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*RESEARCH ARTICLE*

# STUDY OF ELECTROMAGNETIC RADIATION ON FLOWER

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**ABSTRACT**

Electromagnetic Radiation comes out from different electrical, or electronics gadget used for Lab as well as household purposes. As many circuits of household, industrial, and communication systems operate at close proximity of each other and one such circuit can affect the performance of other nearby circuits adversely via inadvertent couplings of their signal through near and far region, propagating electromagnetic fields. Electromagnetic waves generated by different wireless systems like mobile systems, satellite systems, other microwave links, etc. facilitates our communications throughout the world. Thus the hazard of electromagnetic radiation causes interference among these instruments and at the same time affects the living cells which includes both plant and animal cells. Here our research is to study the electromagnetic radiation of all these instruments including mobile phones on the plant cells. For the purpose of this study, here Hibiscus Flower is taken, exposed to electromagnetic radiation for the different time interval with a constant power and at certain temperature. It is observed that the physical condition of the flower as well as dielectric constants is changed. Here, in this case the dielectric properties have been measured on a flower named Hibiscus (petals) using open ended coaxial probe technique at four different temperature levels i.e. at 0th hour, after 1hour, after 2hours and after 3 hours. There are the dielectrics properties for mentioned flowers have been measured and plotted graphically within frequency range of 0.02 GHz to 8.5 GHz at many sample points. Another important observation is that the condition of Hibiscus petals at different time interval after exposing electronic magnetic radiation from Horn Antenna. From this study we can get an idea that how electromagnetic radiation can be affected for plants.

**KEYWORDS**

Hazards of electromagnetic radiation, Effect of electromagnetic radiation, Hibiscus Flower, Dielectric constant.

## 1. INTRODUCTION

IN modern era electronic communication instruments are often considered a health time bomb as this gadget is owned by almost every individual and this is also not merely restricted. In case of communication the cellular network emits low level of radio frequency (RF) energy (Venkatesh and Raghavan, 2005). However, using mobile phones and other wireless communication gadgets are emitting Electromagnetic Radiations (EMR) which have adverse effects on health. There are also some serious damages happening in plants. The EMR is denoted by specific term Specific Absorption Rate (SAR), the measurement of maximum energy which is absorbed by unit mass of exposed tissues. Evaluation of SAR in case of vegetables and fruits due to radio frequency which is emitted from electronic communication devices also depends on the dielectric frequency of the vegetable.

Plant cells also contain moisture and thus SAR values have effects on dielectric properties of the plant as SAR value is largely dependent on the geometry of the dielectric body. Here in this research paper Hibiscus flower is taken for electromagnetic radiation test. Dielectric property is measured with the help of "Agilent 85070E Dielectric Probe Kit" and "Network Analyzer". 20o C is taken for this research as this can be considered as natural environment temperature and also noted down difference in permittivity and loss factors (Guo et al., 2007). This experiment is also taken for several hours at this specific temperature and platelets are observed in different time intervals after exposing the electromagnetic radiation from Horn Antenna with constant power.

"Open ended probe method" which is used for dielectric measurement was introduced by Stuchly in the year of 1980. Dielectric property of tissues can be defined by complex permittivity, which is used to describe the interaction in between the tissues and external electric fields. $\epsilon'$ is called dielectric constant or relative permittivity and $\epsilon''$ reflects the imaginary part of permittivity which also reflects the nature of the tissue.

$$\epsilon(\omega)^* = \epsilon'(\omega) - j\,\epsilon''(\omega) = \epsilon'(\omega) - j\,\frac{\sigma(\omega)}{\omega\epsilon_0}$$

Apart from that flowers and plant cells are destroyed due to natural environment conditions (Kundu and Gupta, 2013). Thus, here in this case if the dielectric properties are known, pest and bacteria controlling methods can be used at the time of testing procedure.

## 2. METHOD

Here in this research hypothesis is developed with help of existing theory and testing processes. Both primary and secondary research takes place with specific processes, thus, the deductive approach takes place in this research process. There are several advantages associated with deductive approach, such as, there is abidance of sources, complete study can be done within a short period of time and there are also abundances of sources (Kraszewski et al., 2002). However, from various secondary

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research this can be found that SAR value have effect of living tissues in terms of area.

$$SAR = \frac{d}{dt}\left(\frac{dW}{\rho \times dV}\right) = \frac{\sigma \times E^2}{2 \times \rho}$$

Increase of temperature can also increase the effect of specific absorption rate, this can be found by this following formula,

$$SAR = C \times \left(\frac{dT}{dt}\right)_{t \to 0}$$

Primary data are collected from the laboratory testing process and secondary data are collected through various journals and related research articles. In order to do primary research, fresh Hibiscus flowers are collected from nearby markets and kept in an air-conditioned room for 2 hours in 20o C temperature. Dielectric property measurements are taken with the help of semi solid or liquid sample measurement processes. Here in this case the end of the coaxial probe is inserted into the solid to get proper values.

However, measurement of dielectric constant and loss tangent values with respective specific frequency is required to be measured with "Agilent 85070E open-ended coaxial line probe kit" and "Agilent Network Analyzer" which is available at Microwave lab, Jadavpur University. This device is connected to the computer via cable and "Agilent 85070Edielectric probe kit software" is installed for computing purposes. Probe is required to connect with VNC through phase stable cable in order to get proper calibration performance. However, VNA in JU microwave lab can measure frequency within the 8.5 GHz range. Therefore, dielectric range can be taken in between 200 MHz to 8.5 GHz.

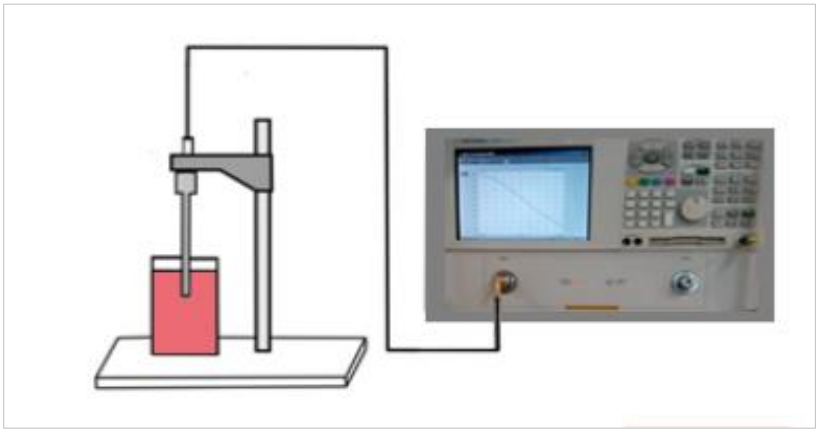

**Figure 1:** Open ended coaxial probe technique

**Figure 2:** Keywords-Dielectric Properties Flower (Hibiscus), Loss factor, Open ended coaxial probe technique, Permittivity

Here in this research dielectric properties are measured for each and every petals of the flower and all data are saved at 101 points by 85070E software.

## 3. Result

Research and analysis of Hibiscus Platelets are done with the help of dielectric property measurement through Agilent dielectric probe kit 85070E and Agilent VNA at different time. After measurements all data are recorded and transferred to the MATLAB software for plotting curves. Here in this research two types of curves are made, which are,

1. Real part of permittivity vs. frequency

2. Loss tangent vs. frequency

Graphical representation of fresh hibiscus at 0th hour, after 1 hour & after 2 hour. The dielectric properties measurement of flowers is done at various times. At 0th hour only one reading is taken, at 1st hour there are two readings and at 2nd hour one reading is taken (Nelson, 2003). However, a temperature dielectric constant measuring probe is required to be gently pressed on inner tissue of the Hibiscus flower petals in order to make no gap within them. Thus, this gives proper measurement in every case.

### 3.1 Hibiscus Fresh 1

#### *3.1.1 At 0th hour*

At the time of fresh hibiscus flower taken for measuring dielectric properties the dielectric constant is around 121.52 at 0.02 GHz. At 0.11 GHz frequency rate the value of dielectric constant value is posted at around 53 (Nelson, 2005). This huge changes is occurred at the first time and after that with increase of frequency the rate of change of dielectric constant is less and this value sticks around 44 to 45. At around 3 GHz the dielectric constant is near about 41. However, SAR in case of higher frequency radiation rate is expected to be lower than SAR value at lower frequency within same temperature. At 8.5 GHz this dielectric constant is observed near about 34. In case of permittivity measurement, the blue graph is responsible and in 0.02 GHz the rate of permittivity value is around 330. This value is reduced to 43.27 at frequency rate of 0.19 GHz. Here in this observation, the tangent of the permittivity curve is continuously decreasing (Nelson et al., 2006). At 2 GHz this value is measured and the value is observed at around 9.3. However, this value is tends to increase after 3.3 GHz and the rate of increase is observed up to 8.5 GHz.

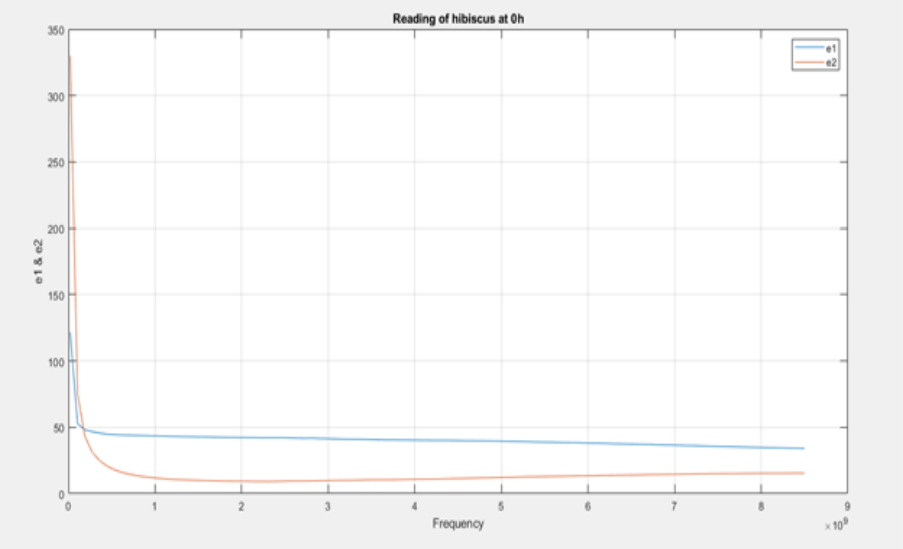


**Figure 3:** Measurement at 0th hour

### *3.1.2 After 1 Hour*

There are two observations taken in the first hour. At first observation the dielectric constant is taken around 73 which at 0.02 GHz frequency rate, which implies that the energy storage capacity in case of Hibiscus is reduced after one hours. These values are also halving 0.02 GHz frequency rate and continuously decrease with the increase of frequency. At 8.5 GHz this dielectric constant gives measurement of 25 (Ripublication.com, 2020). At the time of second reading, dielectric constant is measured at around 50 at 0.02 frequency rate and after that this frequency rate is fluctuating in between 24 and 25 up to 3.5 GHz frequency. The permittivity measurement in case of the first experiment is taken at 0.02 GHz frequency rate is 182. Change of permittivity is dramatically reduced to 6.4 at 3GHz frequency and after that this is increasing very slightly with increase of temperature (Ripublication.com, 2020). The last value of permittivity is observed around 10.742 at 8.5 GHz.

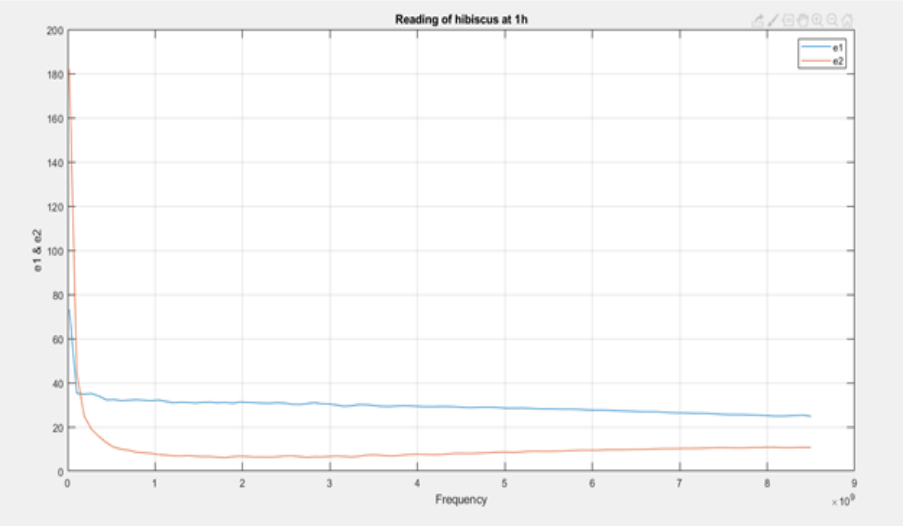


**Figure 4:** Measurement after 1 hour

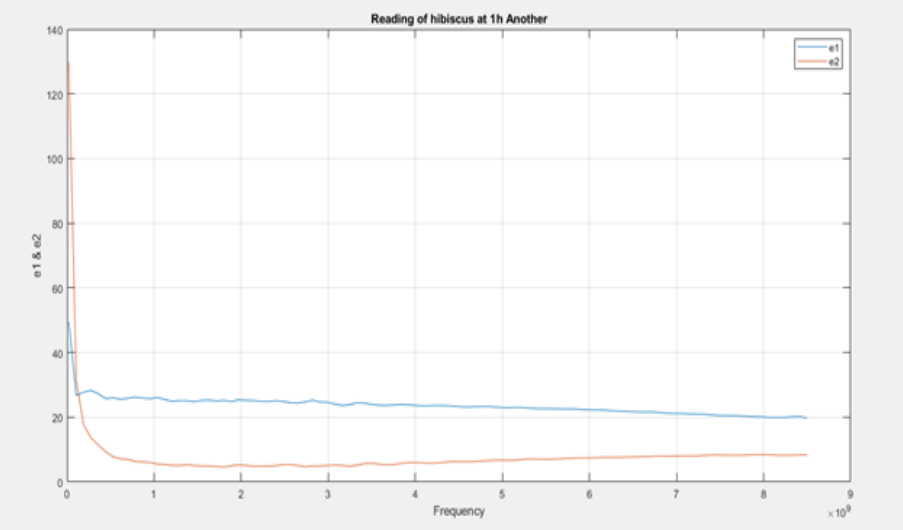


**Figure 5:** Another measurement at first hour

### *3.1.3 After 2 Hour*

In this case Hibiscus flower is taken for measurement dielectric property at 70 in 0.02 GHz frequency rate [10]. This rate changes to 40 after an increase of frequency up to 0.1 GHz. This implies that energy storage capability for Hibiscus is reduced after more than 2 hours. However, permittivity is increased in this case at very first time to 194 at 0.02 GHz (Ripublication.com, 2020). After that, overall implication is same as first data collection at first hour.

### 3.2 Other Observations

There are also some important observations are taken at 2.55 hours, 3.55 hours, 4.55 hours and 5.55 hours after the exposure of electromagnetic radiation.

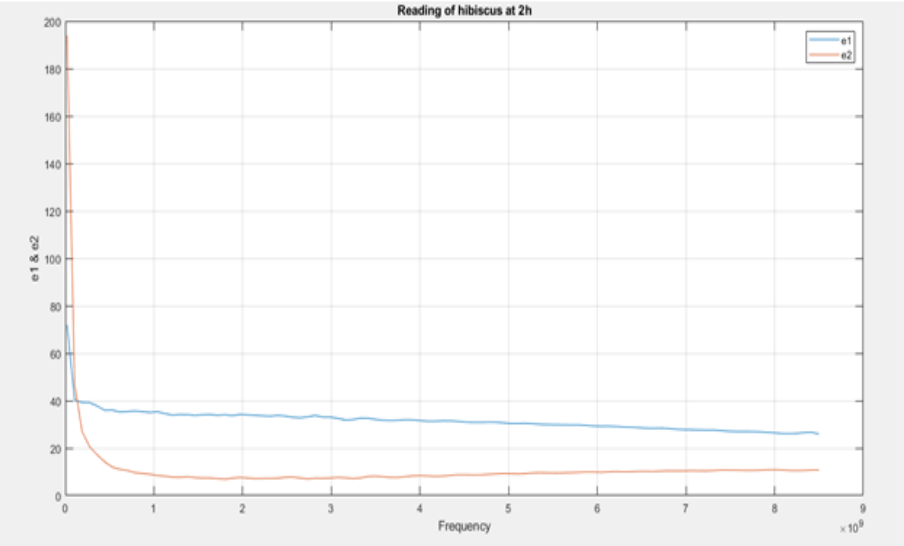


**Figure 6:** Measurement after 2 hour

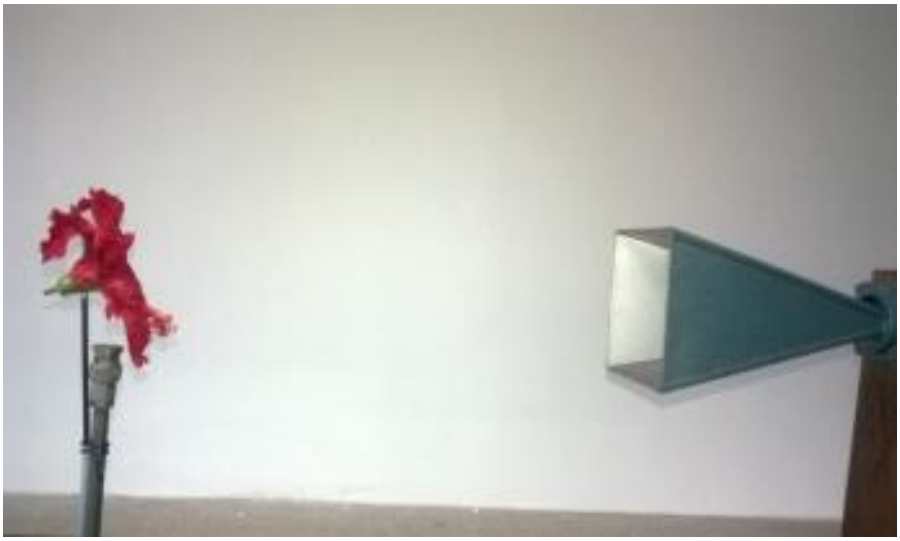

**Figure 7:** Fresh flower has been kept in front of Horn antenna before exposing EM radiation from Horn Antenna

**Figure 8:** Flower has been kept after 1st exposing EM radiation from Horn Antenna, slightly changed its physical condition

**Figure 9:** Flower has been kept after 2nd exposing EM radiation from Horn Antenna, change in its physical condition is observed and various portions of the petals are observed as black

**Figure 10:** Flower has been kept after 3rd exposing EM radiation from Horn Antenna, morechangeinits physical condition is observed and most of the portions of the petals are observed as black

| **Table 1:** At frequency 2.45GHZ | | |
|---|---|---|
| | Permittivity(ε') | Permeability (ε") |
| Fresh flower | 58.2738 | 9.6540 |
| After 30 minutes | 57.4709 | 10.2900 |
| After 60 minutes | 50.7284 | 10.6445 |

| **Table 2:** At frequency 8.5GHZ | | |
|---|---|---|
| | Permittivity(ε') | Permeability (ε") |
| Fresh flower | 46.4057 | 22.3919 |
| After 30 minutes | 44.4570 | 22.0251 |
| After 60 minutes | 38.3729 | 19.1553 |

| **Table 3:** At frequency 2.45GHZ | | | | |
|---|---|---|---|---|
| Fresh flflower | Original Measured value | | With solution measured | |
| | Permittivity (ε') | Permeability (ε") | Permittivity (ε') | Permeability (ε") |
| | 42.1015 | 9.3211 | 39.8369 | 10.7617 |

| **Table 4:** At frequency 8.5GHZ | | | | |
|---|---|---|---|---|
| Fresh flower | Original Measured value | | With solution measured | |
| | Permittivity(ε') | Permeability (ε") | Permittivity (ε') | Permeability (ε") |
| | 31.0328 | 15.8388 | 34.0509 | 15.3785 |

Here in this research complex dielectric measurements are done with respect to Hibiscus flower petals. This flower is taken as there are permittivity is relatively lower and loss tangent plot is considered here within frequency rate of 2 GHz to 8.5 GHz.

### 3.3 Phantom Model Solution

In order to calculate the Specific Absorption Rate in this flower and hazardous effect on their growth, there need to consider the Phantom Model of that flower. However, almost similar solution of dielectric constant is taken within the frequency range of 0.02 GHz to 8.5 GHz. This measured permittivity and dielectric constant can be useful in SAR on the above mentioned flower due to electronic communication. Here, combination of two solution is taken; such as,

#### *3.3.1 Sucrose 1.93 gm*

This is common sugar and this is produced naturally in many plants. This also has a molecular formula of $C_{12}H_{22}O_{11}$.

#### *3.3.2 Gelatin Powder 17.45 gm*

This is one of the colorless, brittle and translucent materials which can be found inside an animal's skin and bones as a collagen form. This can be dissolved in warm water and have chemical composition of water, sodium sulphate, calcium hydrogen phosphate and celite. Molecular formula of this material is $C_{102}H1_{51}N_{31}O_{39}$.

## 4. Conclusion

Here in this research it can be seen that, with increase of electronic communication gadgets in modern era lead a serious effect on plants and its flowers and fruits. Apart from that, with increase of radiation the dielectric constant and permittivity is also changes. However, there are also have the radiation effect on plant is depends on time and duration with its strength. This research is also conclude that with increase of time the effect is also increase and this also changes the structure of plant and in this case the petals are getting black. There are various sources of electromagnetic radiation such as; smart phones, wireless satellite connection, and other wireless devices are increasing day by day and from this study it can be said that it's have some adverse impact on plant growth. Therefore, all electromagnetic communication devices have to adapt different technology in order to mitigate this problem of radiation. However, from different secondary research it had been also seen that effects of magnetic radiation can reduce the ability of photosynthesis and this have directly affects the growth of the plant. Low frequency of 0.1 GHz for very first time can decrease dielectric constant by half. Though this seems less but this can create bigger issues in border section.

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