

**BIOCHEMICAL EFFECTS OF
ELECTROMAGNETIC WAVES ON RATS**

By

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B.Sc. Agric. Sci. (Agric. Biochem.), Fac. Agric., Cairo Univ., 2007

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APPROVAL SHEET

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ABSTRACT

Because of the great growing in mobile phone communications and their services, it was so important to study their electromagnetic waves (EMW) effects on melatonin and biogenic amines (epinephrine, norepinephrine, dopamine, serotonin, and histamine) of the neonatal rat brains during the prenatal period until different postnatal days (P1, P7, P14, P21 and P28).

Female pregnant rats were exposed to EMW from mobile phone antenna (3G SAR 1.25 W/kg body) and the irradiation continued until the 28th day of postpartum time. After parturition, neonatal rats were decapitated under red light and their brains were removed. Melatonin and biogenic amines concentrations were estimated by HPLC (UV detector). Results showed that in the group of neonatal rats that exposed to EMW, there was a significant ($P < 0.05$) increase in melatonin levels accompanied with a significant decrease in dopamine, histamine, norepinephrine and epinephrine in comparison to normal group. Exposure to EMW may cause many disturbances in the nervous system of the neonatal rats.

Key words: Electromagnetic waves, Neonatal rats, Histamine, Dopamine Epinephrine, Norepinephrine, Serotonin and Melatonin.

DEDICATION

I dedicate this work to whom my heart felt thanks; to my dear husband Hany Farid for the sincere support, to my lovely daughter Hamsa, to my close friend Naglaa Ahmed, to my father, my mother, my mother-in-law, to my brother and sisters for their patience and help.

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LIST OF ABBREVIATIONS

ACh	: Acetylcholine
AChE	: Acetylcholinesterase
AD	: Alzheimer's disease
AMPA	: α -Amino-3-hydroxy-5-methyl-4-soxazole Propionic Acid
AOPP	: Advanced Oxidation Protein Product
APP	: Amyloid Precursor Protein
ASD	: Autism spectrum disorder
Aβ	: β -Amyloid peptide
BBB	: Blood Brain Barriers
CAPE	: Caffeic Acid Phenethyl Ester (2-Phenylethyl (2E)-3-(3,4-dihydroxyphenyl)acrylate)
CAT	: Catalase
CB-D28k	: Calbindin D28-k (protein)
CR	: Calretinin (protein)
CREB	: cAMP-Responsive Element Binding Protein
CSF	: Cerebrospinal Fluid
CSFB	: Cerebrospinal Fluid Barrier
CTFs	: Carboxyl-Terminal Fragments
CW	: Continuous Wave
DOPA	: 3,4-Dihydroxyphenylacetic Acid
EEG	: Electroencephalogram
EMF	: Electromagnetic Fields
FCC	: Federal Communications Commission
GABA	: γ -Aminobutyric Acid
GFAP	: Glial Fibrillary Acidic Protein
GPS	: Global Positioning System
GSH	: Glutathione
GSH-Px	: Glutathione Peroxidase
GSM	: Global System for Mobile Communications
GSMA	: Groupe Speciale Mobile Association
GVG	: Gamma-vinyl-GABA
5-HIAA	: 5-hydroxyindoleacetic Acid
HIOMT	: Hydroxyindole-O-methyltransferase
HPLC-ED	: High Performance Liquid Chromatography with Electrochemical Detector
HPLC-FD	: High performance liquid chromatography with

	Fluorescence Detector
5-HT	: 5-Hydroxytryptamine
HVA	: Homovanillic Acid
ICNIRP	: International Commission on Non-Ionizing Radiation Protection
MDA	: Malondialdehyde
MEA	: Microelectrode Arrays
MEPSCs	: Miniature Excitatory Postsynaptic Currents
MF	: Magnetic Fields
mT	: Militesla
NAT	: Serotonin N-acetyltransferase
NREM	: Non-Rapid Eye Movement
3-NT	: 3-Nitrotyrosine
6-OHMS	: 6-Hydroxymelatonin Sulfate
PKC	: Protein Kinase C
PSD95	: Postsynaptic Density Protein-95
REM	: Rapid Eye Movement
RF	: Radio Frequencies
RNS	: Reactive Nitrogen Species
ROS	: Reactive Oxygen Species
SAR	: Specific Absorption Rate
SOD	: Superoxide Dismutase
TEM	: Transverse Electromagnetic cell
UMTS	: Universal Mobile Telecommunications System
W	: Watt
ZO	: Zonula Occludens
ZT	: Zeitgeber Time

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INTRODUCTION

After replacing the land lines, and in addition to internet services, mobile phone becomes the main way of telecommunications. According to Groupe Spécial Mobile Association (GSMA) the global mobile subscription reached 6.9 billion by the end of 2013 (GSMA, 2014).

Specific absorption rate (SAR) is one of the standard guidelines that Federal Communications Commission (FCC) made to ensure that the exposure to mobile phone radio frequencies (RF) is safe, SAR is the energy that absorbed by the body during the exposure to RF, and FCC admit SAR safe limits must not exceed 1.6 watt (W)/kg (FCC, 2014).

However with the long term use of mobile phones or exposure to electromagnetic fields (EMF) from base stations antennas could induce many harmful effects. Many studies reported that RF can affect health like causing brain tumors in adults after using mobile phone for several years (ICNIRP, 2009 and 2011). Also acute exposure to EMF from mobile phone was found to affect the auditory system and hearing threshold level (Alsanosi *et al.*, 2013 and Gupta *et al.*, 2015) besides it changed the blood pressure levels and the variability parameters of the heart rate in humans and affected the muscle contraction of the amphibians (Barker *et al.*, 2007; Andrzejak *et al.*, 2008 and Mortazavi *et al.*, 2015).

Many theories were suggested to explain the actual mechanisms of non-ionizing EMF on biological systems, like inducing thermal