 من اناث الجرذان حيث قسمت الى 3 مجاميع متساوية. المجموعة الاولى جرعت ماء مقطر يوميا ولمدة 3 أشهر وأعتبرت مجموعة سيطرة(C) , المجموعة الثانية (T1) جرعت 8 ملغم / كغم من وزن الجسم محلول كبريتات النحاس المائية يوميا ولمدة 3 أشهر وأعتبرت مجموعة معالجة اولى (المجموعة الثالثة جرعت 40 ملغم / كغم من وزن الجسم محلول كبريتات النحاس المائية يوميا ولمدة 3 أشهر وأعتبرت مجموعة معالجة ثانية (T2) . أجريت عملية سحب الدم من القلب مباشرة شهريا وذلك لغرض أجراء الفحوصات الدموية والكيميائية الحياتية. حيث وجد ان هنالك فقر دم من نوع الكرية الصغيرة ناقصة الصباغ مع زيادة معنوية في العدلات انخفاض في اللمفاويات والصفيحات. اما الفحوصات الكيميائية الحياتية فقد أظهرت زيادة معنوية في انظيمات (GOT,GPT,ALP) وبروتينات المصل. نستنتج إن كبريتات النحاس المائية بالجرع المستخدمه في الدراسة في الجرذان تؤدي الى تغيرات في الصورة الدموية والانظيمات السريرية .

الكلمات المفتاحية: الدموية، الكيميائية الحياتية، كبريتات النحاس، الماشية، الجرذان.