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THE EFFECT OF CURCUMIN ON BASELINE CHARACTERS AND MORPHOMETRY OF TESTIS IN 4G-CELL PHONE-EMR TREATED WISTAR RATS

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doi: [10.33472/AFJBS.6.14.2024.2497-2504](https://doi.org/10.33472/AFJBS.6.14.2024.2497-2504)**ABSTRACT:****Introduction**

The scientific research focuses on the relationship between male infertility and cell phone use. There are conflicting reports from other studies about the potential effects of cell phone radiation on spermatogenesis. This study looked at the effects of electromagnetic waves from 4G cell phones and investigated if Curcumin could shield the testicles of Wistar rats exposed to radiation.

Materials and methods

Male Wistar rats, four weeks old, were divided into four groups, each containing six rats. Control group without a phone; CUR-4 group was given 100 mg of Curcumin per kilogram of body weight orally for four months; the R4 group was subjected to 4G-EMR for 2 hours per day for four months (5 minutes/every half an hour from 8 AM to 8 PM).; and the R+CUR-4 group was exposed to 4G-EMR for 2 hours per day (5 minutes/every half an hour from 8 AM to 8 PM) and got 100 mg of Curcumin per kilogram of body weight orally for four months. Baseline parameters were taken into consideration, including body weight; weight, volume and morphometry of testis.

Results

4G-cell phones-EMR altered the weight, volume and thickness of testis in the R4 group. However, Curcumin effectively protected those parameters from cell phone-radiation in R+CUR group.

Conclusion

Curcumin can safeguard the testis from the 4G-cell phone radiation in Wistar rats.

Keywords: Mobile phones, Electromagnetic radiation, Turmeric, Testis

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1. INTRODUCTION

Infertility is defined by the World Health Organization (WHO) as the inability to become pregnant even after a year of consistent, unprotected sexual activity. Seven percentage of people worldwide are infertile, with men accounting for nearly half of these cases (1). Infertility is influenced by a number of environmental variables in addition to physiological ones. Among the external factors causing decreased fertility are smoking, alcohol consumption and electromagnetic radiation. Both ionizing and non-ionizing radiation are

present in human exposure (1). Electromagnetic radiation (EMR) produced by many electronic devices are harmful to human health. Among these apparatuses is the concern has grown as a result of mobile phones to global public health (2). EMR emitted from cell phones may degrade sperm quality in males and animal models, primarily sperm count, motility, viability, and normal morphology (3). Increased exposure to EMR is linked to the generation of reactive oxygen species (ROS) or heating effect and damaging impact on the reproductive system (2). When subjected to 3G radiation, the main cause of the alteration in sperm mitochondrial activity, sperm membrane integrity, and sperm viability was the ROS produced in rats (1).

The phenolic compounds derived from herbs and plants show antioxidant properties. Curcumin (CUR) is an effective antioxidant that prevents the peroxidation of lipids and scavenges oxygen-free radicals (4). *Curcuma longa* Linn, a perennial rhizomatous monocotyledonous plant belonging to the Zingiberaceae family, is commonly grown in tropical regions of south and Southeast Asia. It has been used as a spice, pigment, and medicine since 1280. It contains protein, carbohydrates, fiber, curcuminoids, essential oils, and resins. Curcumin makes up approximately 70% of the curcuminoids compound, followed by demethoxycurcumin at 17%, bis-demethoxycurcumin at 3%, and cyclocurcumin (curcumin IV) at 10%. Curcumin, the most active ingredient in curcuminoid, is a phenolic compound with a vivid orange-yellow colour (5). It has antibacterial, antiprotozoal, anti-hepatotoxic, antidiabetic and anti-tumour properties (4). Research studies documented that few plant based products protected the testis from cell phone-EMR. However, the impact of curcumin on EMR exposed-testis yet to be investigated. Hence, the present study aimed to show the effect of CUR on weight, volume and morphometry of testis of Wistar rats exposed to 4G cell phone radiation for the duration of four months.

2. MATERIAL AND METHODS

Animals:

Male Wistar albino rats, four weeks old, weighed between 110 and 130 grams, were utilized in the investigation. They were acquired from Biogen Laboratory Animal Facility, Bangalore, India. This study's protocols for using animals for experiments were authorized by the Institutional Animal Ethical Committee (approval letter No. 04/IAEC/MG/09/2021-II, dated September 07, 2021). The Guidelines for the Care and Use of Laboratory Animals were followed when caring for and using the rats. After a week of becoming accustomed to their surroundings, they were housed in Plexiglas cages and fed a commercially balanced food along with unlimited access to tap water. The temperature range of 22–24°C was applied to them with a 12-hour light and dark cycle.

Smartphone-EMR Exposure Setting:

This study used a standard commercial brand of 4G android mobile phones with the manufacturer-specified whole-body SAR value of 1.6W/kg and peak power density of 2W/kg. Using a Cornet Electrosmog RF meter, the electromagnetic field values of the inner side of the rats' cage were measured and the average power density of the phone was determined to be 195.6 mW/m². The phone was housed in a wood-bottomed box that measured roughly 14 x 7 x 5 cm and was suspended from the rats' cage roof. This allowed the animals to roam freely and reach the center of the cage, which was 7.6 cm from both the bottom and the roof (6). To prevent scattered or interfered radiation, it was made sure that there were no other cell phones, metal items, or mobile phone towers in or near the testing room. A video call was made from a different cell phone of the same brand and model while the phone within the cage was turned on and left in auto-answer mode.

Procurement of Curcumin and its Preparation

The curcumin (*Curcuma longa* (turmeric) (Product No: C1386) and 0.5% w/v carboxymethyl cellulose (Product No: C5678) were purchased from Sigma-Aldrich Chemicals Private Limited, Bangalore, India. The CUR was dissolved in 0.5% w/v carboxymethylcellulose (CMC) sodium salt with water to produce concentration of 100 mg/ml (7).

Grouping of Animals

Four groups with a total of six rats each were randomly allocated. The control and curcumin group was managed in a separate EMR-free room with similar environment.

Control group: No cell phone radiation.

CUR-4 group: Received orally 100mg of curcumin /kg body weight/day for four months.

R4 group: Exposed to cell phone-EMR for 2 hours/day for four months (5 minutes/every half an hour from 8 AM to 8 PM).

R+CUR-4: Exposed to cell phone-EMR for 2 hours/day for four months (5 minutes/every half an hour from 8 AM to 8 PM) and treated orally with 100mg of curcumin/kg body weight/day for four months. Twenty-four hours after the completion of the experiment, the rats were anesthetized with an intraperitoneal injection of 45 mg/kg ketamine hydrochloride followed by sacrifice. A trans-abdominal incision was used to extract the testes. The testicles' length, width, thickness, weight, and volume were taken into account. Denver's digital weighing equipment was used to measure the weight of the testes in grams, and a Vernier calliper was used to test the morphometric characteristics in millimetres. The testicular volume was determined and expressed in millilitres (ml) using the water displacement method.

Statistical analysis

Data was entered in the MS Excel 2010, and analysis was done using Statistical Package for the Social Sciences (SPSS) software version 16.0. The variables were calculated as mean $\pm$ standard deviation. One-way ANOVA was used to compare the parameters between the groups and followed by a post hoc test (Tukey test). The p value less than or equal to 0.05 was considered as significant.

3. RESULTS

Baseline Characteristics and Morphometry of Testes:

The bodyweight, testicular weight and volume are shown in Table 1. The R4 group showed significantly different weight and volume of testis from control, CUR-4 and treatment group. The morphometric measurements of the testes are displayed in figure 1, where the thickness of the testis in the R4 group significantly differed from the control and CUR-4 groups whereas R+CUR-4 group displayed higher values as compared to the R4 group. No difference was observed regarding the length and breadth of the testis between the groups.

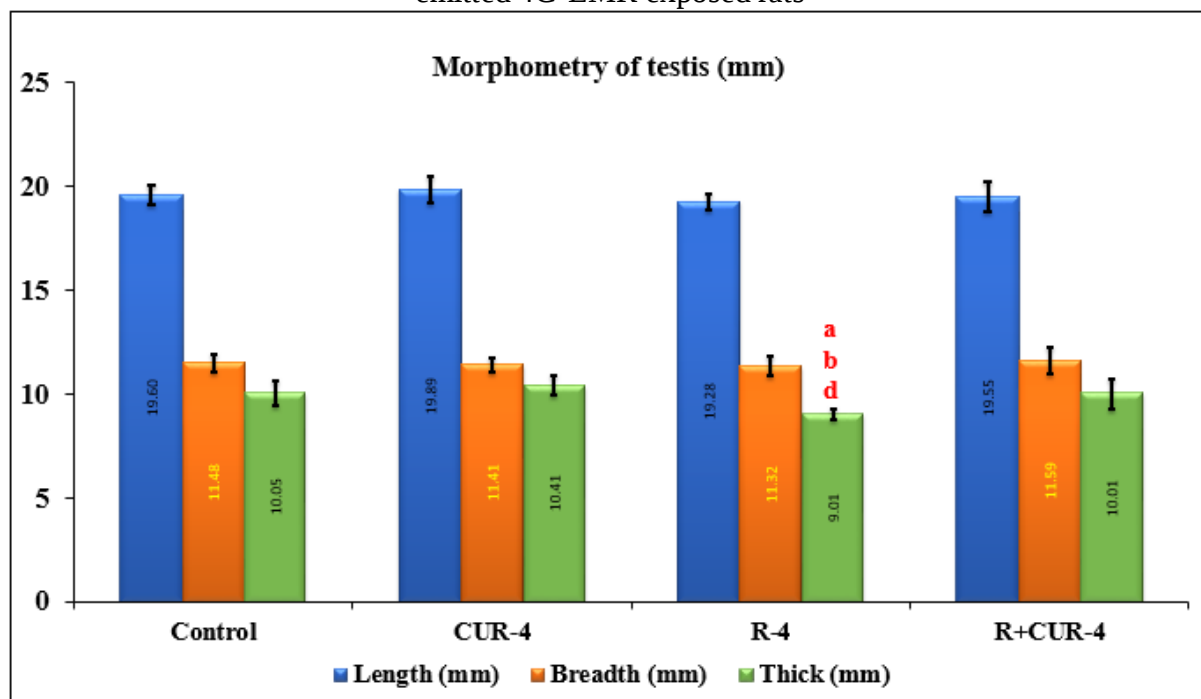
Table 1. The effect of Curcumin on body and testis weights and testicular volume in the cell phone-emitted 4G-EMR exposed rats

Parameters	Control	CUR-4	R4	R+CUR-4	P value
Body weight (gm)	328.33 $\pm$ 27.08	325.5 $\pm$ 21.08	310.17 $\pm$ 30.27	320.33 $\pm$ 25.82	0.65
Testis weight (gm)	1.52 $\pm$ 0.05	1.52 $\pm$ 0.05	1.43 $\pm$ 0.06 ^{a,b,d}	1.53 $\pm$ 0.04	0.004

Testicular volume (ml)	1.48±0.07	1.56±0.05	1.38±0.04 ^{a,b,d}	1.49±0.06	< 0.001
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Values are expressed as mean ± SD. Different superscript letters show significant differences between groups. a- different from the control group; b- different from the CUR-4 group; d- different from the R+CUR-4 group.

Figure 1: The effect of Curcumin on length, breadth and thickness of testis in the cell phone-emitted 4G-EMR exposed rats



Values are expressed as mean ± SD. Different superscript letters show significant differences between groups. a- different from the control group; b- different from the CUR-4 group; d- different from the R+CUR-4 group.

4. DISCUSSION

The human body absorbs the radiant electromagnetic radiation released by cell phones through aerial effect, resonant absorption, and/or mixing the RF waves. This process can modify the testis's typical functioning ability. Higher energy-radiofrequency transmissions are correlated with recent advancements in mobile phone communication technologies and an increase in signal strength. As a result, signals with higher frequencies carry more energy. By interacting with the biological system, the electrical and magnetic properties of the EMR cause both thermal and non-thermal impacts on the human body (8).

In the male reproductive system, spermatozoa, Leydig cells, and seminiferous tubules are the main targets of damage caused by mobile phones (9). The rapid rate of cell proliferation and differentiation in the seminiferous epithelium throughout prepubertal life makes it extremely vulnerable to harmful chemicals (10).

In the present study, 4G-EMR caused a significant reduction in the measurements of weight, volume and thickness of testis. There are few histo-morphometric studies supporting the results of this investigation. According to Kumar et al. rats exposed to EMR for 60 days experienced decreased sperm count, reduced seminiferous tubule diameter, testicular weight

loss, and DNA damage from cell phones operating at 1910.5 MHz (11). Similarly, Kim et al. found that spermatocyte count may be lowered by 2.45 GHz EMF radiation with a power density of 50 mW/cm² for two hours every day for eight weeks (10). As noted by Meo et al. three of the sixteen mice who had a three-month whole-body exposure to mobile phone radiation—three of which experienced maturation arrest-developed hypospermatogenesis (12). Using 4G cell phone, Oh 2018 et. al suggested that one-month duration of EMR exposure could reduce the germ cell count and Johnson's biopsy score in rats (13). Extended exposure to mobile phone radiation results in hypo-spermatogenesis, hypoplasia of Leydig cells, and reductions in serum testosterone levels, sperm motility, and count. Compared to groups exposed to 3G, those exposed to 4G experienced greater severity (2). However, there are literature available stating that EMR from mobile phones fail to cause negative effects in testis. Based on data submitted by Lee et al. rats exposed to simultaneous whole-body exposure to CDMA (SAR-2.0 W/kg) and WCDMA (SAR-2.0 W/kg) RF signals for 45 minutes per day, five days per week, for a period of 12 weeks, were unable to exhibit any alterations in the number of spermatogenesis stages, the appearance of apoptotic cells in the testes, or immunoblotting for p53, bcl2, GADD45, cyclin G, and HSP70 (14). There are evidences show that CUR can protect testis against toxin-induced injuries in animals. The protective effect of CUR is based on its antioxidant and anti-inflammatory activities(5). The creation of oxidative stress through the generation of reactive oxygen species explains the nonthermal action of EMR (3). Research studies documented that CUR is the stronger antioxidant that can act against free radical caused-tissue damage and it has radio protecting effect.(5).CUR is the potent medicine in reversing the altered parameters in animals even with increased scrotal temperature. Afsharet. al showed Curcumin-loaded iron particles have the potential to significantly raise blood testosterone levels by raising the testis' volume, seminiferous tubules' length, sperm parameters, and stereological parameters in mice with long-term scrotal hyperthermia (15).Khorsaviet. al reported similar results with testicular hyperthermia (16).CUR as an antioxidant protected the testis against the effects of compact florescent Lamps by improving serum levels of follicle stimulating hormone, prolactin, testicular weight, sperm motility (17).According to Vafeiet. al, the results of their study showed testis weight index and testis volume decreased in the 4G-LTE-EMR group and increased in Crocin and 4G-LTE-EMR+Crocin groups insignificantly which may be due to lesser duration of exposure (18). However, in this study, CUR could prevent the destructive effects of cell phone radiation in the treatment group.

5. CONCLUSION

Cell phones may have negative consequences on testis and this was demonstrated by altered morphometry and volume of testis. Such evidences could be markers of spermatogenesis impairment. However, CUR could effectively shield the testis from 4G-cell phone-EMR. Regular intake of CUR can effectively combat EMR and maintain reproductive health, as it may be impossible to avoid exposure to mobile phone-EMR.

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