WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 5.045
Volume 3, Issue 9, 160-172. Research Article ISSN 2277– 7105

# ANTIOXIDANT EFFECT OF AJUGA IVA (L) AQUEOUS EXTRACT IN MERCURIC CHLORIDE INDUCED OXIDATIVE STRESS IN RATS

**Youcef Necib[1]*, Ahlem Bahi[1], Sakina zerizer[2] and Soumia Djemai-Zoughlache[3]**

[1]Department of Biochemistry and Biological Cellular and Molecular, Constantine1, Algeria
[2]Departement of Animal Biological, Faculty of sciences, Constantine1, Algeria
[3]Laboratory of Biotechnology of Bioactive Molecular and Cellular Pathology, Faculty of sciences, Batna, Algeria

Article Received on
09 September 2014,

Revised on 03 Oct 2014,
Accepted on 27 Oct 2014

***Correspondence for Author**
**Dr. Youcef Necib**
Department of Biochemistry and Biological Cellular and Molecular, Constantine1, Algeria.

## ABSTRACT

The present study was undertaken, to evaluate the protective effect of Aquaous extract of *Ajuga Iva* against mercuric chloride induced oxidative stress in experimental rats. Female *Albinos Wistar* rats randomly divided into four groups, were the first was served as a control, whereas the remaining groups respectively treated with: *Ajuga Iva* (200mg/ kg b.w; by gavage), mercuric chloride (1 mg/kg body weight i.p) and combination of *Ajuga Iva* and $HgCl_2$. Change in liver enzyme activities, thiobarbituric acid reactive substances (TBARS) level, antioxidants and reduced glutathione (GSH) contents were determined after 10 days experimental period. Exposure of rats to mercuric chloride caused a significant increase the lipid peroxidation level along with corresponding decrease in the reduced glutathione and various antioxidant enzymes in liver. And increase in serum: glucose and bilirubin levels, APL and transaminases activities. Furthermore, treatment with mercuric chloride caused a marked elevation of liver weight and decreased body weight. Supplementation of Aquaous extract *Ajuga Iva* resulted in decreased of lipid peroxidation level and in the serum: glucose and billirubin levels and AST, ALT and APL activities were decreased along with increase in liver GSH level. The activities of antioxidants enzymes: glutathione peroxidase (GSH-Px) and glutathione –S-transferase (GST) were also concomitantly restored to near normal level by Aquaous extract of *Ajuga Iva* supplementation to mercuric chloride intoxicated rats. Liver histological studies have confirmed the changes observed in biochemical parameters and proved the beneficial role of Aquaous extract of *Ajuga Iva*. The results clearly demonstrate that Aquaous extract of

*Ajuga Iva* treatment augments the antioxidants defense mechanism in mercuric chloride induced toxicity and provides evidence that it may have a therapeutic role in free radical mediated diseases.

**KEYWORDS**: Antioxidant enzymes, *Ajuga Iva* , Mercury, Oxidative stress, female Rat

## INTRODUCTION

Mercury a highly toxic metal, results in a variety of adverse health effects including neurological, renal, respiratory, immune, dermatologic, reproductive and developmental sequelle [1] .Due to wide use of mercury in agriculture, industrial, medical and other fields, its exposure is cannot be avoided. Inorganic mercury present in the environment is a well-established toxicant to human health [2]. Exposure to mercury promotes the reactive oxygen species (ROS) formation such as hydrogen peroxides, these ROS enhances the subsequent iron and copper induced production of lipid peroxides and highly reactive hydroxyl radicals [3, 4]. Detrimental effects caused by free radicals occur when there is an imbalance between free radical production and radical scavenging capacity of antioxidant system in favour of former [5]. Mercury induced oxidative stress; make an important contribution to molecular mechanism for liver injury [6]. Recent evidences also show that mercury causes severe oxidative damage [7], thus mercury is proved to be a potential oxidant in the category of environmental factors. Therefore, there is a need to provide protection against mercury induced toxicity. It is important to develop an effective drug for mercury to prevent the mercury induced cellular damages. Historically, plants have been used as folk medicine against various type of disease. Previous studies have been showed that the herbal origin antioxidants can reduce the oxidative stress induced by mercuric chloride [8]. Therefore, treatments with antioxidant and radical scavengers such as vitamin E, vitamine C and herbal antioxidants were found to decrease the oxidative stress induced mercuric chloride [9]. *Ajuga Iva (L.)* Schreiber (Lamiaceae), ocally known as “chendgoura”, in Algeria is used in phytomedicine around the world for a variety of diseases. *Ajuga Iva* possesses hypoglycaemic [10], vasorelaxant [11] and hypolipidemic [12] effects, which have been experimentally demonstrated. Chemical studies on *Ajuga Iva* aqueous extract have revealed the presence of several flavonoids, tannins, terpenes and steroids [13]. Since flavonoids have been reported to present antioxidant and hypocholesterolemic activity[14, 15], it may be suggested that the antioxidant activity of *Ajuga Iva* might be related to these compounds. Indeed, it is well established that flavonoids act as free radical scavenger that prevents lipid

peroxidation [16] and tannins and triterpenes have antioxidant effects [17]. The purpose of this study was to evaluate the protective role of aqueous extract of *Ajuga Iva* on mercury chloride induced oxidative stress in rats.

## MATERIALS AND METHODS

All chemicals used in this work were purchased from sigma chemical company. Laboratory animals, *Albinos Wistar* female rats, were brought from the Algiers Pasteur institute at the age of 4 weeks, with an average live weight of 200g. They were located in a room with an ambient temperature of 21±1°C and up to 12h of light daily. The rats were divided into four experimental groups; each consists of six rattes. The first group was served as the control. The second group was given aqueous extract of *Ajuga Iva* at a dose of 200mg/kg body weight, while the third group ($HgCl_2$) was intraperitoneally given mercuric chloride at a dose of 1 mg/kg body weight. Finally, the fourth group: aqeous extract of *Ajuga Iva* was given (200mg/kg body weight) 5 days before $HgCl_2$ (1 mg/kg body weight) and continued up to 10 days after mercuric chloride treatment. The treatment of all groups was lasted for 10 consecutive days. Twenty four hours after the last administration the blood was collected by retro- orbital sinus punction from each anesthetized rats. After centrifugation at 3000 rpm for 10min, the serum was separated immediately and stored at− 20°c until determination of: glucose and billirubin levels and enzymes (AST, ALT and ALP) activities. Subsequently, rats were decapitated and liver were removed.

### Plant Material and Preparation of the Aqueous Extract of *Ajuga Iva*

*Ajuga Iva (L.)* Schreiber (Lamiaceae) plant was collected in north algeria (colo).The whole plant was washed well with water, dried at room temperature in the dark and then ground in an electric grinder to obtain a coarse powder. Then 50 g of the plant powder was suspended in 500 mL distilled water and heated under reflux for 30 min. The decoction obtained was centrifuged, filtered, frozen at –20°C and then lyophilised. The yield of the dry product was about 25% w/w, which was stored at –20°C until used.

### Tissue Preparation

About 500mg of liver was homogenized in 4ml of buffer solution of phosphate buffered saline (w/v: 500mg tissue with 4ml PBS, PH 7.4) homogenates were centrifuged at 10.000xg for 15min at 4°c. The resultant supernatant was used for determination of: reduced GSH, Thiobarbituric acid- reactive substance (TBARS) levels, and the activities of: GSH-PX and GST.

**Determination of Glucose and Billirubin Levels and Enzymes**

Serum glucose, total billirubin and direct billirubin levels and AST, ALT and ALP activities were determined using automate analyses.

**Determination of Lipid Peroxidation (LPO)**

Lipid peroxidation level in the liver was measured by the method of Buege and Aust (1978)[18]. 125µl of supernatant were homogenized by sonication with 50 µl of PBS, 125 µl of 20% TCA + BHT 1% (TCA-BHT) in order to precipitate proteins, and centrifuged (1000xg, 10min, 4°c), afterwards, 200µl of supernatant were mixed with 40µl of HCl (0,6M), and 160µl of TBA dissolved in tris (120 mM). And the mixture was heated at 80°c for 10min; the absorbance was measured at 530nm. The amount of TBARS was calculated by using a molar extinction coeffient of $1.56x10^5$ M/Cm.

**Determination of reduced Glutathione (GSH)**

GSH content in liver was measured spectrophotometrically by using Ellman's reagent (DTNB) as a colouring reagent, following the method described by Weeck bekeretcory (1988) [19].

**Determination of Glutathione-S-Transferase (GST) (EC2.5.1.18)**

The cytosolic glutathione-S-transferase activity was determined spectrophotometrically at 37°c by method of Habig et al (1974)[20]. The reaction mixture (1ml) contained 0.334ml of 100mM phosphate buffer (PH 6.5), 0.033ml of 30mM CDNB and 0.33ml of reduced Glutathione. After pre-incubating for 2min, the reaction was started by adding 0.01ml of diluted cytosol and the absorbance was followed for 3min at 340 nm. The specific activity of GST is expressed as µmole of GSH-CDNB conjugate formed/ min /mg protein using extinction coefficient of 9.6 $Mm^{-1}$ $cm^{-1}$.

**Determination of GSH-Px (E.C.1.11.1.9)**

Glutathione peroxidase (EC 1.11.1.9) activity was modified from the method of Flohe and Gunzler (1984) [21]. for the enzyme reaction , 0.2ml of the supernatant was placed into a tube and mixed with 0.4ml GSH (reduced glutathione, sigma product, analytical grade), and the mixture was put into an ice bath for 30min. Then the mixture was centrifuged for 10min at 3000rpm, 0.48ml of the supernatant was placed into a cuvette, and 2.2ml of 0.32M $Na_2HPO_4$ and 0.32ml of 1m mol/l 5,5'-dithio-bis(2-nitrobenzoic acid) (DTNB, sigma) were added for color development. The absorbance at wavelength 412nm was measured with a UV

spectrophotometer after 5min. The enzyme activity was calculated as a decrease in GSH within the reaction time as compared with the non-enzyme reaction.

**Protein Quantification**

Protein was measured by the method of Bradford (1976)[22], using bovine serum albumin as the standard.

**Histopathological Examination**

Liver from autopsied animals were excised out and fixed in formalin (10%). five micron think section were prepared by using microtome and these section were stained with hematoxyline and eosin. For histological alterations these slides were observed under light microscope.

**Statistical Analysis**

The data were subjected to student *t* test for comparison between groups. The values are expressed as mean ± SEM. Significance level was set at $P<0.05$, $P<0.01$, $P<0.001$.

**RESULTS**

**Effects of Treatments on Body, Absolute and Relative Liver Weights**

The variations in body and relative liver weights of animals subjected to different treatments were shows in Table 1. During the course of present investigations, it was observed that the control body weight and aqueous extract of *Ajuga Iva* treated group have increased progressively, contrary in $HgCl_2$ treated rats, results revealed significant decrease in body weight gain as compared to the control. Besides, a significant increase of $HgCl_2$ treated group in absolute and relative liver weights and in *Ajuga Iva* treated group as compared to the control.

**Effects of Treatments on Serum Biochemical Parameters**

Treatment with $HgCl_2$ caused a significant ($P\leq 0.01$) increase in the activities of AST, ALT and ALP as compared to the control. Only *Ajuga Iva* treatment did not show any significant alteration. However, the combined treatment of *Ajuga Iva* with mercuric chloride results in gradual recovery in AST, ALT and ALP activities as compared to the control (table 2). The content of serum glucose of the $HgCl_2$ treated group tented to be higher compared to the control. Total billirubun and direct billirubin levels in $HgCl_2$ treated animals were increased,

but the co-administration of *Ajuga Iva* with $HgCl_2$ has produced a recovery in the above mentioned biochemical variables.

**Effects of Treatments on Hepatic Oxidative Stress Parameters**

Mercuric chloride exposure a highly significant depleted in reduced glutathione (GSH) level, GPx and GST activities. And a significant increase in liver lipid peroxidation level in mercury intoxicated rats was noticed. *Ajuga Iva* alone treatment did not show any significant decline. In combined treatment of *Ajuga Iva* with mercuric chloride a highly significant increase in reduced glutathione (GSH) level, GPx and GST activities. And a significant depletion in lipid peroxidation level was recorded with respect to mercury intoxicated rats (Figs. 1 and 2).

**Histological Studies**

Mercuric chloride induces various pathological alterations in liver of rats. These alterations were characterized by centrilobular necrosis, degranulation, destruction of membrane cells, cytoplasmic vacuolization (Fig. 3C). In combination group were *Ajuga Iva* was administered with mercuric chloride showed reparative changes. Liver showed prominent recovery in the form of normal hepatocytes and very less centrilobular necrosis. Pronounced sinusoid .With granular hepatocytoplasm were also evident (Fig.3D). Liver of the control group had a regular histological structure with a characteristic pattern of hexagonal lobules (Fig. 3A). Furthermore, no histological alterations were observed in the liver of *Ajuga Iva* treated group (Fig. 3B).

**Table 1: Changes in body and absolute and relative kidney weights of control and rats treated with Ajuga Iva (AI), mercuric chloride, and combined treatment of mercuric chloride with Ajuga Iva after 10 days of treatment.**

| Parameters | treatment groups | | | |
|---|---|---|---|---|
| | Control | AI | $HgCl_2$ | AI+ $HgCl_2$ |
| Initial body weight (g) | 160±12 | 164.2±16 | 174.15±25 | 168.5±17 |
| Final body weight (g) | 180.25±12 | 167±10 | 154±6.2 | 175.75±7.5 |
| Absolute Liver weight (g) | 5.1±0.3 | 5.8±0.4 | 7.27±0.9** | 6.67±0.7* |
| Relative Liver weight (g/100g b.w) | 0.028±0.02 | 0.034±0.03 | 0.047±0.1 | 0.044±0.02 |

**Table 2: Changes in biochemical parameters of control and rats treated with Ajuga Iva (AI), mercuric chloride, and combined treatment of mercuric chloride with Ajuga Iva after 10 days of treatment.**

| Parameters | experimental groups | | | |
|---|---|---|---|---|
| | control | AI | $HgCl_2$ | AI+ $HgCl_2$ |
| Glucose(mg/dl) | 1.68±0.28 | 1.43±0.27 | 2.0 ±0.47 | 1.82±0.17 |
| SGOT(U/L) | 40.8 ± 0.73 | 35.88±2.67 | 50.13 ± 12 | 49.32 ± 4.1* |
| SGPT(U/L) | 45 ± 3.4 | 51.04 ± 3.7 | 73.72 ± 18* | 50.15 ± 12 |
| ALP(U/L) | 259.34 ± 42 | 177.82± 14 | 326.19± 51 | 277.34 ± 24 |
| Total Bllirubin(mg/dl) | 9.42 ± 0.45 | 8.7 ± 0.58 | 16.97 ±5.2* | 11.55 ± 0.49** |
| Direct Billirubin (mg/dl) | 2.7 ± 0.65 | 1.77 ± 0.56 | 3.4 ± 0.99 | 3.22 ± 0.8 |

Values are given as mean ± SEM for group of 6 animals each. *P≤0.05, compared to controls. **P≤0.01, compared to controls. ***P≤0.001, compared to controls.

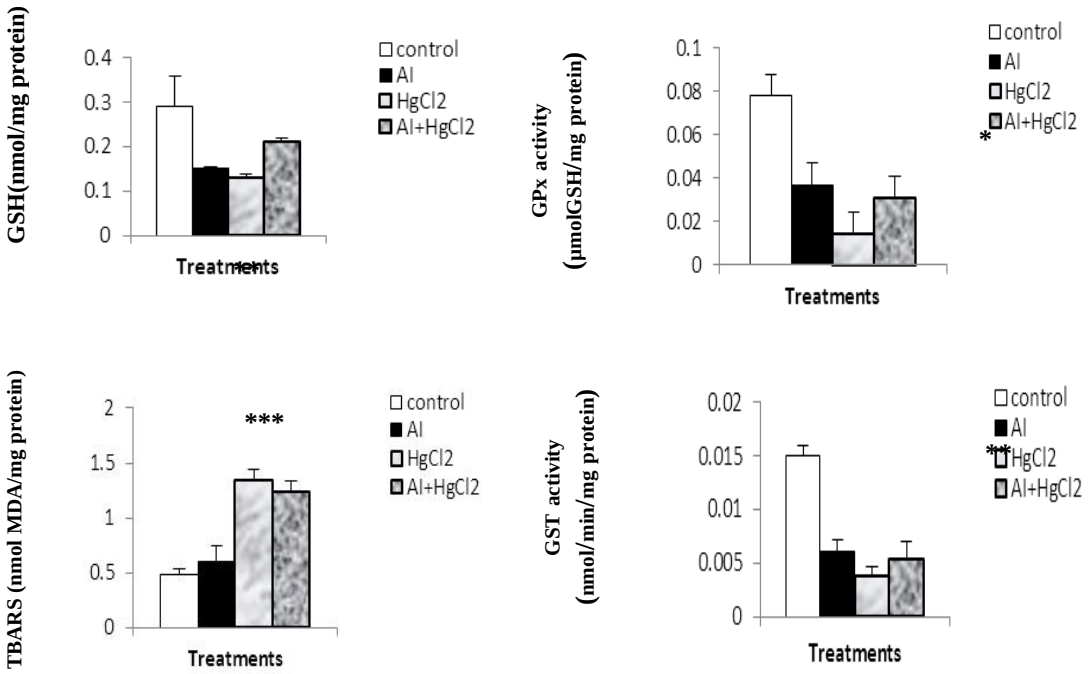


**Fig. 1. Reduced glutathione (nmol/ mg protein) and TBARS (nmol MDA /mg protein) levels in liver of control and rats treated with *Ajuga Iva*, mercuric chloride, and combined treatment of *Ajuga Iva* with mercuric chloride after 10 days of treatment. Values are given as mean ± SEM for group of 6 animals each significant difference: * compared to controls (*P≤0.05; **P≤0.01; ***P≤0.001).**

**Fig.2. Enzyme activities of GPx (µmol GSH/ mg protein) and GST (nmol /min/mg protein) in liver of control and rats treated with *Ajuga Iva*, mercuric chloride, and combined treatment of *Ajuga Iva* with mercuric chloride after 10 days of treatment. Values are given as mean ± SEM for group of 6 animals each significant difference: * compared to controls (*P≤0.05; **P≤0.01; ***P≤0.001).**

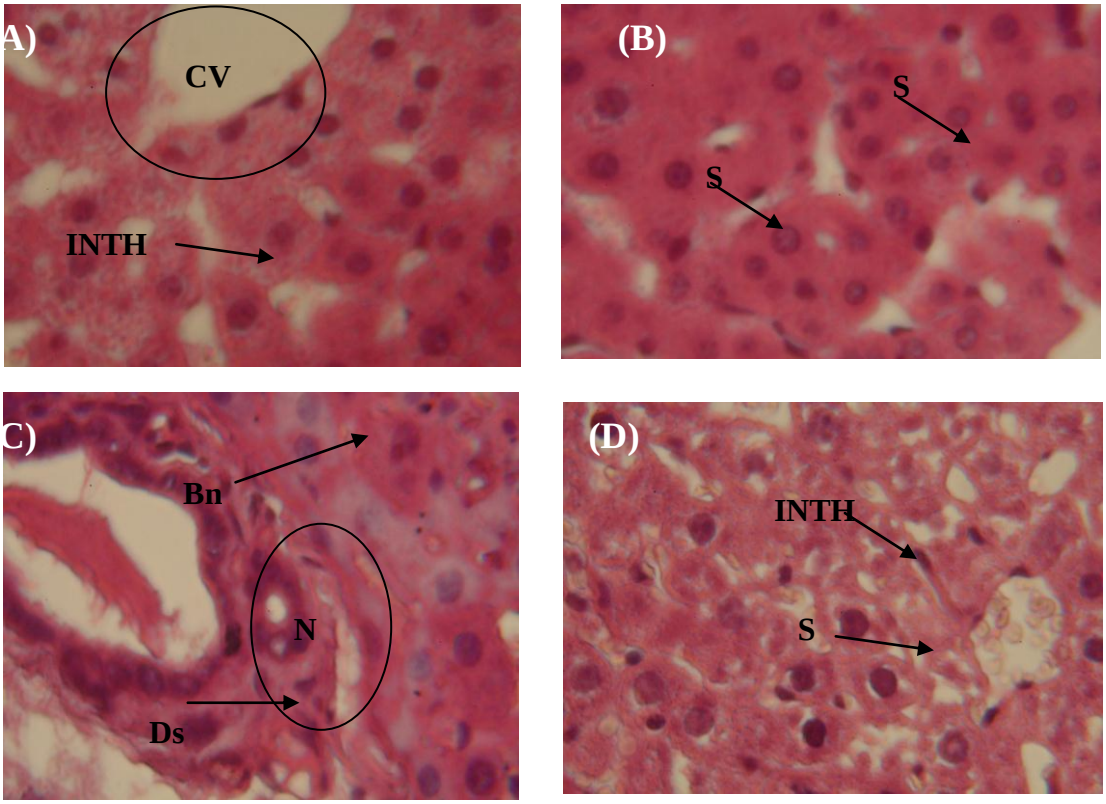


**Fig.3. Microscop evaluation of hepatic tissue from (A) control, (B) treated with *Ajuga Iva*, (C) mercuric chloride and (D) *Ajuga Iva* pre-and post-treated with mercuric chloride after 10 days of treatment, section were stained using the hematoxylin-eosin method (400X). Bn: Bright nuclei, Ds: destruction of membrane cells, N: Necrosis, INTH: Intact hypatocyte cells, CV: central vein, S: Sinusoid. *Ajuga Iva* coadministrated with mercuric chloride shows granular cytoplasm and normal hepatocytes.**

## DISCUSSION

The present investigation revealed that mercuric chloride intoxication causes significant increase in lipid peroxidation and glucose, billirubin levels, AST, ALT and ALP activities, and significant decrease in reduced glutathione, glutathione peroxidase and glutathione-s-transferase in liver. The principal toxic effects of mercury involve interaction with a large number of cellular processes, including the formation of complexes with free thiols and protein thiol groups, which may lead to oxidative stress [23]. Due to its sulfhydryl group binding capability, $HgCl_2$ can also inhibit the activities of many enzymes, especially those involved in the cellular glucose uptake, gluconeogenesis, fatty acid. Oxidation and production of glutathione. GSH, the primary intracellular antioxidant and the conjugating agent, was shown to be depleted and to have impaired function in Hg toxicity. A single Hg ion can bind to and cause irreversible excretion of up to two GSH molecules [24]. In fact, GSH serves as a primary line of cellular defense against Hg compounds. Released Hg ions form complexes

with GSH and cysteine results in greater activity of the free Hg ions, disturbing GSH metabolism and damaging cells [25]. As a result of binding of mercury to glutathione, levels of GSH are lowered in the cell and decrease the anti-oxidant potential of the cell. Antioxidant enzymes such as glutathione peroxidase and glutathione –S-transferase play a major role in the intracellular defense against oxygen radical damage to aerobic cells. Chung *et al* (1982) [26] demonstrated that 10mg/kg of mercury caused time dependent decreases in the activities of the enzyme of the glutathione metabolism pathway in the rat kidney. Girardi and Elias (1995)[27] reported that mercury inhibits the activities of redox cycles enzymes. Recent finding of Bando et al and jadhav *et al* (2006) [28] proved our point that this antioxidant enzymes show decreased level following mercury intoxication. Because of the low activity of antioxidant enzymes in the liver and decreased content of GSH, the liver is hypothesized to be highly susceptible to oxidative stress. Mercury induced oxidative stress turn to severe; the inbuilt mechanism of body fails to alleviate the damage. It has been demonstrated that mercury decreases the anti-oxidative systems and produces oxidative damages via $H_2O_2$ generation therby leading to lipid peroxidation [29]. All these possible mechanisms of mercuric chloride toxicity may lead to the formation of reactive oxygen species (ROS), as found in the present investigation. Therefore, an increase in the formation of ROS by mercuric chloride may induce membrane biochemical and functional alterations and thus induced liver cell damage. Further, mercury intoxication also induces a significant elevation in serum and: billirubun levels and AST, ALT and ALP activities. This increase may be due to cellular necrosis of hepatocytes, which causes increase in the permeability of cell resulting release of transaminases and ALP in blood stream[30]. This confirms our earlier reports on histopathological alterations in liver induced by mercury intoxication [31]. It was observed that *Ajuga Iva* extract when given in combination with mercuric chloride significantly increases liver GSH level, GSH-Px and GST activities as antioxidant potential and thereby declines the level of lipid peroxidation, which in turn reduces the transaminases and ALP activities and glucose, total billirubin and direct billirubin levels in serum. In present investigation, the elevated level of GSH protects cellular proteins against oxidation through glutathione redox cycle and directly detoxifies reactive species [32]. Glutathione, as both a carrier of mercury and an antioxidant, has specific roles in protecting the body from mercury toxicity. Glutathione, specifically bind with methylmercury, forms a complex that prevents mercury from binding to cellular proteins and causing damage to both enzymes and tissue [33]. Glutathione-mercury complexes also reduce intracellular damage by preventing mercury from entering tissue and cells, and becoming an intracellular toxin. The elevated level of

GSH-Px and GST by *Ajuga Iva* as compared to the $HgCl_2$ may have facilited the conjugation reaction of xenobiotics metabolism and may have increased the availability of non-critical nucleophile for inactivation of electrophiles and therefore might be playing a major role in metalloprotection. The *Ajuga Iva* is a traditional herbal medicine used widely as antibacterial, antimalarial, sedative, antispasmodic, anti-inflamatory and relieve diarrhea [34, 35, 36]. Previous studies have been showed that *Ajuga Iva* and its ingredient compounds inhibit the free radical generation and act as antioxidant and free radical scavengers and its has also been demonstrated that treatment with *Ajuga Iva* inhibits the generation of superoxide radicals [37, 38] and recent evidence suggested that GSH-PX and GST play a significant role in the elimination of $H_2O_2$ and lipid peroxidative stress in rats [39, 40]. Thus, inhibition this enzymes may results in the accumulation of the $H_2O_2$ with subsequent oxidation of lipids. The present study has showed that MDA levels were significantly increased and the GSH-PX, GST activities were decreased with treated both dose of *Ajuga Iva* in mercuric chloride groups when compared with control groups which comformed with the histopathological evaluation of liver tissue. Flavonoids are the major component of *Ajuga Iva* which are able to inhibit the oxidants and to protect the cell membrane. This study assess the effects of oxygen free radical scavengers, both mercuric chloride injury and increase of TBA-reactive substance were inhibited by the treatment of free radical scavengers. *Ajuga Iva* extract is an effective free radical scavenger showing antioxidant activity against reactive oxygen production and protecting the damage caused by free radicals [41].This result is supported with biochemical and histopathological findings which the effect of *Ajuga Iva* on mercuric chloride induced oxidative stress in rats. The effect of Ajuga Iva could be attributed to the improvement of antioxidant status of the animals of the presence of free radical scavenging substances such as flavonoid [41]. In conclusion, our study indicate that *Ajuga Iva* extract have hepatoprotective effect against mercuric chloride induced oxidative stress in rats which may be related to its antioxidant effect.

## REFERENCES

1. Risher- john F, Amler-Sherlita N. Mercury exposure: evaluation and intervention, the inappropriate use of chelating agents in diagnosis and treatment of putative mercury poisoning. *Neurotoxicol*, 2005; 26(4): 691-699.
2. WHO. Environmental health criteria 118: inorganic mercury- environmental aspects. World healthorganization, geneva, Switzerland, 1991; 115-119.

3. Miller OM, Lund BO, Woods JS. Reactivity of Hg (II) with superoxide: evidence for catalytic dismutation of superoxide by Hg (II). *J Biochem Toxicol*, 1991; 6: 293.
4. Hussain S, Atkinson A, Thompson SJ, Khan AT. Accumulation of mercury and its effect on antioxidant enzymes in brain, liver and kidneys of mice. *J Environ Scie and Health, Part-B*, 1999; 34(4): 645-660.
5. Garg MC, Chaudhary DP, Bansal DD. Effect of vitamin E supplementation on diabetes induced oxidative stress in experimental diabet in rats. *Ind J Exp Biol*, 2005; 43: 177-180.
6. Farima M F, Soares A, Zeni G, Souza DO, Rocha JB. Additive prooxidative effect of methylmercury and ebselen in liver from suckling rat pups. *Toxicol let*, 2004; 146(3): 227-235.
7. Kim SH, Sharma RP. Mercury alters endotoxin induced inflammatory cytokine expression in liver: differential role of P38 and extra cellular signal-regulated mitogen activated protein kinases. *Immunopharmacol and Immunotoxicol*, 2005; 27(1): 123-135.
8. Necib Y, Bahi A, Zerizer S. Argan oil (Argania Spinosa .L) provides protection against mercuric chloride induced oxidative stress in rat albinos wistar. *Int j of bas and appl scie*, 2013a; 2(1): 73-80.
9. Necib Y, Bahi A, Zerizer S. Protective role of sodium selenite on mercuric chloride induced oxidative and renal stress in rats. *j of stress physiol and biochem*, 2013b; 9(2): 160-172.
10. El-Hilaly J, Lyoussi B. Hypoglycemic effect of the lyophilized aqueous extract of ajuga iva In normal and streptozotocin diabetic rat. *J Ethnopharmacol*, 2002; 80: 109-113.
11. El-Hilaly J, Lyoussi B, Wibo M, Morel N. Vasorelaxant effect of the aqueous extract of ajuga iva in rat aorta. *J Ethnopharmacol*, 2004; 93: 69-74.
12. El-Hilaly J, Tahraoui A, Israili ZH, Lyoussi B. Hypolipidemic effects of acute aand sub-chronic administration of an aqueous extract of Ajuga iva L. whole plant in normal and diabetic rats. *J Ethnopharmacol*, 2006; 105: 441-448.
13. Houghton PJ, Raman A. Laboratory Handbook for the fractionation of natural extract, first ed. ITPR, London, 1998.
14. Syrov VN, Khushbaktova ZA, Abzalova MKH, Sulta-nov MB. Hypolipidemic and antiatheroscerotic properties of phytoccdysteroids. *Dokl Akad Nauk ussr*, 1983; 9: 44-45.
15. Wagner H, acaille-Dubois MA. Recent pharmacological results on bioflavonoids. In: Antus, S., Gabor, M., Vetschera, K. (Eds.). Flavonoids and bioflavonoids. Akademiai Kiado, Budapest, 1995; 53-72.

16. Soto C, Recoba R, Barron H, Alvarez C, Favari L. Sylimarin increases antioxidant enzymes in alloxan-induced diabetes in rat pancreas. *Toxicol Pharmacol*, 2003; 136: 205-212.
17. Larkins N, Wynn S. Pharmacognosy: phytomedicines and their mechanisms. *Vet Clin North Am Small Anim Pract*. 2004; 34: 291-327.
18. Buege JA, Aust SD. Microsomal lipid peroxidation. *Methods enzymol*, 1984; 105: 302-10.
19. Weckbercker G, Cory JG. Ribonucleotide reductase activity and growth of glutathione-depended mouse leukaemia L 1210 cells in vitro. *Cancer let*, 1988; 40: 257-264.
20. Habig WH, Pabst Jakoby WB. Glutathione-S-transferase the first step in mercapturic acid formation. *J of Biol and Chemical*, 1974; 249: 7130-9.
21. Flohe L, Gunzler WA. analysis of glutathione peroxidase. *Methods enzymol*, 1984; 105: 114-21.
22. Bradford MA. Rapid and sensitive method for the quantities of microgram quantities of protein utilizing the principale of protein-dye binding. *Anal Biochem*, 1976; 72: 248-54.
23. Stacey NH, Kappus H. Cellular toxicity and lipid peroxidation in response to mercury. *Toxicol and App Pharmacol*, 1982; 63(1): 29-35.
24. Hultberg B, Andersson A, Isaksson A. Interaction of metals and thiols in cell damage and glutathione distribution: potentiation of mercury toxicity by dithiothreitol. *Toxicol*, 2001; 156: 93-100.
25. Chung AS, Maines MD, Reynolds WA. Inhibition of the enzymes of glutathione metabolism by mercuric chloride in the rat kidney: reversal by selenium. *Biochem and pharmacol*, 1982; 31: 3093-3100.
26. Girardi G, Elias MM. Mercury chloride effects on rat renal redox enzymes activities: SOD protection. Free *rad and Biol Med*, 1995; 18(1): 61-66.
27. Bando I, Rens M I, Andres D, Cascales M. Endogenous antioxidant defence system in rat liver following mercuric chloride oral intoxication. *J of Biochem Mol and Toxicol*, 2005; 19(3): 154-161.
28. Jadhav SH, Sarkar SN, Aggarwal M, Tripathi HC. Induction of oxidative stress in erythrocytes of male rats subchronically exposed to a mixture of eight metals found as ground water contaminants in different parts of india. *Arc Environ Contam and Toxicol*, 2007; 52(1): 145-151.
29. Vandenberghe J. Hepatotoxicology: mechanisms of liver toxicity and methodological aspects. In: niesink JM, vries JD, CRC press, bocaroton. 1995; 718.

30. Sharma M K, Kumar M, Kumar A. (study of mercury induced toxicity in liver and its modulation by spirulinafusiformis and ocimum sanctum). In: proceeding of third word congress on cellular and molecular biology held at jena, Germany. *Cell and Mol Biol*, 2000; 46: 227.
31. Ketterer B. Glutathione-stransferase and prevention of cellular free radical damage. *Free rad Rese*, 1998; 28: 647-658.
32. Kromidas L, Trombetta LD, Jamall IS. The protective effects of glutathione against methylmercury cytotoxicity. *Toxicol let*, 1990; 51: 67-80.
33. Bhattarai NK. Folk herbal remedies for diarrhea and dysentery in central neptal. *Fitoterapia*, 1993; 64: 243-250.
34. Thebtaranonth C, Thebtaranonth Y, Wanauppaphamkul C and Yuthavong Y. Antimalarial sesquiterpenes from tubers of cyperus rotundus. Structure of 10, 12 peroxycalamenene, asesquiterpenes endoperoxide. *Phytochemistry*, 1995; 40: 125-125.
35. Zhu M, Luk HH, Fung HS and Luk CT. Cytprotective effects of cyperus rotundus gastric ulceratin in rats. *Phytother Res*, 1997; 11: 392-394.
36. Oladipupo A L and Oyedeji A O. Chemical composition of the essential oils of cyperus rotundus L. *from south Africa Molecules*, 2009; 14: 2909-2917.
37. Kilani SA, Abdelwahed I, Chraief R, Ben Ammar N, Hayder M, Hammami K, Ghedira and Chekir-Ghedira L. Chemical composition, antibacterial and antimutagenic activities of essential oil from (Tunisian) cyperus rotundus. *J Essent Oil Res*, 2005a; 17: 695-700.
38. Seo WG, Pae GS, Chai KY and Kwon TO et al. Inhibitory effect of methanol extract of cyperus rotundus rhizome o notric oxide and superoxide production by murin macrophage. *J Ethnopharmacol*, 2001; 76: 59-64.
39. Necib Y, Bahi A, Zerizer S, cherif A, Boulakoud M, chettoum A, Hallas A. Effect of argan oil (Argania Spinosa .L) on kidney function impairment and oxidative stress induced by mercuric chloride in rats. *Int j of pharma scie review and resea*, 2013c; 22(2): 144-148.
40. Necib Y, Bahi A, Zerizer S, cherif A, Boulakoud MS. Hepatoprotective role of sodium selenite against oxidative damage induced by mercuric chloride in rat albinos wistar. *j of stress physiol and biochem*, 2013d; 9(4): 230-240.
41. Kilania SJ, Ledauphinb I, Bouhlela S, Mohamed J, Boubakera and Skandrania I. Comparative study of cyperus rotundus essential oil by a modified GC/MS analysis method. Evaluation of its antioxidant, cytotoxic and apptotic effects. *Chem Bodivers*, 2008; 5: 729-741.