ORIGINAL ARTICLE

Loranthus longiflorus protect central nervous system against oxidative damages of electromagnetic radiation on rat

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Background: The interaction of mobile phone radio-frequency electromagnetic radiation (RF-EMR) with the brain is a serious concern of our society. In this study, we aimed to experiment on the anti-oxidative property of a parasitic plant *Loranthus longiflorus* (Loranthaceae) to protect central nervous system against oxidative damages of mobile phone electromagnetic field (EMF). **Materials and Methods:** Healthy male albino wistar rats were exposed to RF-EMR by giving 5 min calling/5 min interval for 1 hour per day for 2 months, keeping a GSM (0.9/1.8 GHz) mobile phone in silent mode (no ring tone) in the cage. After 15, 30, 45, 60 days exposure, three randomly picked animals from each group were tested with using behavioural model of CNS on rats. **Results and Conclusion:** *Loranthus longiflorus* bark extract could be effective in decreasing immobility ($P < 0.05$) and increased locomotor activity ($P < 0.05$). This result indicates the protective effect of *Loranthus longiflorus* bark against EMF induced oxidative damage of central nervous system.

Key words: Depression, electromagnetic radiation, locomotor, *Loranthus longiflorus* bark, mobile phone

INTRODUCTION

As recent increase in the use of electromagnetic field (EMF) producing equipments, such as mobile phones, both epidemiological and experimental studies have been motivated. Indisputable reports from harmful effects of these microwaves have been associated with growing concern and some alarms in our today society. In the year 1990, 12.4 million people worldwide had cellular subscriptions. By the end of 2009, only 20 years later, the number of mobile cellular subscriptions worldwide reached approximately 4.6 billion, 370 times the 1990 number, penetrating the developing economies and reaching the bottom of the economic pyramid. The interaction of mobile phone radio-frequency electromagnetic radiation (RF-EMR) with the brain is a serious concern of our society. Mobile telephones emit radiations that are intercepted in the proximity of the brain and cranial nerves. There is now an added worry if these radiations are carcinogenic or tumour promoter or have any other health implications.[1] The use of mobile phones is increasing day by day, and it is estimated that approximately 500 million people worldwide are using mobile phones currently. A large proportion of users are made up of children and teenagers. Mobile phone has negative effects on sperm motility,[2] anti-oxidant enzymes[3] and sperm concentration.[4] Exposure to EMF at even low frequencies (900-1800 Hz) causes some established pathologic consequences such as increased permeability of the blood–brain barrier, disturbed neurons function and alteration in electroencephalography (EEG) disturbed regional cerebral blood flow, oxidant and anti-oxidant balance, neurotransmitter imbalance and genomic responses.[5,6] *Penafiel et al*., have shown that the radiation from TDMA digital cellular phones can cause significant changes in ornithine decarboxylase activity (ODC), which is essential for DNA synthesis.[7] *Kolomytkin et al*., studied specific receptor binding of three neurotransmitters: Gamma-aminobutyric acid (GABA), an inhibitory transmitter and acetyl choline and glutamate, both excitatory to rat brain synaptosomes.[8] Experimental studies have shown that the RF-EMR emitted from the mobile phones can affect the brain in various ways. These effects have been described *in vitro* and *in vivo* in a number of studies in particular, effects on cerebral blood flow,[9] blood–brain barrier permeability,[10] oxidant and anti-oxidant balance,[11] neurotransmitter balance,[12] nerve cell damage[13] and genomic responses[14] have been reported. Anti-oxidative substances have to protect from central nervous system in front of oxidative effect of EMF. We have studied and use herbal extracts as anti-oxidative

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agents, because herbal-base medications are accompanied with lower imposed side effects and have more facing today society. *Loranthus longiflorus* (belongs to Loranthaceae family) is a perennial climbing woody parasitic plant. It is indigenous to tropical regions especially in India, Sri Lanka, Thailand, China, Australia, Bangladesh, Malaysia and Myanmar,[15] and widely distributed throughout in India.[16] It is a hemi-parasitic plant whose whole plant is used in indigenous system of medicine as a potential medicinal agent like cooling, bitter, astringent, aphrodiasic, narcotic, diuretic and useful in pulmonary tuberculosis, asthma, menstrual disorders, swelling wounds, ulcers, renal and vesical calculi and vitiated conditions of kapha and pitta.[15] Decoction of plant is used by women as an anti-fertility agent and also has anti-cancer activity.[17,18] Leaf paste is used in skin diseases, also applied on boils, setting dislocated bones and extracting pus. The plant has been scientifically proved to have anti-lithiatic, diuretic, cytotoxic and immunomodulatory activities.[19-22] *Loranthus longiflorus* also has anti-oxidative and neuroprotective effects against oxidative stress in NG108-15 cells.[23] Synonyms**:** *Loranthus amplexifolius* Desr., *Loranthus bicolor* Roxb., *Loranthus falcatus* L.f., *Loranthus longiflorus* Desr. The objective of this research was to see the effect of *Loranthus longiflorus* on central nervous system that is induced by EMF.

MATERIALS AND METHODS

Plant Material

The selected plant, *Loranthus longiflorus*, a hemi-parasite, was collected from the host tree *Ficus religiosa*, during the month of October, around Nagercoil town, Kanyakumari District, Tamil Nadu and identified based on the characters of Gamble Flora. The herbarium of the plant was prepared and authenticated by comparison with a voucher specimen in the department of Botany, S.T. Hindu College, Nagercoil, Kanyakumai, District, Tamil Nadu, and India.

Plant Extraction

The bark of *L. longiflorus* collected from host tree were washed in freshwater to remove adhering dust and then dried under shade. The air dried, powdered bark of *Loranthus* was extracted at 20% (w/v) in Soxhlet extraction successively with ethyl acetate. The successive extracts were evaporated to dryness and the stored residues were used for activities.

Phytochemical Screening

Preliminary screening reveals that the ethyl acetate extract contains phenol, steroids, tannins and flavonoids compounds.

Animals

Wistar albino rats weighing between 200 and 300g of either sex were used. All animals were housed in well ventilated polypropylene cages at 12/12 h light/dark schedule at 25 ± 2°C and 55-65 RH with free access of food (standard laboratory rodent's chow) and water. All the animal experiments were approved by IAEC of Truba Institute of Pharmacy, Bhopal (M.P.) and the Committee for the purpose of Control and Supervision of Experiments on Animals (CPCSEA). CPCSEA Approval Number: -1196/a/08/CPCSEA and Ethical Clearance Number to conduct the animal study: - PIC/IAEC/2010/PN-04.

Electromagnetic Radiation Exposure Setup

Keeping a GSM (0.9/1.8 GHz) mobile phone in silent mode (no ring tone) in the cage (36 × 23 × 21 cm). Animals were exposed to RF-EMR by giving 5 min calling/5 min interval for 1 hour per day for 2 months. Each call was of the duration of 5 min. Animals were free to move in the cage. The phone was kept in a small wood bottomed cage sized 12 × 7 × 7 cm. The wire mesh on top of the wood bottom cage prevented the animals from contact with the phone. After 15, 30, 45, 60 days exposure, three randomly picked animals from both groups were tested for using behavioural screening model of central nervous system.[24]

Experimental Design

The animals were allocated into four experimental groups. Each group consisted of six animals.

- Group I (control) – Animals treated by vehicle, orally (p.o) applicated every day
- Group II – Everyday exposed rats with mobile phone radiation
- Group III – Mobile phone radiation exposed rats treated with Extract of *Loranthus longiflorus* bark (700 mg/kg, p.o.).

Pharmacological Studies

Tail-suspension Test

A cord of about 50 cm in length was stretched between two metal tripods at a height of 70 cm, to which the rats were attached by the tail with sticky tape. Measurement was carried out for 6 min. After the initial period of vigorous motor activity, the rats became still and the immobility time was measured with a stopwatch, for a total duration of last 4 min. Rats were considered immobile when they hung passively and completely motionless.[25]

Forced-swimming Test

Measurement of immobility time was carried out by observing the motoric activity of the rats, which were placed in a pool of water. A glass cylinder, 25 cm in diameter and height of 23 cm, was filled with water to a height of 12 cm. The temperature of water was 23 ± 1°C. Measurement was carried out for 6 min. The first 2 min the animal was allowed to adjust to the new conditions, after these 2 min, the immobility time that alternated with conditions of enhanced motor activity was measured. Immobility time was measured with a stopwatch for the next 4 min. Each

time animals were removed from the water, dried with a soft towel and placed in separate cage. Immobility time is the time during which the animal floated on the surface with front paws together and made only those movements which were necessary to keep afloat.[26]

Actophotometer

The locomotors activity was studied using actophotometer. The movement of the animal interrupts the beam of light falling on a photocell at which the count was recorded and displayed digitally. Each rat was placed individually in the actophotometer for 10 min and the basal activity was obtained. The rats were observed in a square open field arena (68 × 68 × 45 cm) equipped with two rows of eight photocells, sensitive to infrared light, placed 40 and 125 mm above the floor, respectively. The photocells were spaced 90 mm apart and the last photocell in a row was spaced 25 mm from the wall. Measurements were made in the dark in a ventilated, sound-attenuating box.[27]

Statistical Analysis

All the data were given as means ± S.E.M (n = 10). Data were analysed by one-way analysis of variance (ANOVA). Whenever ANOVA was significant, further comparisons between vehicle- and drug-treatment groups were performed using the Dunnett's test. The level of statistical significance adopted was $P < 0.05$.

RESULTS AND DISCUSSION

Our experimental results revealed that EMF exposure affected behavioural model of depression like forced swim test, tail suspension test and locomotor activity. It significantly increases immobility and decreases the locomotor activity in comparison with control group ($P < 0.05$). *Loranthus longiflorus* (EAL) bark extract feeding was not significantly effective to be protective in front of radiation after 15 days evaluation. After 45 and 60 days *Loranthus longiflorus* bark extract could be effective in decreasing immobility ($P < 0.05$) and increased locomotor activity ($P < 0.05$). This result indicates the protective effect of *Loranthus longiflorus* bark against EMF induced oxidative damage of central nervous system and are showed in Figures 1-3.

Plants and natural products are extensively used in several traditional systems of medicine, so screening of these products for radio-protective compounds has several advantages, because they are usually considered non-toxic and widely accepted by humans. Many natural anti-oxidants consumed before or after radiation exposure indicated some level of radio-protection. The RF-EMR emitted from the mobile phones can affect the brain in various ways. A previous study showed that EMF

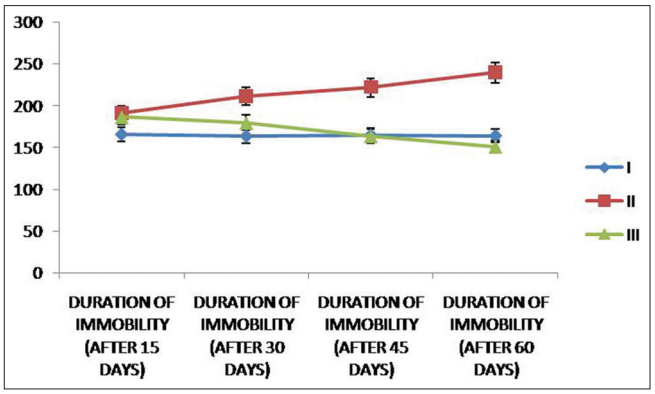

Figure 1: Effect of 700 mg/kg body weight Loranthus longiflorus bark extract and Mobile phone Electromagnetic radiation on forced swimming test

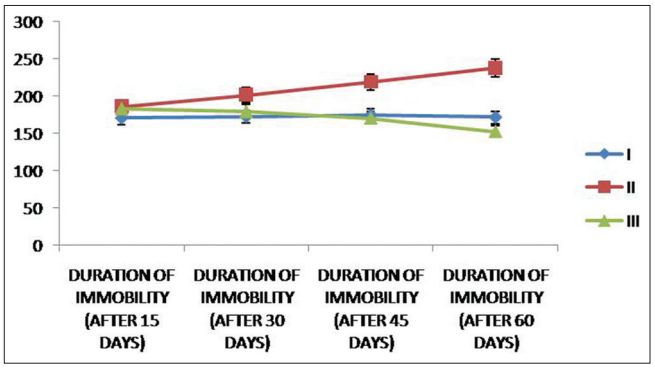

Figure 2: Effect of 700 mg/kg body weight Loranthus longiflorus bark extract and Mobile phone Electromagnetic radiation on Tail suspension test

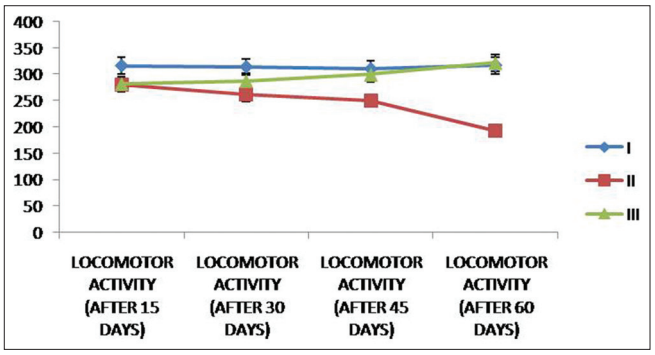

Figure 3: Effect of 700 mg/kg body weight Loranthus longiflorus bark extract and Mobile phone Electromagnetic radiation on locomotor activity

exposure immediately altered the metabolism of free radicals, decreased SOD activity in plasma.[28] EMF is able to generate destructive reactive oxygen species (ROS) including superoxide, hydrogen peroxide and hydroxyl radical and frequently used to produce oxidative and narcotic damages.[29] Formation of ROS and increased oxidative stress may be involved in the action of microwave radiation on the biological system. ROS also causes injury by reacting with biomolecules, such as lipids, proteins and nucleic acid as well as by depleting enzymatic and non-enzymatic anti-oxidants in the brain. Anti-oxidant treatments in animals and humans could be beneficial in

preventing or reducing some complications of microwave radiation. Anti-oxidants play an important protective role against the ROS.[30] The anti-oxidant effect is mainly due to phenolic components, such as flavonoids, phenolic acid and phenolic diterpenes because of their redox properties, which can play an important role in absorbing and neutralising free radicals, quenching singlet and triplet oxygen or decomposing peroxides.[31] The present study shows that *Loranthus longiflorus* bark extract have protective effect in exposed animals to EMF-induced depression, which is referred to its anti-oxidative potency and free radical scavenging activity.[23] We cannot stop technology that emitted EMF, but we can protect ourselves, especially teen agers and young persons, against hazardous effects of radiations.

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