EFFECTS OF SHORT-TERM MOBILE PHONE RADIATION ON TULSI PLANT ON ITS MORPHOLOGICAL FEATURES

ASWATHY E. B.

(19-MSVP-01)

DISSERTATION

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF SCIENCE

(Wildlife Studies)

2022

Faculty of Veterinary and Animal Sciences

Kerala Veterinary and Animal Sciences University

KVASU CENTRE FOR WILDLIFE STUDIES

KERALA VETERINARY AND ANIMAL SCIENCES UNIVERSITY

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DECLARATION

I hereby declare that this dissertation entitled **"Effects of short-term mobile phone radiation on Tulsi plant on its morphological features"** is a bonafide record of research done by me during the course of research and that the dissertation has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other University or Society.

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CERTIFICATE

Certified that this dissertation, entitled **"Effects of short-term mobile phone radiation on Tulsi plant on its morphological features"** is a record of research work done independently by **Aswathy E.B. (Roll no. 19-MSVP-01)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to him/her.

Place: Pookode
Date:

Dr. Abdul Azeez C. P.

Chairman

Advisory Committee

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We, the undersigned members of the advisory committee of **Aswathy E.B. (Roll no: 19-MSVP-01),** a candidate for the degree of Master of Science in Wildlife Studies, agree that this dissertation entitled **“Effects of short-term mobile phone radiation on Tulsi plant on its morphological features”** may be submitted by **Aswathy E.B. (Roll no: 19-MSVP-01)** in partial fulfilment of the requirement for the degree.

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EXTERNAL EXAMINER

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Aswathy E. B.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

1. INTRODUCTION

Mobile phones have become inevitable in the daily lives of people around the globe. As cell phone use has become more widespread, concerns have mounted regarding the potentially harmful effects of electromagnetic radiations (EMR) from these devices. It is estimated that approximately 500 million people worldwide are using mobile phones currently. Due to this large usage of mobile phones, the interaction of EMR with human organs and, in particular, with the brain is increasing. Experimental studies have shown that EMR emitted from the mobile phones can affect the brain in various ways. Cell phones use radio waves to communicate. Radio waves transport digitalized electrical and magnetic fields, called electromagnetic field (EMF). The rate of oscillation is called frequency. Radio waves carry the information and travel in air at the speed of light. Cell phones transmit radio waves in all directions. The waves can be absorbed and reflected by surrounding objects before they reach the nearest cell tower. The parameter used to measure the radiation emitted by cell phones is the specific absorption rate (SAR) given in units of Watts of power absorbed per kilogram of tissue (W/kg). The permissible upper limit for cell phones set by the U.S. Federal Communications Commission (FCC) is 1.6 W/kg of RF radiation. EMR emitted by mobile phones may cause harmful effects in humans. Meanwhile, studies on plants are also warranted. It has been reported that the natural radio frequency environment of the earth has remained more or less unaltered till before 1800. The major components of the earlier environment were broadband radio noise from space (galactic noise), from lightning (atmospheric noise), and a smaller radio frequency (RF) component from the sun. We may assume that plants have evolved learning to use these environmental signals, along with visible light, in order to regulate their periodic functions. Being sensitive to radiation, they may also be sensitive to man-made RF fields. Ionizing radiation imposes on living organisms a series of alterations, usually leading to a biological injury. Much concern is given to the effects of this radiation to human life and environmental health. Even though concern has been raised for plants too, there are only very few studies.

The plant tulsi, known as “Queen of herbs”, is described as a sacred and medicinal plant in ancient literature. This plant belongs to the family Labiatae, characterized by square stem and specific aroma. In India, the plant is grown throughout the country from Andaman and Nicobar to Himalayas up to 1800 meters above the sea level. There are mainly 4 types of tulsi plants (*Ocimum sanctum*) in India. They are Krishna Tulsi, Rama Tulsi, Vana Tulsi, and Kapoor Tulsi. In this, Krishna Tulsi and Rama Tulsi almost have a similar chemical constitution.

Divison	Magnoliaphyta
Class	Magnoliopsida
Order	Lamiales
Family	Lamiacea
Genus	Ocimum
Species	Sanctum

It is an important symbol of religious tradition. Tulsi is a plant which we all happen to meet in our daily life. It is already proven that tulsi has a huge variety of medicinal properties like anticancer activity, antidiabetic activity, antilipidemic activity, antibacterial activity, antifertility activity, anti-inflammatory activity, antioxidant activity etc. Because of these important properties, it is important to do a study on tulsi plant. Yet, there are no studies on tulsi plant about the effect of EMR from mobile phones.

This study was conducted with the following objectives:

1. To compare the morphological features of tulsi plants that are exposed and un exposed to mobile phone radiation.
2. To analyze the plants for flavonoids and carbohydrates.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. PHYTOCHEMICAL ANALYSIS

Four medicinal plants' aqueous ethanolic extracts were used by Joshi *et al*. (2010) to do in vitro anti-bacterial assay against *Escherichia coli*, *Salmonella typhi*, *Salmonella paratyphi*, *Staphylococcus aureus*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* which all are human pathogens, by cup diffusion method. *Eugenia caryophyllata* (Clove) was identified to be most effective against *S. typhi* among the four plants tested. There was no effect against *E. coli* and *K. pneumoniae*. *Achyranthes bidentata* was identified to be not effective against all the organisms which were tested. With *E. coli*, the greatest inhibition zone (22 mm) was attained. *Azadirachta indica* was found to have a Minimum Bactericidal Concentration (MBC) of 5 mg/l against *S. typhi* and *K. pneumoniae* and *E. coli* was reported to be resistant to all of the plant extracts. For the detection of alkaloids, glycosides, terpenoids, steroids, flavonoids, tannins and reducing sugars, a qualitative phytochemical analysis was performed.

Rahman *et al.* (2011) proved the medicinal properties of tulsi plant like anti-bacterial activity, anti-anaphylactic activity, antihistaminic and mast cell stabilization activity, wound healing effect, radio-protective effect, anti-diabetic activity, antioxidant activity, anti-carcinogenic characteristics, immunologic effects, contraceptive effect, larvicidal effect, anti-genotoxic impact, neuro-protective effect, cardio-protective effect, and other activities. And also, a wide variety of chemical compounds like eugenol, euginal, urosolic acid, carvacrol, linalool, limatrol, caryophyllene, methyl carvicol, sitosterol, anthocyans etc. were found in this plant.

Shetty *et al.* (2013) conducted a study to detect the presence of chemical constituents like alkaloids, tannins, cardiac glycosides, saponins, flavonoids and terpenoids. To identify these compounds, they did hydraulic extraction of plant leaves and then the dried extract was subjected to phytochemical analysis. The study proved the presence of these compounds.

Borah *et al.* (2018) performed phytochemical analysis of *Ocimum sanctum* leaves with two different solvents (methanol and ethanol) and in aqueous conditions. In organic solvents, the amount of extraction was more than in that of water. It was found that high quantity of phenols were present in tulsi from the quantitative analysis of tulsi leaf extract. Consequently, the amount of alkaloids and flavonoids ranged from 0.91 to 1.28 and 1.56 to 2.24 per cent respectively.

Singh *et al.* (2018) provided a review of about *Ocimum sanctum*'s chemical constituents and their related anticancer, antioxidant, anti-inflammatory, antistress, γ-irradiation protection, anti-diabetic and anti-leishmanicidal activities. Beyond 60 chemical compounds have been reported from phenolics, flavonoids, phenyl propanoids, terpenoids, fatty acid derivatives, essential oil, fixed oil, and steroids and all are found in *O. sanctum*.

2.2. EFFECTS OF MOBILE PHONE RADIATIONS ON PLANTS

Sharma *et al.* (2009) explored whether Electro-Magnetic Field radiation (EMFr) from cell phones inhibited growth of *Vigna radiata* (mung bean) through induction of conventional stress responses. EMFr effects of cell phone were identified by measuring the generation of reactive oxygen species (ROS) in terms of malondialdehyde and hydrogen peroxide (H_2O_2) content, root oxidizability and changes in levels of antioxidant enzymes. After the experiment, the results showed that there is a significant inhibition in the germination and radicle and plumule growths in mung bean in a time-dependent manner. And also in mung bean roots, cell phone EMFr increased MDA levels (indicating lipid peroxidation), as well as H_2O_2 build up and root oxidizability, triggering oxidative stress and cellular damage. Despite increased antioxidant enzyme activity, cell phone EMFr inhibited mung bean root growth by causing ROS-generated oxidative stress.

Abdollahi *et al.* (2011) studied the leaves of two-year-old trees of lime (*Citrus aurantifolia*) infected by the *Candidatus phytoplasma aurantifoliae* and the effects of electromagnetic fields on the changes of lipid peroxidation, content of H_2O_2, proline, protein, and carbohydrates were studied. A 10 KHz quadratic EMF with a maximum power of 9 were discontinuously exposed to healthy and infected plants for 5 days, each 5 h, at 25^0C. Compared with control plants, the fresh and dry weight of leaves, content of MDA, proline, and protein increased in both healthy and infected plants under electromagnetic fields. In both healthy and infected plants compared to those of the controls the hydrogen peroxide and carbohydrates content decreased due to electromagnetic fields.

Sharma and Parihar (2014) reported that radiation emitted from mobile phones affected early growth and biochemical changes in the emerging seedlings of *Pisum sativum* (Pea) and *Trigonella foenumgraecum* (Fenugreek). When compared with control seeds it was observed that radiations emitted from mobile phones showed considerable increase in the germination percentage, seedling length, proteins, lipid and guaiacol content. The study concluded that radiations emitted from mobile phones interfered with both morphological and biochemical processes and affected growth and nodule formation in plants.

Halgamuge *et al.* (2015) conducted a study to detect the possible effects of radiation pollution on plants. The alliance between base station (long duration, very low amplitude) and cellular telephone (short duration, higher amplitude) radiation exposure and the growth rate of soybean (*Glycine max*) seedlings was investigated. The outcome for the subjection to higher amplitude GSM radiation was the diminished outgrowth of the epicotyl. Reduced amplitude GSM radiation did not result in any alterations in epicotyl, hypocotyl, or root outgrowth. Root outgrowth was reduced when exposed to greater amplitude continuous waveform CW radiation, whereas hypocotyl outgrowth was reduced when exposed to lower amplitude CW radiation. This study showed that the observed effects were significantly dependent on field strength as well as amplitude modulation of the applied field.

Stefi *et al.* (2016) conducted an experiment to check the structural or biochemical changes on *Arabidopsis thaliana* plants by giving long term exposure to non-ionizing radiation emitted from the base unit of a cordless DECT system. When exposed plants were compared to their control counterparts, their biomass and leaf structure seemed to be affected. Thinner leaves and fewer chloroplasts were observed.

Khan *et al.* (2018) reviewed the available literature about the feedbacks of various flowering plant species towards GSM and GSM-like radiations using physiological, and *in vitro* techniques to identify biochemical, molecular, and cytological markers. Using both GSM mobile phone and GSM simulators different monocots (tomato, onion, wheat and maize *etc*.) and dicots (pulses, mustard and flax) were studied. In both dose and time-dependent studies, overall reductions in germination, root-shoot lengths, and dry weight were observed. Furthermore, when onion roots were exposed to EMF radiations, cytological abnormalities were discovered. The entire literature assessment revealed that GSM and GSM-like radiations had deleterious effects on the plant species studied.

Chandel *et al.* (2019) examined the potential of 2100 MHz radio frequency radiations to act as cytotoxic and genotoxic agent. For this, they used fresh onion roots and then they exposed it to electromagnetic field radiation for different durations and examined for mitotic index (MI), phase index, chromosomal aberrations, and DNA damage. A notable increase in the MI and aberration percentage was recorded upon 4 h of exposure when compared to the control. EMFr exposure showed DNA damage with a significant decrease in HDNA accompanied by an increase in TDNA upon exposure of 4 hours. Examining of the post-exposure effects of EMFr did not show any significant change/recovery. This study had a great significance in view of the slowly rising EMFr in the surrounding environment and their potential for inciting aberrations at the chromosomal level, thus posing a genetic hazard.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

3.1. SAMPLE COLLECTION

Same species of 36 tulsi plants (*Ocimum sanctum*) with almost same height between 16 cm - 25 cm were collected from M.S. Swaminathan Research Foundation, Wayanad. These plants were divided into 3 groups (Control Group, Group 1 & Group 2), each consisting of 12 plants. The study was conducted at the lab of Centre for Wildlife Studies, KVASU, Pookode, Wayanad.

3.2. BASIS OF GROUPING

Group 1 and Group 2 were considered as experimental groups in which 12 plants of both Group 1 & Group 2 were provided with a mobile phone of the same model (Samsung Galaxy). For plants in Group 1, 1 hour of continuous calls were given for 6 hours per day with an interval of 30 minutes between each call, and for plants in Group 2, 100 text messages were given per day and the phone was kept in airplane mode for the whole night, because airplane mode terminates all the wireless connections so it does cut the vast majority of mobile phone radiations. Control Group was kept inside a Faraday's Cage (Barthakur and Arnold, 1988).

3.3. FARADAY'S CAGE AND MOBILE PHONE RADIATION

Faraday's cages are metal enclosures that conduct electromagnetic waves, but only on the exterior of the cage. That makes the interior completely free of electric charge, blocking many wavelengths and frequencies, like radio waves and microwaves. Actually, cell phones do work in Faraday cages these days. What happens is that the conductor in the cage is not ideal, and there is some amount of leakage of electromagnetic radiation to and from the inside of the cage, specially at high frequencies. In order for the cage to be perfectly blocking it would need to have no holes at all (hence it is no longer a cage, but a box) and made of a perfectly conducting material, such as a superconductor, with a thickness larger than about 3 times the penetration depth of the radiation for that material. The sizes of the holes need to be smaller than the wavelength of the EM radiation, so that the effects of the holes may be ignored. Wavelength is inversely proportional to the frequency of the radiation. The most important concept relating Faraday cage hole size to cell phone signal attenuation is the idea of a cut off frequency. For round holes, you would model them as cylindrical wave guides. For simplicity, we'll consider rectangular wave guides instead.

3.4. METHOD OF STUDY

A Faraday's cage was constructed with an iron mesh (Plate 1). The whole cage was covered with aluminium foil to hide the holes on the cage and then a mobile phone was kept inside the cage and call was given to that mobile phone to check whether it was connecting the call. While giving the call, the phone was not ringing. This showed that the Faraday's cage was working properly. White light was used for providing light to the plants, and at night the lights were kept off so that the duration of day and night was 9 hours and 15 hours respectively. Same type of soil was used for all 36 plants and no fertilizers were used for the growth. All plants were watered twice a day. The plants were kept at room temperature. The duration of the study was 5 weeks. Growth of the plants in each group was assessed by measuring its height. The growth rate of the plants in 5 weeks (height of the plant in 5^{th} week minus height of the plant in 1^{st} week) in Control Group, Group 1 and Group 2 were compared using one-way-ANOVA and pair wise comparison of the group was performed using DMRT at $\alpha=0.05$. All the analyses were performed using SPSS version 24. The percentage of leaf fall was observed every day and percentage bar graph was plotted after statistical analysis. Change in the colour of the leaves of each plant was also examined.

3.5. EXTRACTION METHODS

After finishing the experiment, leaves were collected from the plants of each group and were dried. The dried leaves were taken for methanolic extraction using

Soxhlet apparatus (Yadav *et al.,* 2011). After the extraction process, the extract was collected in a rotary evaporatory flask for doing rotary evaporation to remove all the methanolic content from the extract to get pure extract. After collecting the pure extract, it was transferred into a glass plate for drying, and was kept on the glass plate for the whole night. Then the dried extract was collected into a collecting bottle for further tests.

3.6. TEST FOR FLAVONOIDS

3.6.1. Shinoda Test

Shinoda test was done to test the presence or absence of flavonoids in the extract (Sharma *et al.,* 2012). Crude extract was mixed with small amount of magnesium and concentrated HCl was added drop wise. Appearance of pink scarlet colour after few minutes indicated the presence of flavonoids.

3.7. TEST FOR CARBOHYDRATES

3.7.1. Fehling's Test

Equal amount of Fehling's Reagents A and B was mixed and 2 ml of it was added to the plant extract and then heated gently. Appearance of brick red precipitate indicated the presence of sugar.

3.7.2. Benedict's Test

Crude extract was mixed with 2 ml of Benedict's Reagent and boiled. A reddish-brown precipitate indicated presence of carbohydrates.

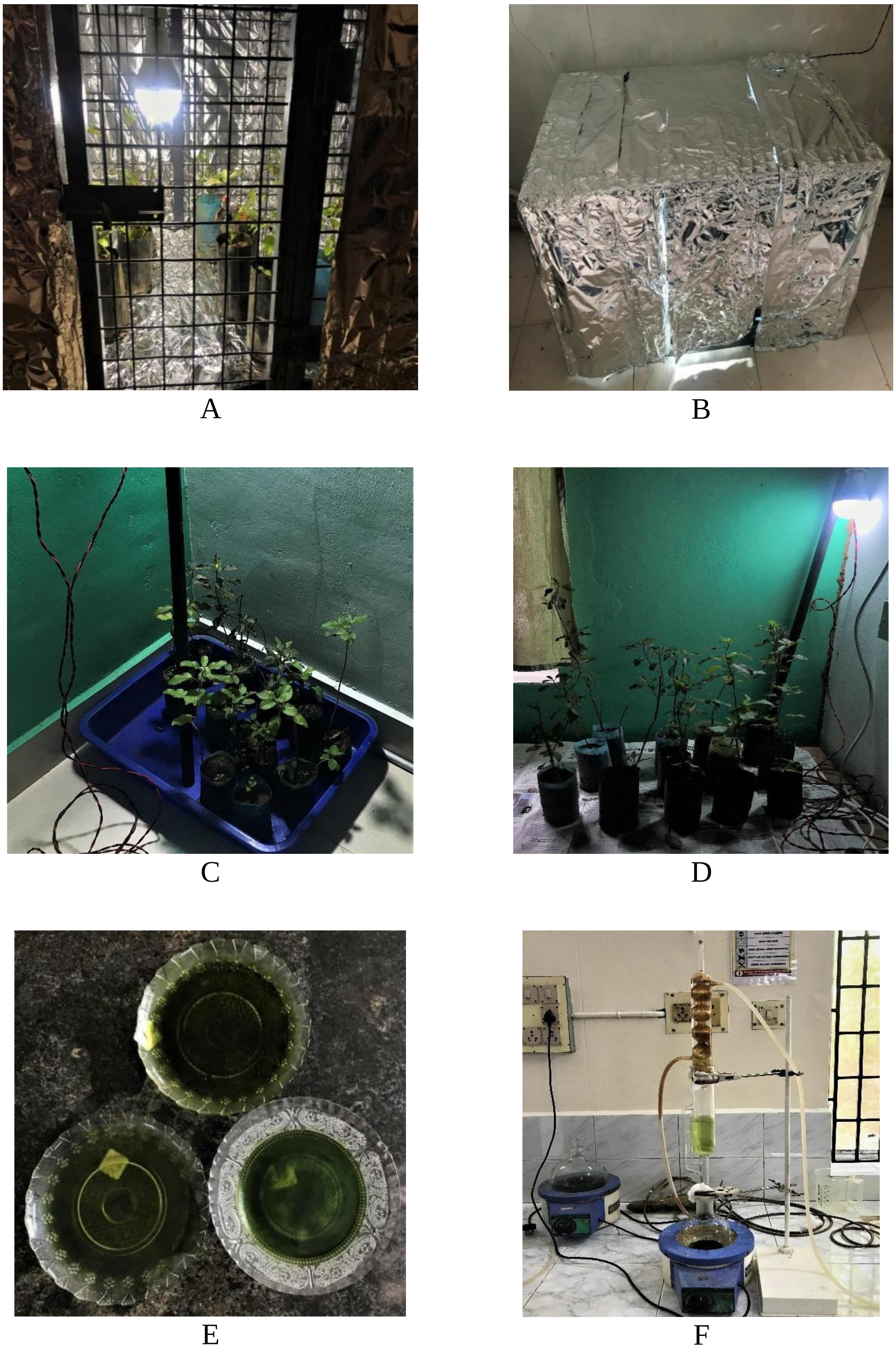

Plate 1. Experimental set-up. (A) Control group inside view (B) Control group outside view (C) Group 1 (D) Group 2 (E) Dried Extract (F) Soxhlet apparatus.

RESULTS

4. RESULTS

4.1. PER CENT OF LEAF FALL WITH RESPECT TO EACH WEEK

Each group consisted of 12 tulsi plants. To examine the per cent of leaf fall, the approximate amount of leaf fall from the plants in each group on each day was noted. At the end of each week, amount of leaf fall was then converted into per cent. A bar graph of per cent of leaf fall with respect to each week was plotted with week on x-axis and per cent of leaf fall on y-axis (Figure 1.), where each bar on the given bar graph represents each group; Control Group, Group 1 and Group 2.

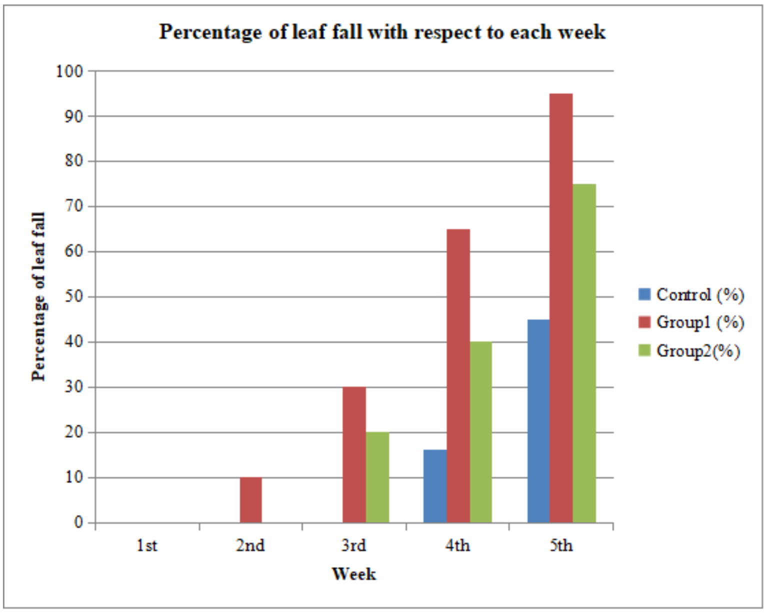

Figure 1. Per cent of leaf fall with respect to each week

There were no leaf fall in any group during the first week. During the second week, Group1 showed 10 per cent falling of leaves. In Group 2, leaf fall started only during third week. At the end of the last week, the maximum amount of leaf fall was observed in Group 1 and minimum amount of leaf fall was observed for plants under Control Group (Table 1). The graph shows that the amount of leaf fall for each group with respect to each week is Group 1> Group 2> Control. Hence, the graph shows that the plants in the group in which calls were given had more per cent of leaf fall and in the group in which plants were kept inside the Faraday's cage with zero amount of radiation had least amount of leaf fall.

Table 1.Per cent of leaf-fall with respect to each week

Week	Control (%)	Group 1 (%)	Group 2 (%)
1st	0	0	0
2nd	0	10	0
3rd	0	30	20
4th	16	65	40
5th	45	95	75

4.2. CHANGE IN THE COLOUR OF THE LEAF

Any unusual colour change or appearance of any kind of spots on the leaf surface was recorded. After 5 weeks of the experiment, there was no notable colour change or spots.

4.3. MEAN INCREASE IN HEIGHT

The mean increase in height of each plant from each group are discussed below.

The height difference of plants between 5th and 1st week of each group were calculated (Table 2). The mean height of each group was calculated and a simple bar graph was plotted (Figure 2).

Table 2. Mean increase in height of the pant between 1st and 5th week

Plant number	Control(cm)	Group1(cm)	Group2(cm)
1	1.8	0.5	1.2
2	1.4	0.7	0.8
3	1	0.6	1.2
4	1.4	0.4	0.8

Plant number	Control(cm)	Group1(cm)	Group2(cm)
5	1.2	0.7	0.8
6	1.4	0.6	0.7
7	1.3	0.8	0.8
8	0.8	0.9	0.8
9	1.1	0.5	0.8
10	1.3	0.5	1
11	1.6	1	1
12	0.9	0.5	0.9
Sum	15.1	7.7	10.8
Mean height	1.258	0.641	0.9

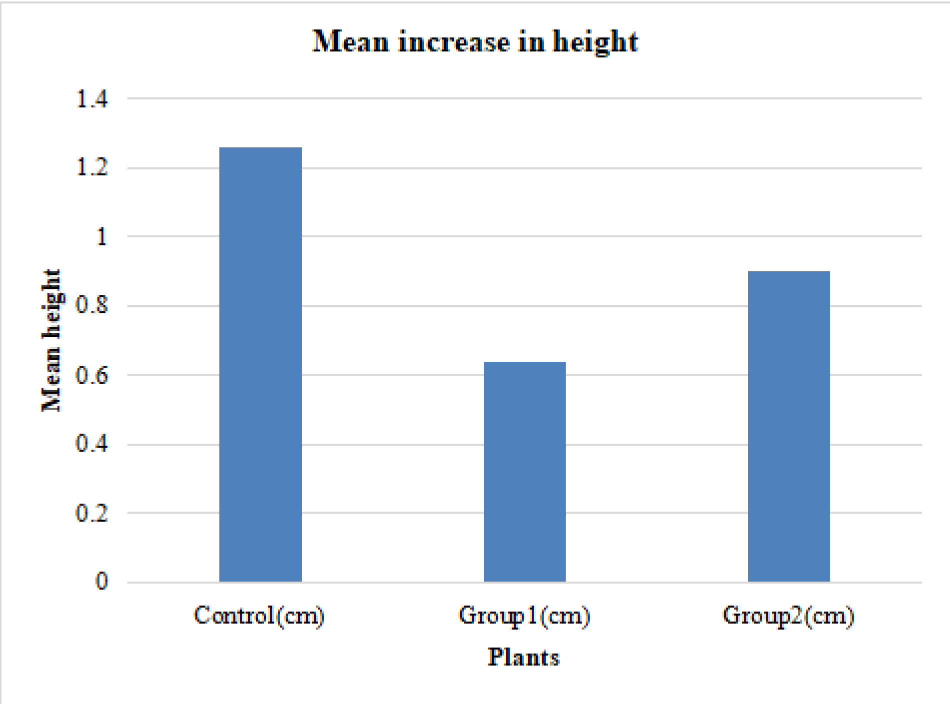

Figure 2. Mean increase in height

From the Figure 2, it is clear that plants under control group with no radiation showed maximum increase in height and plants in Group 1, where continuous phone calls were given showed minimum increase in height and plants in Group 2 showed a moderate level of growth. Control Group, Group1 and Group2 were compared using one-way-ANOVA (Table 3).

Table 3. One-way-ANOVA table of each experimental group

	Mean ± SEM	**F value**	**P value**
Control	1.2583 ± 0.07829[a]	25.689	<0.001
Group 1	0.6417 ± 0.05288[c]		
Group 2	0.9000 ± 0.4767[b]		

On comparing, there was statistically significant difference of growth rate of plants in 3 different groups with F value = 25.689 and P value = <0.001 (at α = 0.05).

Therefore, the analysis suggested that short term mobile phone radiations had a significant effect on the increase in height of the plants.

4.3.1. Mean Height of Plants in Each Week with Respect to Each Group

Comparison of each plant mean height in each group for 5 weeks was done by taking the average height of plants in each group on each week in the form of mean height and standard deviation. Mean height variation of plants in each group with respect to each week is given below (Table 4 and Figure 3).

Table 4. Mean height variation in each study group

Week	**Control (mean ± SD)**	**Group 1 (mean ± SD)**	**Group 2 (mean ± SD)**
1st week	19.52 ± 1.811	19.86 ± 1.847	20.86 ± 2.308
2nd week	19.75 ± 1.808	19.97 ± 1.869	21.01 ± 2.295
3rd week	20.20 ± 1.809	20.17 ± 1.846	21.275 ± 2.252
4th week	20.46 ± 1.751	20.33 ± 1.855	21.525 ± 2.274
5th week	20.78 ± 1.752	20.51 ± 1.833	21.76 ± 2.247

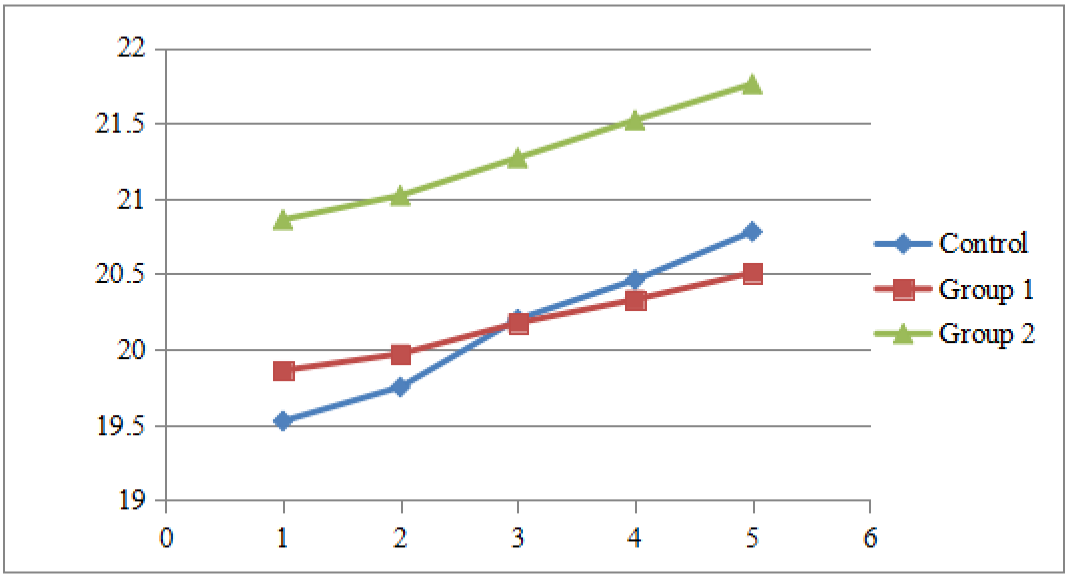

Figure 3. Mean variation in heights of the plants

4.4. QUALITATIVE ANALYSIS

The qualitative analysis of the tulsi plant extract showed the presence of carbohydrates and flavonoids.

DISCUSSION

5. DISCUSSION

The leaves of the plants continued to fall in the course of time of the experiment. The leaf fall started in the second week for the Group 1. The leaf fall was not noticed in the control group till 4^{th} week. In addition, the per cent of leaf fall was higher in Group 1 and Group 2 than the control group. This suggest that the mobile phone radiation might have influenced the leaf fall.

The change in the colour of the leaf is another indicator of the physiological changes. But in this study, there was no notable colour change on the plants between the groups.

The mean increase in the height of the plants was 1.25 cm in the control group. This happened within a period of 5 weeks. The increase in height of the plants in the other two groups was significantly lower as suggested by the one-way-ANOVA test.

The above results suggest that, in the current study the radiation from the mobile phone has influenced the normal growth and physiology of the plant. Several published research have discussed the impact of radiations on the biochemistry and physiology of plants (Abdollahi *et al.*, 2011; Sharma and Parihar, 2014; Stefi *et al*. 2016). Even though this did not conduct a quantitative analysis of the biochemical extracts, the differentiating morphological changes observed the different study groups suggest the possibility of a negative impact of the mobile phone radiation on the tulsi plants.

SUMMARY

6. SUMMARY

Nowadays the use of mobile phones has increased enormously. Hence, studies on the effects of mobile phone radiations are also increasing. Nevertheless, studies on plant species about the effects of mobile phone radiations are very less. So this study focused on how mobile phone radiations affected the growth of tulsi plants by examining the increase in height of the plant, percentage of leaf fall on each week, and colour change on leaves, in addition to qualitative analysis of leaf extract for carbohydrates and flavonoids. The study duration was 5 weeks. The tulsi plants were grouped into 3; Control group, Group 1 and Group 2. In Control Group, 12 plants were kept inside a Faraday's cage. Inside a Faraday's cage the total EMF would be zero so the plants inside this Faraday's cage were completely devoid of mobile phone radiations. In Group 1, the plants were subjected to 6 hours of continuous calls with 30 minutes interval after each call. In Group 2, the plants were subjected to text messages. The major aim of this research was to compare the plants in Group 1 and Group 2 with those of the Control Group to analyse which group was affected more by the radiation. The growth rate was studied by measuring the height, percentage of leaf fall, colour change on the leaves, and qualitative analysis for carbohydrates and flavonoids. This study showed that the effect was more in Group 1 in case of increase in height and percentage of leaf fall. The results showed that growth was more in the plants kept inside Faraday's cage and less in Group 1. The increasing order of growth was Group1<Group2<Control Group. The plants in Group1 showed high percentage of leaf fall and the plants in control group showed very less percentage of leaf fall (Control Group<Group2<Group1). No specific colour change was observed in any group. So, this study suggested that even a short-term mobile phone radiation could bring phenotypical changes. After the qualitative analysis, the presence of flavonoids and carbohydrates was detected in each group.

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7. REFERENCES

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EFFECTS OF SHORT-TERM MOBILE PHONE RADIATION ON TULSI PLANT ON ITS MORPHOLOGICAL FEATURES

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(19-MSVP-01)

DISSERTATION

Submitted in partial fulfilment of the requirement for the degree of

MASTER OF SCIENCE

(Wildlife Studies)

2022

Faculty of Veterinary and Animal Sciences

Kerala Veterinary and Animal Sciences University

KVASU CENTRE FOR WILDLIFE STUDIES

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8. ABSTRACT

Nowadays the use of mobile phones is increasing enormously and hence studies on the effects of mobile phone radiations are also increasing. But, studies on plant species about the effects of mobile phone radiations are very scarce. This study on tulsi plant investigated how mobile phone radiations affect plant growth by examining the height of the tulsi plant, percentage of leaf fall on each week, colour change on leaf petals, and also by qualitative analysis for carbohydrates and flavonoids. The study was of 5 weeks duration. The plants were grouped into three: Control Group, Group 1 and Group 2. In Control Group, the plants were kept inside a Faraday's cage, where the radiation would be mostly zero. The results from Group 1 and Group 2 were compared with the results from Control Group. From the results, it was observed that the growth of the plants was more in Control Group and percentage of leaf fall was very less in the Control group when compared with other two groups. No specific colour change was noted in any of the study groups. Qualitative analysis confirmed the presence of carbohydrates and flavonoids. The study suggested that short term mobile phone radiation can have significant effect on the growth of the plants.

Acad. Form No.19a

KERALA VETERINARY AND ANIMAL SCIENCE UNIVERSITY

Faculty of Veterinary and Animal Sciences

PROGRAMME OF RESEARCH WORK FOR DISSERTATION FOR MASTER OF SCIENCE DEGREE

1. Title of dissertation:
   Effects of short-term mobile phone radiation on Tulsi plant on its morphological features
2. a) Title of the department /KVASU research:
      NIL
   b) Project of which this forms a part:
      NIL
   c) Code No. if any, and order by which the departmental/KVASU research project is approved:
      NIL
3. a) Name of student: Aswathy E.B.
   b) Admission No: 19-MSVP-01
   c) Name of the programme: Master of Science (Wildlife Studies)
4. a) Name of Guide: Dr. Abdul Azeez C. P.
   b) Address: Associate Professor
      Department of Animal Reproduction, Gynaecology and Obstetrics
      College of Veterinary and Animal Sciences,
      Pookode, Wayanad-6735765
5. Objectives of the study:
   1. To compare the morphological features of tulsi plants that are exposed and un exposed to mobile phone radiation.
   2. To analyze the plants for flavonoids and carbohydrates.

6. Practical /Scientific utility:

Mobile phones have become inevitable in the daily lives of people globally. As cell phone use has become more widespread, concerns have mounted regarding the potentially harmful effects of EMR from these devices. It is estimated that approximately 500 million people worldwide are using mobile phones currently. Due to this large usage of mobile phones, the interactions of EMR with human organs and in particular with the brain is increasing. Experimental studies have shown that the EMR emitted from mobile phones can affect the brain in various ways. Cell phones use radio waves to communicate. Radio waves transport digitalized electrical and magnetic fields, called electromagnetic fields (EMF). The rate of oscillation is called frequency. Radio waves carry the information and travel in air at the speed of light. Cell phones transmit radio waves in all directions. The waves can be absorbed and reflected by surrounding objects before they reach the nearest cell tower. The parameter used to measure the radiation emitted by cell phones is the specific absorption rate (SAR) given in units of Watts of power absorbed per kilogram of tissue (W/kg). The permissible upper limit for cell phones set by the U.S. Federal Communications Commission (FCC) is 1.6 W/kg of RF radiation. Studies on plants are also needed. Tulsi, known as "Queen of herbs", belongs to the family Labiatae, characterized by square stem and specific aroma. In India, the plant is grown throughout the country from Andaman and Nicobar to Himalayas up to 1800 meters above the sea level. There are mainly 4 types of tulsi plants (*Ocimum sanctum*) in India; they are Krishna Tulsi, Rama Tulsi, Vana Tulsi, and Kapoor Tulsi. In this Krishna tulsi and Rama tulsi almost have a similar chemical constituent.

7. Important publications on which the study is based:

Stefi *et al.* (2016) conducted an experiment to check the structural or biochemical changes on *Arabidopsis thaliana* plants by giving long term exposure to non-ionizing radiation emitted from the base unit of a cordless DECT system. When exposed plants were compared to their control counterparts, their biomass and leaf structure was found to be affected. Thinner leaves and fewer chloroplasts were observed.

Chandel *et al.* (2019) evaluated the mitotic index, chromosomal aberrations, phase index and DNA damage of onion roots after exposed to EMFr for different durations (1h and 4h). A significant increase in MI and aberration percentage was recorded upon 4 hours of exposure and also DNA damage with a significant decrease in HDNA accompanied by an increase in TDNA upon exposure of 4hours.

Daud Khan *et al.* (2018) reviewed all the available literature about the responses of different flowering plant species towards GSM and GSM like radiations using physiological, biochemical, molecular and cytological markers using *in vitro* approaches. After the study, they arrived at a conclusion that there was an overall reduction in germination, root-shoot lengths and dry-weight in both dose and time-dependent manner.

Selsam *et al.* (2016) conducted a study in the cities of Bamberg and Halstalt (Germany) to verify the connection between unusual tree damage and radio frequency exposure. During the study, they were able to construct an electromagnetic map of the power flux density, and statistical analysis showed that EMR from mobile phone masts was harmful for trees.

Singh *et al.* (2013) conducted qualitative estimation of phytochemicals and antimicrobial activity of aqueous and methanol extractions of root and leaves of *Ocimum sanctum* against pathogenic bacteria. The study showed the presence of steroids, alkaloids and tannins. Significant level of antimicrobial activity of plant extract was also observed.

Kumar *et al.* (2013) studied the medicinal property of *Ocimum sanctum*. And after the study the results showed that tulsi possessed significant properties like antibacterial, antifungal and anti-inflammatory activity.

8. Outline of the technical programme:

Same species of 36 tulsi plants (*Ocimum sanctum*) with almost same height between 16cm-25cm will be collected from M.S. Swaminathan Research Foundation, Wayanad. These plants will be divided into 3 groups (Control Group, Group 1 and Group 2). Eeach group will have 12 number of tulsi plants. Study will be conducted at the lab of Centre for Wildlife Studies, KVASU, Pookode, Wayanad. Group 1 and Group 2 will be provided with mobile phones of the same model. For plants in Group 1, 1 hour of continuous calls will be given for 6 hours per day with an interval of 30 minutes between each call. For plants in Group 2, 100 text messages will be given per day and the phone will be kept in airplane mode for the whole night. In Control Group, the tulsi plants will be placed inside a Faraday's cage (Barthakur and Arnold, 1988). White light will be used for providing light to the plants, and during night lights will be off in such a way that the durations of day and night will be 9 hours of day and 15 hours of night, same type of soil will be used for all 36 plants and no fertilizers will be used. All plants will be watered twice a day. The plants will be kept at room temperature. The duration of the study will be 5 weeks. The growth of the plants in each group will be examined by measuring its height at periodic intervals. The percentage of leaf fall for each day will be noted and bar graph will be plotted. Any colour change on the leaves will be noted. After the completion of the experiment, dry leaves will be collected and methanolic extraction by Soxhlet apparatus (Yadav *et al.*, 2011) will be performed. This extract will be used for further qualitative tests.

9. Main items of observations to be made:

   1. Percentage of leaf fall
   2. Mean increase in height
   3. Qualitative analysis of leaf extract

10. Duration of research work:

    One Semester

Signature of the Student

Project coordination group proposed: NIL

Place:

Date:

Signature of Guide

Name, address and signature of members of the Advisory committee

1. Dr. Sanis Juliet
   Professor & Head
   Department of Veterinary
   Pharmacology and Toxicology,
   College of Veterinary and Animal
   Sciences, Pookode.

2. Dr. George Chandy,
   Course Director and Special Officer
   Centre for Wildlife Studies, Kerala
   Veterinary and Animal Sciences
   University, Pookode.

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CERTIFICATE

Certified that the research project has been formulated observing the stipulations laid down under the Prevention of Cruelty to Animals Act (Amendment, 1998).

Place: Pookode

Date:

Dr. Abdul Azeez C. P.

(Major Advisor)

CURRICULUM VITAE

1.	Name of the candidate	Aswathy E. B.
2.	Date of Birth	22/08/1997
3.	Place of Birth	Wadakkanchery
4.	Marital Status	Unmarried
5.	Permanent Address	Wildlife Studies
6.	Major field of Specialization	Ellikkal House, Kallepadam Post, Pazhayannur, Thrissur, Pin: 680587
7.	Educational Status	Graduate
8.	Professional Experience	NIL
9.	Publications Made	NIL
10.	Membership in Professional Societies	NIL