INTERNATIONAL JOURNAL OF ADVANCES IN PHARMACY, BIOLOGY AND CHEMISTRY

Research Article

Ameliorative role of *Mentha arvensis* against the Aluminum induced Oxidative Stress in Albino mice

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ABSTRACT

Aluminum (Al) is a well reported environmental toxicant, its accumulation in tissues leading to significant oxidative damage involved in the etiology of various disorders like neuro, hepato and nephrotoxicity. Now a days herbal medicine offers a great remarkable remedies gained more attention on metal induced toxicity. In the present study therapeutic potential of *Mentha arvensis* against aluminum induced oxidative stress was determined. Al administration resulted in significant increase and deleterious effects in lipid peroxidation (LPO) levels and decrease in the levels of superoxide dismutase (SOD) and catalase (CAT) antioxidant enzymes in brain, liver and kidney tissues indicates its high accumulation and inflicting toxic effect in tissue damage. Whereas the *Mentha arvensis* ethanolic extract administered group showed almost similar results as in control. The simultaneous administration of *Mentha arvensis* with Al expressed decreased LPO levels and increased SOD, CAT levels compared to Al treated group, which explores its protective role against Al toxicity. Thus, supplementation of *Mentha arvensis* along with Al alleviated potential therapeutic effect over oxidative stress induced neuro, hepato and nephrodamage in albino mice.

Keywords: Aluminum, lipid peroxidation, superoxide dismutase, catalase and *mentha arvensis*

INTRODUCTION

Aluminum (Al) is most abundant element in the biosphere, it is not known to have any biological role but is toxic under special circumstances. Aluminium has gained wide industrial and commercial importance because of its physical and chemical properties. However it can be regarded as harmful element for humans and it has been associated with several human diseases, such as dialysis encephalopathy[1], amyotrophic lateral sclerosis and Parkinsonism dementia complex of Kii peninsula and Guam [2,3] renal osteodystrophy[4], anaemia (microcytic, hypochromic)[5], Alzheimer's disease[6,7], breast cancer[8] and autoimmune (auto-inflammatory) syndrome induced by vaccination[9]. Chronic exposure to Al generates free radicals/reactive oxygen species (ROS) which are responsible for neurotoxicity[10]. Aluminum induced ROS can diminish the activities of primary anti oxidative enzymes and trigger membrane peroxidation[11, 12]. It causes adverse effects on various organs including the brain, liver, kidney and heart. Aluminum may involve membrane-related effects, oxidative stress resulting from increased production of reactive oxygen species (ROS), increases lipid peroxidation and alterations in membrane fluidity, which is responsible for initiating the process of apoptosis [13, 14].

In recent years research in natural antioxidants of plant origin has been enormously enhanced. *Menthaarvensis (M. arvensis)* belonging to the family of Lamiaceae, commonly known as pudina or corn mint or wild mint in Bangladesh and India. It is native to the central Asia, temperate regions of Europe and East to the Himalaya and eastern Siberia, and America. It is a perennial, moderate sized herb growing to 10–60 cm (rarely to 100 cm) tall. The

leaves are in opposite pairs, simple, 2–6.5 cm long and 1–2 cm broad and hairy. In traditional system of medicine it is extensively used for various ailments like carminative, antispasmodic, anti-peptic ulcer agent, and has been given to treat indigestion, skin diseases, coughs and colds and also used for the treatment of liver and spleen disease, jaundice and asthma [15]. The leaves of the plant are used to treat rheumatism, indigestion, vomiting in pregnancy, infantile troubles, hysteria and as remedy for inflamed joints[16] .

In folk medicine *M. arvensis* is reported to be a good antioxidant but, as per the author's knowledge, it has not been used in biological works against aluminum toxicity. Hence the present experimental study was carried out to determine the efficiency of *M. arvensis* in antagonizing the toxic effects of aluminum on liver, brain and kidney of male albino rats.

MATERIALS AND METHODS

Aluminum acetate and Epinephrine were purchased from the Sigma Chemical Company, Other chemicals were obtained from Merck and Qualigen Companies.

M. ARVENSIS EXTRACT PREPARATION

The *M. arvensis* leaves were obtained from Tirupati local market. The leaves were thoroughly washed with tap water and then with double distilled water and dried in shade, in dust free condition for one week at room temperature before being ground to a fine powder. Finally powdered plant material (50g) was extracted with ethanol (500 ml). The mixture solution was left on constant magnetic stirring at room temperature for 24hrs. The extract was filtered and it was lyophilized.

TREATMENT

Twenty four albino mice of 4 months age, weighing 25-30 g were used for this study. Animals, obtained from the Sri Venkateswara Traders, Banglore, were housed in polypropylene cages under hygienic conditions. They were fed standard pellet diet (Hindustan Lever Limited, India). Mice were kept on a 12-h light: 12-h dark cycle and checked for health status frequently.

EXPERIMENTAL DESIGN

Animals were equally randomized to four groups of 6 animals each.

GROUP I- Control: administered with (0.9%) saline solution only;

GROUP II-Aluminum acetate (Al) treated mice: Aluminum acetate dissolved in (0.9%) saline solution, was administered intraperitoneally (i.p) at a dose of 5 mg/kg b.w. for 15 days

GROUP III: *M. arvensis* administered mice: *M. arvensis* was administered intraperetoneally at a dose of 10 mg/kg b.w. for 15 days

GROUP IV- Al + *M. arvensis* treated group: *M. arvensis* administered simultaneously with Al by i.p injection.

PREPARATION OF TISSUES HOMOGENATES

After experimental period, each group consisting of six mice was sacrificed by cervical dislocation and the tissues such as brain, liver and kidney were isolated in ice cold medium. Tissues were then processed and homogenates (10% w/v) were prepared in 10Mm sodium phosphate buffer using electric motor with Teflon glass and pestle. All procedures were carried out in cold conditions.

BIOCHEMICAL ASSAYS DETERMINATION OF THIOBARBITURIC ACID-REACTIVE SUBSTANCES (TBA-RS)

TBA-RS, an index of lipid peroxidation, was estimated[17]. The amount of TBA-RS was determined spectro photometrically at 532nm. TBA-RS values were expressed as µ moles of TBA-RS per mg protein.

MEASUREMENT OF ANTIOXIDANT ENZYME ACTIVITIES SUPEROXIDASE DISMUTASE ACTIVITY (SOD)

Aliquots of cytosolic fraction were used for biochemical studies. SOD activity was measured as the inhibition of photoreduction of nitro blue tetrazolium (NBT) by the enzyme[18]. Results expressed as unit of SOD/min/mg protein.

CATALASE ACTIVITY (CAT)

CAT was assayed spectrophotometrically[19]. The decrease in absorbance was then observed for 60 s at every 15 s interval at 240nm. Catalase activity is expressed as µ mol H2O2 decomposed/min/g tissue.

PROTEIN ESTIMATION

Protein content was estimated[20]. Bovine serum albumin was used as standard, and the colour developed was read at 660nm.The enzyme activity was expressed as units of enzyme activity/ mg of protein.

STATISTICAL ANALYSIS

The data were statistically analyzed using one way analysis of variance (ANOVA) followed by turkey's post-test using SPSS (Student Version 16.0, SPSS Inc, Chertsey, UK). The data were presented as mean ± S.D. Differences were considered to be significant at $p < 0.001$.

RESULTS AND DISCUSSION

The increasing demand in herbal medicine has stimulated the improvement in analysis and quality control of their herbal materials and products. *M. arvensis* is commonly called as mint. It has topical use, it relives tension, headaches and it is equivalent to acetaminophane[21] *M. arvensis* phytoconstituents are responsible for showing antioxidant property and anti-inflammatory[15]. Protective effects of *M. arvensis* on aluminium induced oxidative stress modifications in mice were evaluated. In current study TBA-RS levels were enhanced and antioxidant enzymes such as SOD and CAT were decreased significantly ($P<0.005$) in aluminum treated mice compared to control (Fig: 1).Whereas simultaneous administration of aluminum with *M. arvensis* caused significant ($P<0.005$) reduction in TBA-RS levels and increased levels of SOD and CAT compared to aluminum treated mice (Fig: 2&3). According to a toxicokinetic study of aluminum, Al can cause adverse effects on brain, liver and kidney[22]. The results are agreement with previous study indicated that aluminum lead to damage brain, liver and kidney[23]. Oxidative stress is a biochemical process that results in the formation of Reactive oxygen species (ROS), diseases are mainly linked to oxidative stress[24]. It attacks numerous molecules such as proteins and lipids[25]. However, levels of TBA-RS were more pronounced in brain than kidney and liver due to aluminum exposure. It is known that brain is highly susceptible organ for aluminum induced oxidative stress because of its high oxygen consumption and excessive reactive oxygen species[26]. Significant increase in lipid peroxidation and decrease in antioxidant enzymes due to aluminium exposure have been evidenced in many studies [12, 22, 25]. In the present study, *M. arvensis* administered group showed almost similar results as in control, Simultaneous administration of *M. arvensis* with aluminum caused significant reduction in TBA-RS levels (39.07% in brain, 18.04% in liver and 29.95% in kidney) and enhancement of antioxidant enzymes SOD (42.58% in brain, 27.55% in liver and 57.06% in kidney) and CAT (86.86% in brain, 41.47% in liver and 43.5% in kidney) compared to aluminum alone treated mice. The anti-oxidant activity of *M. arvensis* could be possibly due to the direct scavenging of the superoxide radicals by the polyphenols or the flavanoids which are known as phytochemical constituents[27]. *M. arvensis* was found to be effective in decreasing the oxidative stress in the aluminum treated animals. As per the author's knowledge the present study is the first report to demonstrate that the *M. arvensis* antagonizes the toxic effects caused by aluminum. To find out the mechanism further investigations are needed.

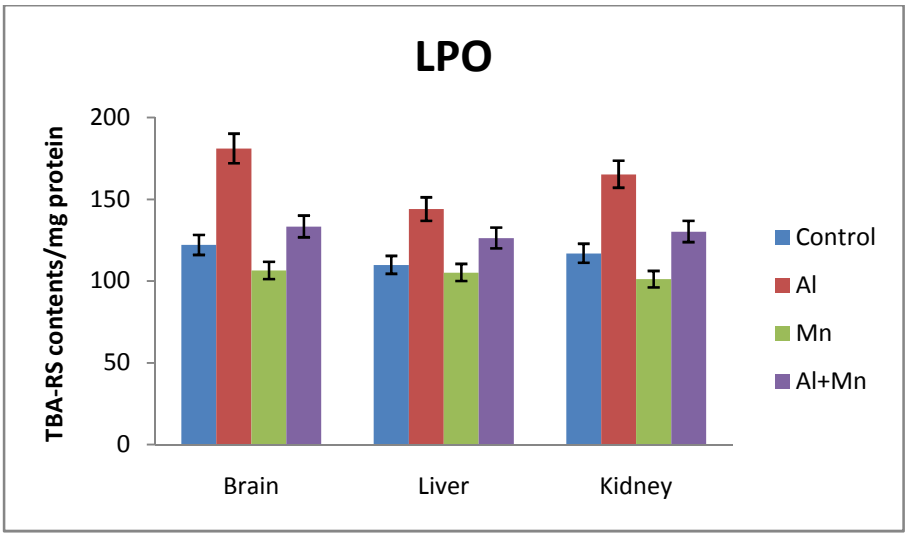

Fig 1

Thiobarbituric acid reactive substances: Data expressed as mean ± S.D of six mice in each group. Al: aluminum, *M. arvensis*. Groups-I: Control mice; Al: mice treated with Al; *M. arvensis*: mice treated with *M. arvensis*; Al+ *M. arvensis*: mice treated with Al+ *M. arvensis* statistically different from control and *M. arvensis* values ($p<0.01$). Statistically different as compared with Al + *M. arvensis* values ($p<0.01$).

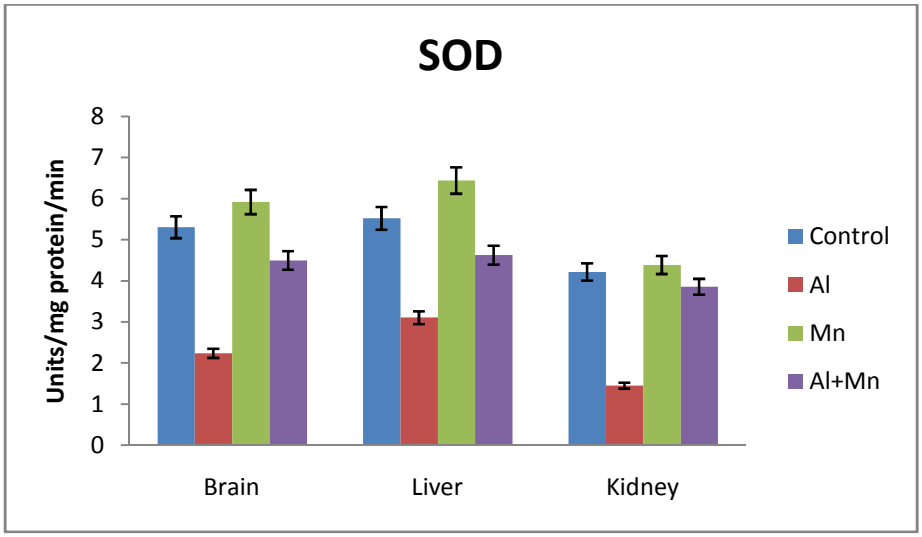

Fig 2

Superoxidase dismutase activity: Data expressed as mean S.D of six mice in each group. Al: aluminum, *M. arvensis*: *M. arvensis.* Groups-I: Control mice; Al: mice treated with Al *M. arvensis*;: mice treated with *M. arvensis*; Al+ *M. arvensis*: mice treated with Al+ *M. arvensis* statically different from control and *M. arvensis* values ($p<0.01$).Statistically different as compared with Al+ *M. arvensis* values ($p<0.01$).

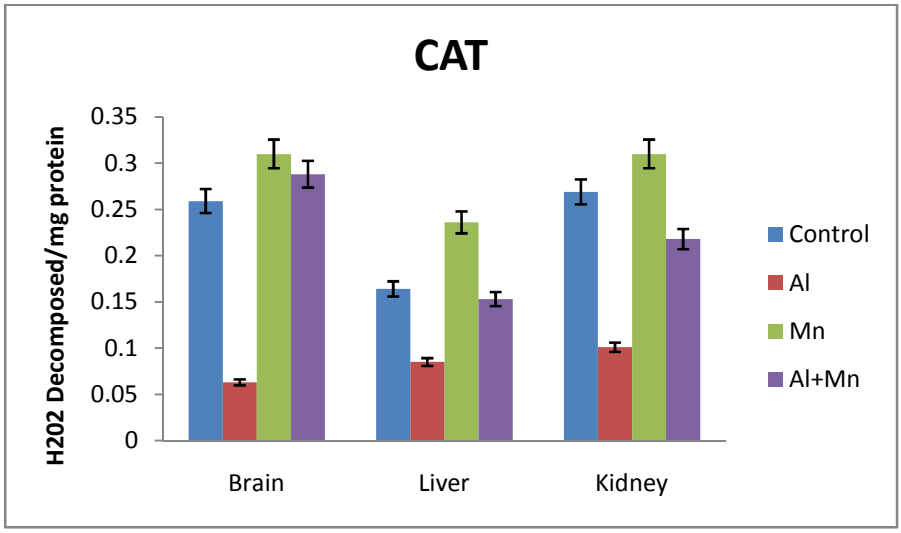

Fig 3

Catalase: Data expressed as mean S.D of six mice in each group. Al: aluminum, *M. arvensis*. Groups-I: Control mice; Al: mice treated with Al; *M. arvensis:* mice treated with *M. arvensis*; Al+ *M. arvensis*: mice treated with Al+ *M. arvensis* statistically different from control and *M. arvensis* values ($p<0.01$). Statistically different as compared with Al+ *M. arvensis* values ($p<0.01$).

CONCLUSION

In the present study aluminum administration induced oxidative damage by increase in LPO levels and decrease in SOD and CAT levels in brain, liver and kidney tissues of albino mice. *M. arvensis* administered group showed almost similar results as in control, Simultaneous administration of *M. arvensis* with aluminum caused significant reduction in TBA-RS levels and enhancement of antioxidant enzymes SOD and CAT compared to aluminum treated mice. Hence this gives adirect evidence on effective antioxidant role of *M. arvensis* against aluminum induced oxidative damage without causing any toxic effect and for the first time establishes the ameliorative role of *M. arvensis* in order to minimize the adverse effects caused by aluminium.

ACKNOWLEDGEMENTS

The corresponding author Dr. N. John Sushma is highly grateful to DST-SERB for providing Major Research Project (SB/EMEQ-341/2013 dated: 17/10/2013). One of the authors P. Anusha is highly thankful to Department of Biotechnology (DBT) New Delhi for providing financial assistance in the form of "In house Projects".

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