Effect of Melissa Officinalis L. on Oxidative Stress and Biochemical Parameters in Aluminum toxicity in rats

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Research Journal Specific Education

Faculty of Specific Education

Mansoura University

ISSUE NO. 35, JULY. 2014

مجلة بحوث التربية النوعية – جامعة المنصورة

العدد الخامس والثلاثون – يوليو ٢٠١٤

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Abstract

The main objective of this study was to investigate the effect of Lemon balm (Melissa officinalis, L.) on some nutritional parameters and liver enzymes, kidney functions, lipid profiles, acetyl cholinesterase activities and antioxidants activities for aluminum toxicity induced in rats. The experiment was carried out using thirty two male albino rats. The rats were divided randomly into two main groups, the first main group fed on the basal diet only as a negative control (normal group) while, the second main group were intraperitoneally injected with aluminum chloride (AlCl3) to induce aluminum toxicity and divided into 3 subgroups (each 8 rats) as follow: Subgroup (1): was kept without any treatment as a positive control (+ve group) and fed on basal diet. Subgroups (2 & 3): were fed on basal diet containing 4% and 8% lemon balm, respectively. At the end of the experiment period (8 weeks). Results indicated that, injected rats with AlCl3 increased significantly all the previous parameters, except FI, BWG %, FER, high density lipoprotein, superoxide dismutase (SOD) activity, and total antioxidants that showed significant decreasing compared with (C-ve group). Also histopathological results of organs showed damage in them. In contrary, feeding rats on diets containing lemon balm especially at high level (8%) revealed a marked improvement of these parameters and histopathological examinations of organs compared to +ve control group injected with AlCl3. The present study recommended that consuming lemon balm improved the symptoms of aluminum toxicity and prevent its complications.

Keywords: Melissa officinalis- Aluminum chloride- Acetyl cholinesterase – Antioxidants.

INTRODUCTION

Al is widely distributed in the environment and extensively used in daily life, which causes its easy exposure to human beings (Kumar and Gill, 2009). In fact, AL can be found in almost everywhere in food, beverages, cosmetics, toothpaste, cook ware, cans ,containers, and as adjuvant in

different parenteral preparation and pharmaceutical agents. It has been shown that users of Al-containing antacids and buffered aspirin may have increased body Al (Krewski et al., 2007). Also, Al is added to drinking water for purification purposes (Turkez et al., 2010).

Workers in the industries related to Al, are usually in a chronic exposure to Al more than that expected coming from normal daily diet. Al production workers who are occupationally exposed to Al have an oxidative stress situation that is evident in their blood (Ranjbar et al., 2008). As reviewed recently by (Mohammadirad and Abdollahi, 2011), most of toxicities of Al in human being are mediated through disturbing the balance between body oxidant and antioxidant. The most common condition related to Al exposure is Alzheimer's Disease (AD). Al is known to induce or worsen AD by its oxidant effects (Garcia et al., 2010). With the same mechanism of action, Al is known as a risk factor for Parkinson's disease (Sanchez-Iglesias et al., 2009). Since oxidant/antioxidant imbalance is involved in the pathogenesis of many diseases (Abdollahi et al., 2004) thus it would not be surprising to find strong links between Al exposure and many deliberating diseases other than AD and Parkinson.

Lemon balm (Melissa officinalis, L.) a member of Lamiaceae family is a perennial herb native to southern climates of Europe and North America (Sharafzadeh et al., 2011). Originally native to the east Mediterranean region and west Asia, Melissa officinalis (L.) (Lamiaceae) (lemon balm) is also encountered in certain tropical countries, such as Brazil, where it is popularly known as ‘erva-cidreira’ and ‘melissa’ (Souza et al., 2004). Aqueous and alcoholic extracts from the aerial part of Melissa officinalis are traditionally used in the treatment of fevers and colds, indigestion associated with nervous tension, hyperthyroidism, depression, mild insomnia, epilepsy, headaches, toothaches, and so on (Carnat et al., 1998; Herodez et al., 2003; Salah &Jäger, 2005 and Dastmalchi et al., 2008). Furthermore, its antioxidant activity has been described by various authors (Mimica-Dukic et al., 2004; Souza et al., 2004 and Canadanovic-Brunet et al., 2008).

Lemon balm is used for several purposes such as an additive in food, a herb tea, an ingredient in cosmetics, an ornamental and a medicine(Sarı and Ceylan, 2002). Essential oil is currently used in medicine and pharmacology (anti-tumor, anti-bacterial, antimicrobial, antihistaminic, antispasmodic and antioxidant, by means of its antiviral effect curing of the herpes (Allahverdiyev et al., 2004) antiulcerogenic, moderate Alzheimer’s disease,

modulation of mood and cognitive performance, stimulating the immune system (against anti HIV-1) (Yamasaki, et al., 1998). In addition, lemon balm has traditionally been used due to its memory enhancing properties, but using of which is currently more widely used as sedative or calm, spasmolytic and antibacterial agent and sleep aid has been more popular recently(Coleta et al., 2011; Kennedy et al., 2004 and Sadraei et al., 2003).

Headspace solid-phase micro extraction (HS-SPME) coupled with gas chromatography–mass spectrometry (GC–MS) has been used for the chemical analysis of Melissa officinalis (leaves) cultivated in Institute Germplasm. The HS-SPME analysis led to the identification of 22 components constituting 99.1% of the total volatile constituents present in the leaves whereas its hydrodistillate led to the identification of 24 volatile constituents constituting 98.1% of the volatile material. The chemical composition of the SPME and hydrodistilled extract of M. officinalis leaves comprised mainly of oxygenated monoterpenes (78.5% and 57.8% respectively) and sesquiterpene hydrocarbons (14.9 and 29.7% , respectively). The major components identified in the HS-SPME extract were citronellal (31.1%), citronellol (18.3%), b-caryophyllene (12.0%), (E)-citral (11.9%), (Z)-citral (9.6%), geraniol (3.6%), (Z)-b-ocimene (3.1%) and 1-octen-3-ol (2.0%) whereas hydrodistilled essential oil was rich in (Z)-citral (19.6%), b-caryophyllene (13.2%), (E)-citral (11.2%), citronellal (10.2%), germacrene-D (8.3%), d-3-carene (5.0%), 6-methyl-5-hepten-2-one (3.7%) and citronellyl acetate (3.7%) (Rehman et al., 2013).

Material and Methods

- ***Materials***

Lemon balm (Melissa officinalis, L.) leaves were purchased as dried material from spice dealer from local market in Cairo. Anhydrous aluminum chloride (AlCl3) was obtained from Sigma Chemical Co. Casein (> 85% protein) was obtained from Misr Scientific Company, Giza, Egypt. Cellulose and DL- methionine were purchased from Morgan Company, Cairo, Egypt. Minerals and vitamins constituent, sucrose, glucose and absolute ethanol were obtained from El-Gomhoriya Pharm. and Chem. Ind. Co. Cairo, Egypt. Corn oil was obtained from the local market. Corn starch was obtained from Starch and Glucose Company, Helwan, Egypt.

- ***Animals***

Thirty two male albino rats, Sprague Dawley strain, weighing (135 ± 10g) were purchased from the animal house of Agriculture Research Center, Giza, Egypt. The animals were housed in plastic cages, maintained on a natural light-dark cycle at room temperature of 26 ± 2º C and fed standard diet according to Reeves et al., (1993) and water ad libitum. Rats were kept for one week as acclimatization period before the start of the experiment. All rats were handled in accordance with the standard guide for the care and use of laboratory animals.

- ***Methods:***

Preparation of plant formulations:

Lemon balm leaves were milled in a mixer to give a powder and kept in dusky stoppered glass bottles in a dry location till using.

Experimental design:

The experiment was performed in Animal House in the Food Technology Research Institute, Agriculture Research Center, Giza. After the acclimatization period, rats were divided randomly into two main groups, the first main group (n= 8 rats) fed on the basal diet only as a negative control (normal group) and intraperitoneally injected with saline solution. While, the second main group (n= 24 rats) were intraperitoneally injected with AlCl3 at dose of (20 mg/kg bw.) 4 times weekly to induce aluminum toxicity according to Berlyne et al., (1972).

The second main group (injected with AlCl3) was divided into 3 subgroups (each 8 rats) as follows: Subgroup (1): was kept without any treatment as a positive control (C +ve group) and fed on basal diet. Subgroups (2 & 3): were fed on basal diet containing 4% and 8% lemon balm respectively. Body weight (BW) was recorded weekly during the experimental period and feed intake was measured daily during the experimental periods.

Blood sampling:

At the end of the experiment period (8 weeks), rats were sacrificed after overnight fasting under ether anesthesia. Blood samples were taken from hepatic portal vein and were left to clot by standing at room temperature for 15 minutes, and then centrifuged at 3000 rpm for 20

minutes. Serum was carefully separated and transferred into clean quite fit plastic tubes and kept frozen at - 20°C until the time of analysis.

Biological evaluation:

At the end of the experiment, biological evaluation of the tested diets was carried out by determining total feed intake (FI), body weight gain% (BWG%) and Food efficiency ratio (FER) according to Chapman et al., (1959).

Biochemical analysis:

Determination of liver enzymes:

Serum alanine and aspartate aminotransferases (ALT & AST) were estimated according to Reitman and Frankel, (1957) while alkaline phosphatase (ALP) was assayed by (Kind and King, 1954).

Determination of kidney functions:

Serum creatinine, uric acid and urea were determined according to the methods described by Bohmer, (1971); Fossati et al., (1980) and Patton and Crouch, (1977), respectively.

Determination of serum lipids:

Enzymatic colorimetric determination of triglycerides was carried out according to Fossati and Prencipe, (1982). Total cholesterol was determined by colorimetric method according to Allian et al., (1974). Determination of HDL (high density lipoprotein) was carried out according to the method of Fnedewaid, (1972). The determination of VLDL (very low density lipoproteins) and LDL (low density lipoproteins) were carried out according to the method of Lee and Nieman, (1996) by calculation as follows:

* VLDL (mg/dl) = Triglycerides /5
* LDL (mg/dl) = Total cholesterol –HDL-VLDL

Determination of serum acetycholinesterase and antioxidant parameters

Acetycholinesterase (AchE) activity was determined according to Knedel and Boottger, (1967). Superoxide dismutase (SOD) activity, total antioxidants capacity (TAC), and malondialdehyde (MDA) were determined according to Nishikimi et al.,(1972); Cao et al., (1993) and Ohkawa et al.,(1979), respectively.

Histopathological examination:

Liver, kidney and brain sections were taken from different rats in each group immediately after sacrification. The tissues were washed with the normal saline solution to remove blood, fixed in 10% neutral formalin as fixative and sent to Cancer Institute for histopathological examination according to Bancroft et al., (1996).

Statistical analysis:

The obtained data were statistically analyzed using computerized SPSS (Statistic Program Sigmastat, Statistical Soft-Ware, SAS Institute, Cary, NC). Effects of different treatments were analyzed by one way ANOVA (Analysis of variance) test using Duncan's multiple range test and $p<0.05$ was used to indicate significance between different groups (Snedecor and Cochran, 1967).

Results

Effect of lemon balm on body weight gain, feed intake and food efficiency ratio % in rats received AlCl3 was illustrated in table (1). It could be noticed that group received AlCl3 (+ve) control recorded a significant decrease in body weight gain BWG, feed intake (FI), and food efficiency ratio % (FER%) compared with healthy control group. Whereas, BWG , FI and FER % of all treated groups increased significantly compared with (+ve) control untreated group, however it could not reach the normal value recorded by healthy control group.

Table (1): Effect of lemon balm on body weight gain, feed intake and Food efficiency ratio % in rats received AlCl3.

Groups / Parameters		Body weight gain (g)	Feed intake g/day	Food efficiency ratio (FER) %
AlCl3	Normal control group	138.0±7.0 a	17.9±0.58 a	0.179±0.04 a
	(+) control group	99.0± 5.3 c	16.3±0.58 c	0.163±0.01 c
	40g lemon balm /kg diet	116.6±6.9 b	17.3±0.37 b	0.172±0.00 b
	80g lemon balm /kg diet	125.0±7.6 b	17.4±0.45 b	0.173±0.01 b

Values are expressed as mean ± SD. Significance at $p<0.05$.
Values which don't share the same letter in each column are significantly different.

Effect of lemon balm on liver functions in rats received AlCl3 was illustrated in Table (2). It could be observed that, the mean values of serum AST, ALT and ALP enzymes in the positive control group increased significantly as compared to the healthy control group. Addition of lemon balm to the diet (all tested levels) showed a significant decrease in mean value of serum AST, ALT and ALP enzymes activity than the positive control group especially, the high level 8% for AST and ALP.

Table (2): Effect of lemon balm on liver functions in rats received AlCl3.

Parameters / Groups		AST Activity (Iu/l)	ALT Activity (Iu/l)	ALP Activity (Iu/l)
AlCl3	Normal control group	50.33±1.53c	38.67±1.15c	198.21±8.00c
	(+) control group	82.33±3.05a	60.66±3.21a	272.13±13.10a
	40g lemon balm /kg diet	61.67±3.78b	44.67±3.05b	220.14±11.06b
	80g lemon balm /kg diet	51.01±1.00c	45.66±2.08b	201.21±9.17c

Values are expressed as mean ± SD. Significance at $p<0.05$.
Values which don't share the same letter in each column are significantly different

Effect of lemon balm on kidney functions in rats received AlCl3 was illustrated in Table (3). Data revealed that, injected rats with AlCl3 led to significant increase in serum creatinine, urea and uric acid as compared to (non-injected) normal group of rats. Treating AlCl3 groups with any level from lemon balm resulted in significant decrease in all mean values of kidney functions.

Table (3): Effect of lemon balm on kidney functions in rats received AlCl3.

Parameters / Groups		Creatinine mg/dl	Urea mg/dl	Uric acid mg/dl
AlCl3	Normal control group	1.03±0.06 b	49.01±1.02 c	3.01±0.12 b
	(+) control group	1.47±0.2 a	65.33±2.52 a	4.78±0.18 a
	40g lemon balm /kg diet	1.13±0.06 b	54.33±3.05b	3.26±0.26 b
	80g lemon balm /kg diet	1.07±0.06 b	50.67±3.06 bc	3.20±0.18 b

Values are expressed as mean ± SD. Significance at $p<0.05$.
Values which don't share the same letter in each column are significantly different.

Effect of lemon balm on lipid profile in rats received AlCl3 are presented in Table (4). Total serum cholesterol, triglycerides, LDL-c and VLDL-c increased significantly in the positive control group (group received AlCl3) as compared to healthy group. All groups of rats which treated with the two levels of lemon balm had a significant decrease in the mean values of serum total cholesterol, triglycerides, LDL-c and VLDL-c

comparing to the AlCl3 positive control group especially at high level (8%) that revealed a marked improvement of these parameters. The mean value of HDL-c decreased significantly in (+ve) control group compared to (-ve) control group. Whereas, the treated groups of rats with lemon balm showed significant higher mean values of HDL-c than that of the (+ve) control group especially at high level (8%). The best results for all lipoproteins were noticed in the groups of rats fed on diet containing high level (8%) lemon balm as compared to 4% low level treated group.

Table (4): Effect of lemon balm on lipid profile in rats received AlCl3 .

Parameters / Groups		TC mg/dl	TG mg/dl	LDL-c mg/dl	VLDL-c mg/dl	HDL-c mg/dl
AlCl3	Normal control group	103.00±12.10d	148.00±11.00d	48.67±3.51b	29.60±1.20d	44.12±1.73 a
	(+) control group	140.67±13.79a	245.01±13.61a	71.33±2.08a	49.01±1.72a	28.67±1.21d
	40g lemon balm /kg diet	115.67±11.53b	213.67±14.04b	34.00±2.00c	42.73±1.81b	32.02±1.11c
	80g lemon balm /kg diet	109.33±12.08c	161.33±11.53c	35.67±2.31c	32.27±1.31c	39.69±1.53b

Values are expressed as mean ± SD. Significance at $p<0.05$.
Values which don't share the same letter in each column are significantly different.

Effect of lemon balm on antioxidant parameters and acetyl cholinesterase in rats received AlCl3 were illustrated in table (5). It could be observed that the mean value of serum malondialdehyde and acetyl cholinesterase in +ve control untreated group was significantly higher than in healthy control group. All levels of lemon balm were able to reduce serum MDA and acetyl cholinesterase significantly compared with untreated group especially at high level 8%.

In general, the best result of MDA and acetyl cholinesterase activity was noticed in group treated with the high mixture (80g lemon balm/kg diet) as its mean value was the nearest from that recorded by the healthy control group. Followed, group of (40g lemon balm /kg diet). Regarding the mean values of serum total antioxidant and superoxide dismutase in +ve control group received AlCl3 were significantly lower than in healthy control group. In general, the best result was noticed also in group treated with the high level 8% lemon balm.

Results of the histopathological examination of liver, kidneys and brain of rats from different experimental groups were illustrated in histopathological images. The obtained biochemical results are confirmed by the histopathological examination. The best results of liver, kidneys and brain were noticed also in groups treated with the higher level (80g/kg diet) of lemon balm followed (40g lemon balm /kg diet) group.

Table (5): Effect of lemon balm on antioxidant parameters and Acetyl cholinesterase in rats received AlCl3

parameters / Groups		Acetyl cholinesterase (AchE) U/L	Malondialdehyde (MDA) mmol/L	Total antioxidants mmol/L	Superoxide dismutase (SOD) U/mL
AlCl3	Normal control group	119.73±1.61 d	3.67±0.33 c	2.35±0.22 a	179.70±9.95 a
	(+) control group	321.70±10.75 a	10.49±1.09 a	1.37±0.15 c	119.00±7.00 d
	40g lemon balm /kg diet	163.00±4.58 b	4.90±0.26 b	1.77±0.15 b	146.37±8.55 c
	80g lemon balm /kg diet	148.83±3.75 c	3.83±0.21 bc	1.94±0.06 b	154.73±9.07 b

Values are expressed as mean ± SD. Significance at $p<0.05$.
Values which don't share the same letter in each column are significantly different.

Results of the histopathological examination of liver, kidneys and brain of rats from different experimental groups were illustrated in histopathological images. The obtained biochemical results are confirmed by the histopathological examination. The best results of liver, kidneys and brain were noticed also in group treated with the higher level (80g/kg diet) of lemon balm followed (40g/kg diet) group.

Histopathological of the liver

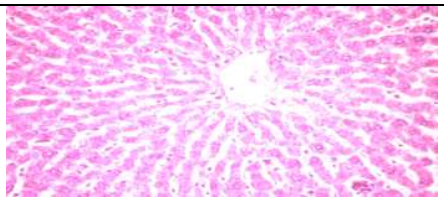

Fig. 1: Liver of rat from healthy group showing the normal histological structure of hepatic lobulle (H and E X400)

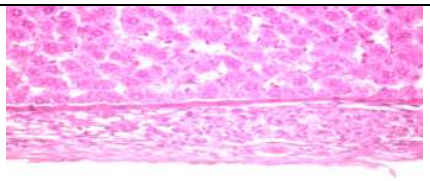

Fig. 2: Liver of rat from AlCl3 control group showing chronic inflammation of hepatic capsul (H and E X400)

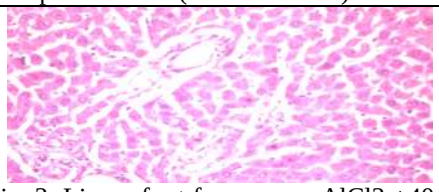

Fig. 3: Liver of rat from group AlCl3 +40g. lemon balm/kg diet showing cytoplasmic vacuolization of hepatocytes and presence of few leucocytes in the hepatic sinusoids (H and E X400)

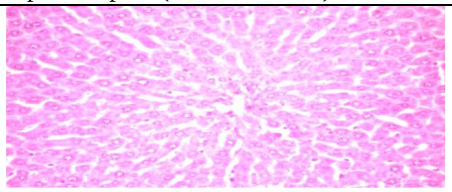

Fig. 4 : Liver of rat from group AlCl3 +80g. lemon balm /kg diet showing no histological changes (H and E X400)

Histopathological of the kidneys

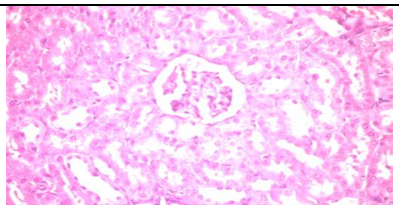

Fig. 1: Kidney of rat from healthy group showing the normal histological structure (H and E X400)

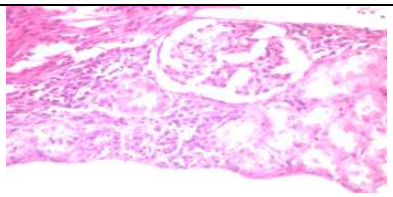

Fig.2 : Kidney of rat from AlCl3 control group showing interstitial nephritis (H and E X400)

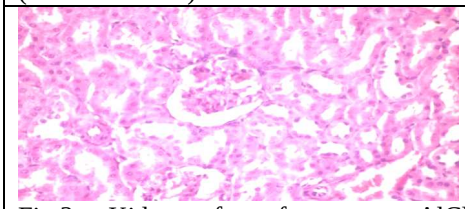

Fig.3 : Kidney of rat from group AlCl3 +40g. lemon balm /kg diet showing no histopathological changes (H and E X400)

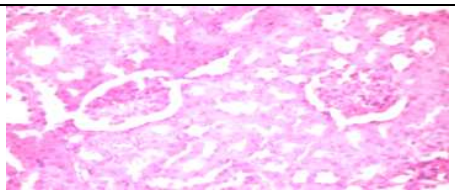

Fig.4 : Kidney of rat from group AlCl3 +80g. lemon balm /kg diet showing no histopathological changes (H and E X400)

Histopathological of the brain

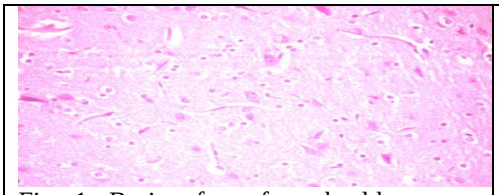

Fig. 1: Brain of rat from healthy group showing no histopathological changes (H and E X400)

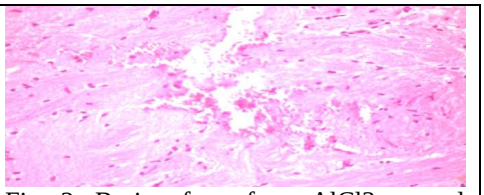

Fig. 2: Brain of rat from AlCl3 control group showing focal cerebral haemorrhage (H and E X400)

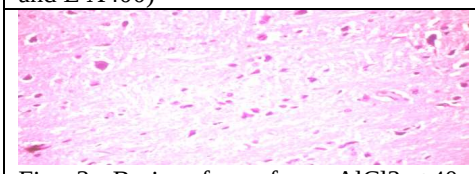

Fig. 3: Brain of rat from AlCl3 +40g. lemon balm /kg diet group showing necrosis of neurons and neuronophagia (H and E X400)

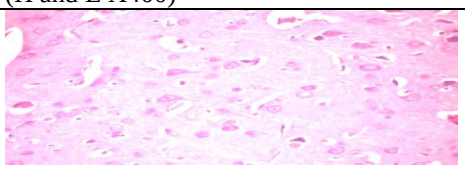

Fig.4:Brain of rat from group AlCl3 +80g. Ginseng /kg diet showing no histopathological changes (H and E X400)

DISCUSSION

Treatment with AlCl3 recorded a significant decrease in body weight gain, feed intake, and food efficiency ratio % of +ve group compared with healthy control group. In this respect Domingo, (1987) found a significant decrease in body weight gain associated with a decrease in food consumption at 260 mg of aluminium per kg of body weight per day.

Al accumulates in all tissues of the mammals, including kidney, liver, heart, blood, bone and brain (Al-Kahtani, 2010). Accumulation of Al in liver produces hepatic injury at higher concentrations (Shati and Alamri, 2010). Al ions alter properties and structure of cellular membranes, inhibit many enzymes like alkaline phosphatase, and adenyl cyclase (Qitu et al., 2002). Kidney plays a major role in preventing accumulation of Al by excreting it out through urine (Stoehr et al., 2006). Accumulation of Al induces free radicals and oxidative stress. Al is one of the most studied neurotoxicant affecting nervous system, including various regions of brain (Nehru and Bhalla, 2006). Some experts believe that Al plays a role in the formation of Alzheimer like neurofibrillary tangles (Sharma et al., 2009). Antagonistic interactions between Al ions and other elements such as: calcium, magnesium, iron, silicon, phosphorus, copper, and zinc were observed in biological systems (Ward et al., 2001).

It could be observed that, the mean values of serum AST, ALT and ALP enzymes in the positive control group increased significantly as compared to the healthy control group. In this respect, Molecular changes such as DNA damages and gene suppression or expression may happen to hepatic cells when the model animal exposed to toxic materials (Burham, 2006). Aluminum has been reported to affect the activities of translation machinery components in mouse liver in vivo and in vitro as Al can bind to phosphorylated bases on DNA, induce considerable changes in chromatin structure and disrupt protein synthesis, and catabolism (El-Demerdash, 2004 and Vieželienė et al., 2006).

Addition of lemon balm to the diet (all tested levels) showed a significant decrease in mean value of serum AST, ALT and ALP enzymes activity than the positive control group especially, at the high level 8% for AST and ALP. In support of the present findings, Administration of Melissa officinalis L. extract reduced total cholesterol, total lipid, ALT, AST and ALP levels in serum and LPO levels in liver tissue, moreover increased glutathione levels in the tissue (Bolkent et al., 2005). In this respect, Molecular changes such as DNA damages and gene suppression or expression may happen to hepatic cells when the model animal exposed to toxic materials (Burham, 2006). Aluminum has been reported to affect the activities of translation machinery components in mouse liver in vivo and in vitro as Al can bind to phosphorylated bases on DNA, induce considerable changes in chromatin structure and disrupt protein synthesis, and catabolism (El-Demerdash, 2004 and Vieželienė et al., 2006).

Injected rats with AlCl3 led to significant increase in serum creatinine, urea and uric acid as compared to (non-injected) normal group of rats. Treating AlCl3 groups with any level from lemon balm resulted in significant decrease in all mean values of kidney functions. These results were agreement with Birdane et al., (2007) who showed that, antioxidative properties and radical scavenging activity may be the possible mechanisms. Phytochemical studies carried out with M. officinalis have demonstrated the numerous constituents, polyphenolic compounds (rosmarinic acid, caffeic acid and protocatechuic acid), essencial oils (citral), monotherpenoid aldehides, sesquiterpenes, flavonoids (luteolin) and tannins (Carnat et al., 1998 and Guginski et al., 2009). Pharmacological investigation concerning its essential oil has revealed that, besides this being an efficient antibacterial and antifungal agent (Mimica-Dukic et al., 2004), it is also endowed with

intrinsic anxiolytic properties (Pereira et al., 2005). The antioxidant and antitumoral properties are implied from a literature that is mainly addressed to core components, other than extracts or infusions per se (Souza et al., 2004; Pereira et al., 2009 and Carvalho et al., 2011). Natália Cassettari de Carvalho1, Maria Júlia Frydberg Corrêa-Angeloni1, Daniela Dimer Leffa1

Use of Lemon balm infusion in Al groups caused a significant increase in serum antioxidants and a significant reduction in hepatic and lipid markers. This results in agreement with Randell et al., (2005) who noticed that, exposure to Al can affect the triglyceride metabolism and triglyceride concentrations in the body. In this regarding, Aluminum has been found to cause oxidative stress in the plasma and the tissues of male rabbits. The mechanism of Al induced toxicity has been attributed to its ability to potentiate the activity of iron Fe^{2+} and Fe^{3+} ions in such a way as to cause oxidative damage (Newairy et al., 2009 and Burham, 2006). In the body, non-enzymatic anti-oxidation including GST and enzymatic anti-oxidation including GPx, CAT, and SOD occur to protect cell membranes and intracellular materials from reactive oxygen species, including free radicals. SOD is a very important enzyme in the body produced in the early stage of free radical generation, converting superoxide into O_2 and H_2O_2. GPx and CAT eliminate the H_2O_2 produced during the enzymatic reaction by SOD to protect the body from peroxidative damage.

Acetylcholine (ACh) is an important neurotransmitter that plays a critical role in memory and learning processes. In central cholinergic systems, ACh is synthesized from choline and acetyl-CoA by choline acetyltransferase (ChAT) (Ohno et al., 2001). After being delivered in the synapses, ACh is hydrolyzed, resulting in choline and an acetyl group in a reaction catalyzed by the enzyme cholinesterase (ChE) (Ballard et al., 2005). ChE is distinguished primarily by its substrate specificity. Acetylcholineserase (AChE) hydrolyzes ACh more efficiently than other choline esters, while butyrylcholinesterase (BuChE) hydrolyzes mainly butyrylcholine (BCh) among other types of ACh. Therefore, the effectiveness of ginseng extracts against memory loss may result from the cholinergic activity of these extract via reduction of the degradation rate of ACh by inhibition of the ChE activity (for both types of ChE) (Mi et al., 2011).

Many in vitro and ex vivo studies have shown antioxidant activity of Melissa officinalis extracts but in vivo studies especially in

human are rare. In vivo studies just showed that Melissa officinalis L. extract could decrease LPO in rodents (Birdane et al., 2007) and in liver tissue of hyperlipidemic rats (Bolkent et al., 2005) and in radiology staff (Zeraatpishe et al., 2011). Melissa officinalis L. extract has been useful as rich source of antioxidants (Dastmalchi et al., 2008). The main phenolic compounds which were identified in tea infusion from Lemon balm were rosmarinic acid, luteolin 7-O-glucoside, quercetin 3-rutinoside, gallic acid, quercetin 3-O galactoside and ferulic acid. Lemon balm contains a rich source of natural antioxidants and effective in many oxidant-related disorders (Hasani-Ranjbar et al., 2009). A recent study indicated that Lemon balm is beneficial in protection against oxidative stress and DNA damage in subjects exposed to long-term low-dose ionizing radiation (Zeraatpishe et al., 2011). Hence, it seems that Lemon balm, due to its antioxidant components and scavenging properties could increase the activity of antioxidant defense and decrease oxidative stress and triglyceride, cholesterol and AST in Al toxicity. CONCLUSION: It could be concluded that, addition lemon balm to the diet are effective in protect the body from the oxidative stress induced by aluminum chloride.

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تأثير الميليسا علي الإجهاد التأكسدي والمؤشرات الحيوية للفئران المسممة بالألومونيوم

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الملخص العربي

الهدف الرئيسي هو دراسة تأثير بلسم الليمون (الميليسا المخزنية) على بعض المؤشرات الغذائية وإنزيمات الكبد، وظائف الكلى، صورة الدهون، ونشاط الأسيتيل كولين و مضادات الأكسدة لسمية الألمونيوم المستحثة في الفئران. وقد أجريت التجربة باستخدام اثنين وثلاثين فأرا من ذكور الألبينو. وتم تقسيم الفئران عشوائيا إلى مجموعتين رئيسيتين، تغذت المجموعة الرئيسية الأولى على الغذاء الأساسي فقط (كمجموعة ضابطة سالبة) بينما المجموعة الرئيسية الثانية تم حقنها بكلوريد الألمونيوم ($AlCl_3$) لاستحداث سمية الألمونيوم و تم تقسيم المجموعة الثانية إلى ٣ مجموعات فرعية (كل ٨ الفئران) على النحو التالي : المجموعة الفرعية الأولي مجموعة ضابطة موجبة تم تغذيتها علي الغذاء الأساسي (١). و المجموعات الأخرى تم تغذيتها على غذاء أساسي يحتوي على ٤٪ و ٨٪ من بلسم الليمون، على التوالي كمجموعات فرعية (٢ و ٣).

في نهاية فترة التجربة (٨ أسابيع)، أشارت النتائج إلى أن الفئران المحقونة بكلوريد الألمونيوم زادت لديها المؤشرات الحيوية بشكل ملحوظ ، باستثناء الغذاء المتناول و نسبة الاستفادة منه و معدل الزيادة في الوزن و الليبوبروتينات عالية الكثافة بينما أظهر نشاط المواد المضادة للأكسدة انخفاضا كبيرا مقارنة مع المجموعة الضابطة السالبة .كما أظهرت نتائج فحص الأنسجة التضرر المرضي فيها. في العكس من ذلك، كشفت تغذية الفئران على وجبات تحتوي على بلسم الليمون وخصوصا على مستوى عال منه (٨٪) تحسنا ملحوظا في هذه المؤشرات والفحوصات النسيجية المرضية بالمقارنة مع مجموعة المراقبة لقد حقنت بكلوريد الألمونيوم. و توصي الدراسة باستهلاك بلسم الليمون لتحسين أعراض سمية الألمونيوم ومنع مضاعفاته.

الكلمات المفتاحية:

الميليسا – كلوريد الألومونيوم - الأسيتيل كولين - مضادات الأكسدة.

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