

RESEARCH ARTICLE | SEPTEMBER 16 2020

## Effect of handphone EMF radiation on survival rate and morphological reproductive organ changes of fruit fly (*Drosophila melanogaster* Meigen, 1830) ✓

Ignatius Sudaryadi ✉; Azizah Nur Rahmawati; Meliana Rizqiyah

AIP Conf. Proc. 2260, 040030 (2020)

<https://doi.org/10.1063/5.0015846>



View  
Online



Export  
Citation

### Articles You May Be Interested In

Auditory sensitivity, spatial dynamics, and amplitude of courtship song in *Drosophila melanogaster*

*J. Acoust. Soc. Am.* (August 2018)

Agar-polydimethylsiloxane devices for quantitative investigation of oviposition behaviour of adult

*Drosophila melanogaster*

*Biomicrofluidics* (June 2015)

Development and fertility studies on post-bio-electrosprayed *Drosophila melanogaster* embryos

*Biomicrofluidics* (November 2009)

# Effect of Handphone EMF Radiation on Survival Rate and Morphological Reproductive Organ Changes of Fruit Fly (*Drosophila melanogaster* Meigen, 1830)

Ignatius Sudaryadi<sup>1, a)</sup>, Azizah Nur Rahmawati<sup>1</sup> and Meliana Rizqiyah<sup>1</sup>

<sup>1</sup>Laboratory of Entomology, Faculty of Biology, Universitas Gadjah Mada, Jl. Teknik Selatan, Sekip, Bulaksumur, Yogyakarta 55281, Indonesia.

<sup>a)</sup>Corresponding author: dsudaryadi@ugm.ac.id

**Abstract.** Electromagnetic field (EMF) radiation can provide biological effects on biomolecules and cells. Handphone (Mobile phone) is one of device that emits the strongest EMF radiation. The growth of cellular communication has occurred in last decade to be a thing to consider for its impact on environment and health. One attempt to overcome the effects of EMF radiation is by consuming antioxidant-rich nutrients such as those contained in fruits. Insects are one component of environment ecosystem that has various roles. Fruit fly was used as an animal model because it has short life cycle and easy to observed. The experiment aimed to determine the effect of feeding medium on the survival and morphological changes of reproductive organ fruit flies after EMF radiation treatment. The experiment was performed by EMF radiation from Handphone exposed to *D. melanogaster* with 3 variation treatments of feed medium namely Guava (PJ), Banana (PP), and Apple (PA). Banana feeding medium was used as standard control. Data were statistical analyzed by One Way Anova test and Tukey test ( $\alpha = 0.05$ ). The results showed that EMF radiation was capable to suppress the survival of imago and reduce the morphology of reproductive organs. Survival rate result of Adult *D. melanogaster* were 84.70% (control); 84.37% (PJ); 65.73% (PP) and 58.09% (PA).

## INTRODUCTION

Electromagnetic fields (EMF) or electromagnetic fields are physical fields produced by electrically charged objects. all who live, always move EMF from various sources, both natural and artificial. In the last few rounds the source of artificial EMF has become one of the things to consider because usage is increasing [1]. In 2015, there were more than 7 billion cellphone subscriptions worldwide, in 2000 fewer than 1 billion [2].

EMF handphone was used in this study because of its increased usage and to find out the effect on ecology, especially in animals around the EMF-exposed environment. To better understand this and see the effect of cell phone EMF on survival and reproductive organs, research on the effect of cell phone EMF radiation on fruit flies was carried out (*Drosophila melanogaster* Meig.). It can be surmised that cellphone EMF radiation can cause damage effects on both germ cells and somatic cells, where cell division is a radiation sensitive target [3][4].

*D. melanogaster* is used as a radiation object in this study because it has several advantages, namely easy to maintain and cosmopolitan distribution, so it is easy to obtain. In addition, fruit flies have a short life cycle of 9 days, while spermatogenesis occurs at 3-5 days of age. So if a fruit fly is irradiated at 3-5 days, there will be a disturbance in the process of cell division (meiosis) precisely in spermatogenesis [5].

This study aims to determine the effect of mobile EMF radiation treatment on the survival and morphology of the reproductive organs (testes and ovaries) of fruit flies (*Drosophila melanogaster*). In addition, to find out the potential for recovery ability in the guava, apple and banana feed medium after exposure to EMF handphone. The benefits of this study specifically as a basic research information that is about the reactivation of mobile EMF derived from antioxidant-rich fruits, one type of antioxidant is vitamin C. Whereas, the general benefits as

information development of science about recovery after exposure to EMF handphone radiation which can be applied to the welfare of human life.

## **METHODS**

### **Fruit Fly Sampling**

In this study, culture of fruit fly was obtained through sampling in the area of along Parangtritis Street at Mergangsan District, Brontokusuman Village. The sampling method used a trap from a jar that contained a banana as insect attractant. Feed extract medium was made by apples juice, bananas juice, cassava, sodium benzoate. Feed extract were refined into 10 bottles. Than each bottle filled 5 male and 5 female of adult flies from initial culture were reared for about one month.

### **Isolation of Male and Female Virgin**

Pupa was put into 24 bottles and maintained until adult. Male and female virgin fruit flies were isolated from pupa's cultures. Virgin Adult Fruit flies were maintained in new culture for next treatment.

### **Cultivation of Fruit Fly**

The method of cultivation referred to and was developed by Hodson and Chiang [6]. Cultivation of Fruit Fly was used small container to facilitate the effectiveness and minimize handling in order to avoid contamination and or fly away. In addition the jar bottle used for culture was sterilized using 96% alcohol, by spraying it throughout the surface of the bottle and then dried with a paper tissue.

### **Preparation of Handphone EMF Treatment**

EMF radiation treatment was done by using a 4G mobile handphone (HSDPA 2100) branded with Smartfren. Mobile phone and placed 0.5 cm from the bottle with the state covered so as not to be biased by environmental factors. EMF radiation was carried out for 6 hours from 09.00 - 15.00 WIB, on each virgin adult fruit fly. Treatment was continued for three days after fruit flies were attached to each treatment bottle which amounted to six bottles. Than followed by observations from the F1 generation without irradiation treatment. Six other culture bottles without radiation treatment. The other six bottles without radiation treatment were placed in the rearing room.

### **Preparation Of Male and Female Reproductive Organ And Morphometry**

Reproductive Organ samples were isolated from (4 various treatments): Three (3) pairs of fruit flies were reared in Banana medium after radiation treatment, 3 pairs of fruit flies were reared Apple medium after radiation treatment, 3 pairs of fruit flies without banana medium and radiation treatment and 3 pairs of fruit flies without apple medium and radiation treatment. Isolation of the testes and ovaries were carried out by referring to Zamore and Ma [7]. Glass objects were placed on black HVS paper. Male and female fruit flies collected from 12 jar bottles (6 bottles of EMF handphone radiation treatment jar and 6 bottles of jar without radiation of EMF handphone treatment). Fruit flies were mutilated with chloroform. Than, fruit flies were transferred to petri dishes. 70% alcohol was taken using a pipette and dropped on fruit flies. fruit flies were positioned abdomen facing upward, so that the position of the reproductive organs consistent between dextral and sinistral. The wing of the fly was lifted and held with a slow pin prick between the sixth abdominal segment (A6) and the seventh abdominal segment (A7). Gently pull the needle toward the posterior. The testes and ovaries were separated from other organs and surgical debris. Testicles and ovaries were measured and observed using a digital microscope supereyes magnification 10 times. Morphometry measurement of male and female reproductive organ was done for each group.

## Data Analysis

Data were obtained from survival rate of insect life phase and analyzed by formula [8] :

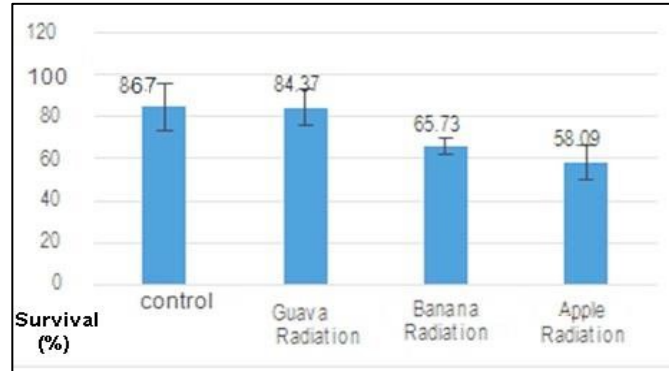
$$\text{Survival} = \frac{\text{Number of Imago}}{\text{Number of Larvae}} \times 100\%$$

$$\text{EMF-rad suppression} = 100\% - \text{survival}$$

Statistical analysis used in one way ANOVA continued with Tukey test. Morphological observation was analyzed descriptively and reproductive organ morphometry of data were analyzed with T-test. All statistical data were used significance of P less than or equal to 0.05.

## RESULTS AND DISCUSSION

Survival rate is the percentage of living things in the test group that are treated and can survive for a certain period of time [8]. In this study the survival of fruit flies was defined as the percentage of imago that lived after EMF radiation treatment for a certain period of time.



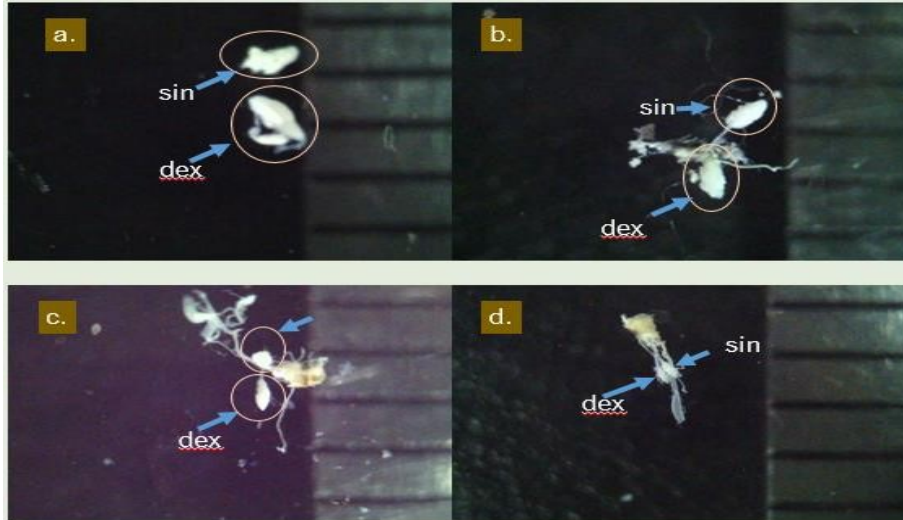
**FIGURE 1.** Survival rate of fruit flies in one life cycle.

The results showed that control had the highest survival rate followed by radiation treatment of various kinds of mediums, namely the treatment of guava, banana, and apple. Based on the analysis with One Way Anova significance of 0.05 and continued by Tukey test it can be seen in Figure 1 that the control is only significant for the radiation treatment of apple feed medium. This is consistent with the results of the vitamin C test (Table 2.) where apples have the lowest vitamin C content when compared to guava and bananas.

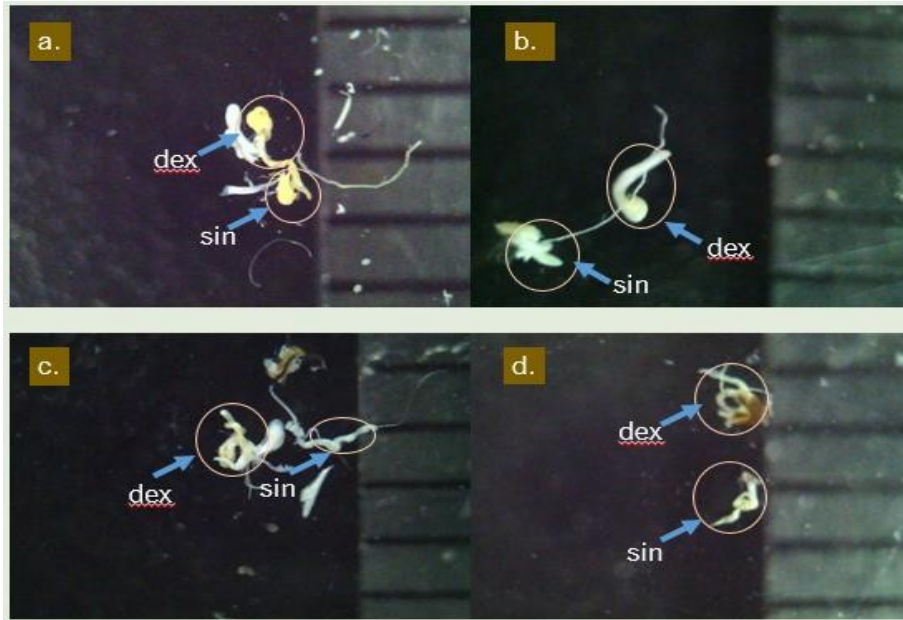
**TABLE 1.** Vitamin C content (mg/100g).

|        |               |
|--------|---------------|
| Guava  | 163.02 ± 8.58 |
| Banana | 22.53 ± 3.22  |
| Appel  | 14.28 ± 0.7   |

Guava which has the highest antioxidant content, especially vitamin C shown in (Table 1.) has a high recovery effect. This is indicated by the results of the Tukey test analysis which showed no significant effect on controls. From these data it can be assumed that the nutrient of the herbal medicine has the ability to be optimally consumed, so that vitamin C which is a non-enzymatic antioxidant and antioxidant from the body in the form of enzymatic antioxidants work together to overcome ROS which acts as a byproduct of metabolism. The following is the mechanism of reaction of vitamin C binding to ROS.

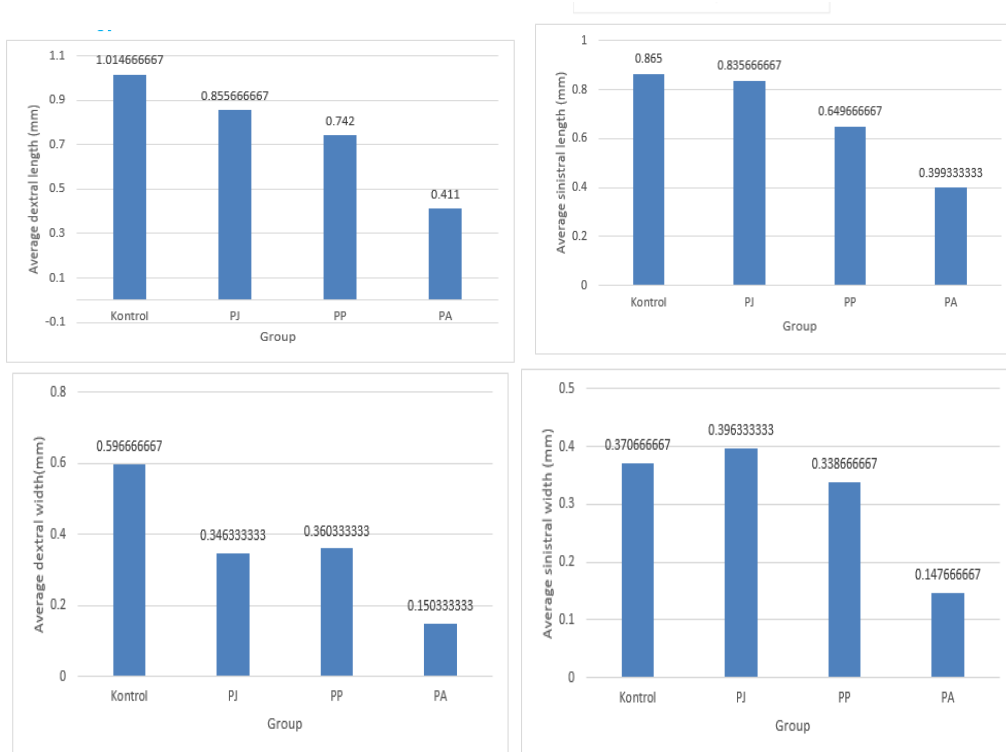


**FIGURE 2.** Reproductive organs of female fruit flies: a) ovarian control group; b) ovaries treated with guava medium (PJ); c) ovaries treated with banana (PP) medium; d) ovaries treated with apple (PA) medium.



**FIGURE 3.** Reproductive organs of male fruit flies: a.) Testicular control group; b.) testicular treatment with guava medium (PP); c.) testicular treatment with banana guava (PP) medium; d.) testicular treatment with apple (PA) medium.

Qualitatively, if no measurements are taken Figure 2 and Figure 3. EMF radiation treatment able to shorten the size of organ reproduction, both in male (testicular) and female (ovarian) reproductive organs in PP and PA. These size looked shorter than normal and indicates that the reproductive organs that were exposed with EMF radiation to be less and not-well developed compared to control. The stressor as ROS from EMF radiation are assumed to be the cause reduced development of the reproductive organs. Meanwhile, in groups PJ treatment of male and female reproductive organs has no significance different to the control. Besides, the control group were showed more concentrated color of testes than the treatment group. It is assumed that, high concentration of vitamin C in guava, was able to ward off free radicals due to EMF radiation treatment. The quantitative results morphometry of male and female fruit fly reproductive organs in each group and each various treatment can be seen in following Figure 4 and Figure 5.

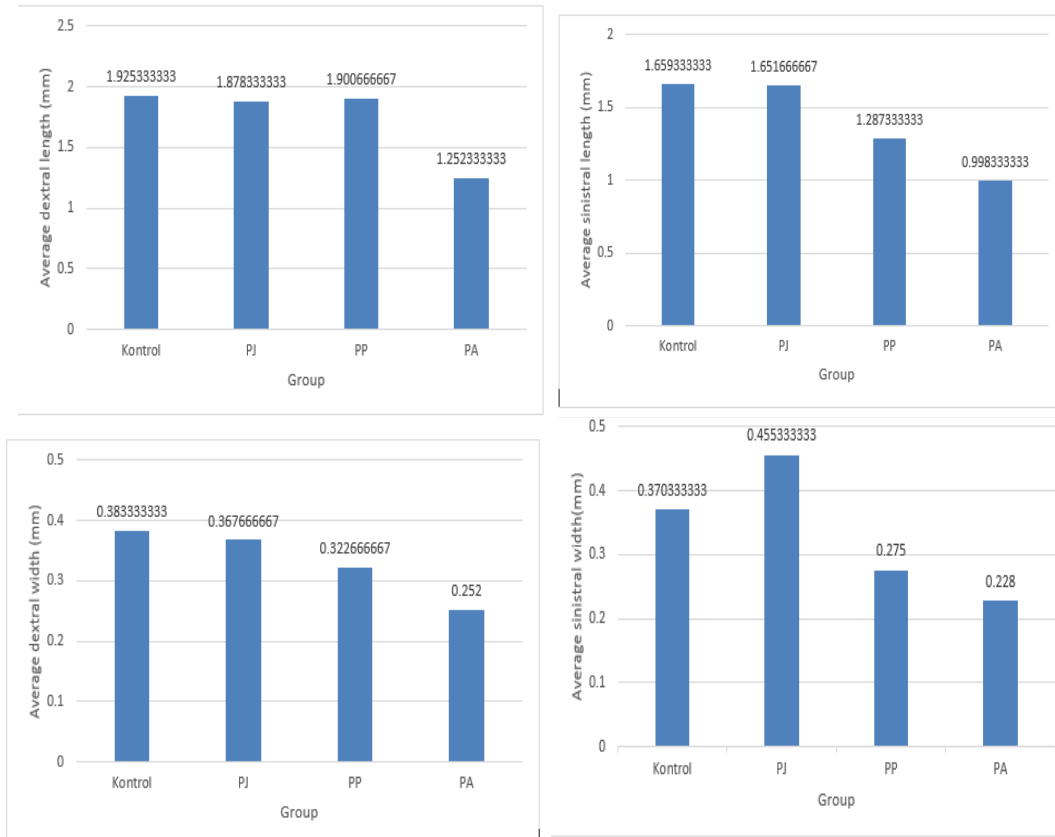


**FIGURE 4.** The morphometry of the female fruit fly's reproductive organs.

However, ovarian dextral length, ovarian sinistral length, ovarian dextral width, dextral length testis and width of the testicular sinistral control were only significant to radiation treatment apple feed medium. This is consistent with the results of the vitamin C test which showed that apple has the lowest vitamin C content when compared to guava and banana.

The treatment of mobile EMF radiation to changes in reproductive organs related to survival. Cellphone EMF radiation can decrease fertility by decreasing ability to reproduce as showed in the survival data (Figure 1.). Another result of the mobile EMF radiation is reduced reproductive organs both male and female. Reduced reproductive organs were caused by Reactive Oxygen Species (ROS). ROS has an effect at the cellular level and is able to interact directly with DNA [9]. In addition, electromagnetic radiation can increase oxidative stress Reactive Oxygen Species (ROS) damaging sperm and excess production of free radicals or reactive oxygen ROS has been known as one of the causes of infertility, wave radiation Wi-Fi electromagnetic radiation emission will affect the decrease sperm count and sperm motility [10].

It is assumed that, the effect of ROS was difficult to suppress in the treatment of EMF exposure the cellphone has disturbed DNA. If the regulation is disturbed, then also disturbed formation of main functional and structural proteins of the body. As a result, morphology of parts of body becomes smaller so that the organs reproduction also changed.



**FIGURE 5.** The morphometry of the male fruit fly's reproductive organs.

## CONCLUSION

Handphone EMF radiation can suppress the survival of fruit flies and change the morphology of their reproductive organs. The greatest suppression of survival and the marked changes in reproductive organ was found in the EMF radiation treatment and reared with Apple medium (PA) this correlated with lowest vitamin C. Guava and Banana medium treatment have a good potential for fertility recovery based on the results of the survival rate of fruit flies that were not significantly different with control.

## ACKNOWLEDGMENTS

Thanks were delivered to Faculty of Biology UGM for the financial support under Research Award 2019 and Laboratory of Entomology, Biology Faculty, Universitas Gadjah Mada, Yogyakarta, Indonesia for research facilities.

## REFERENCES

1. R. R. Feynman, Leighton, and M. Sands. The Feynman Lectures on Physics Vol II: Mainly Electromagnetism and Matter (Basic Books, New York, 2013).
2. International Telecommunication Union. ICT Fact & Figures. (International Telecommunication Union: ICT Data and Statistics Division, Geneva. 2015).
3. R. Sofyan, Y. Sumpena, S. Syarif, I. Adiyati, Jurnal Berita Biologi. Letters **8**(4), 2-3 (2007).
4. S. Baatout and H.Derradji, JBRHA. Letters **6**(1), 102-105 (2004).

5. D. Borror, C. A. Triplehorn and N. F. Johnson, *An Introduction to the Study of Insects*. 6th ed. (Academic, New York, 1992).
6. A. C. Hodson and H. C. Chiang, *Scientific Journal Series. Letters* **20**(3), 176-177 (1948).
7. P. D. Zamore, and S. Ma, *J. Vis. Exp. Letters* **51**, 26 (2011).
8. NCI, *NCI Dictionary of Cancer Terms* (2019). <[www.cancer.gov](http://www.cancer.gov)>
9. N. E. I. Birben, S. Wigby, J. M. Boone, L. Partridge, and T. Chapman, *Proc. R. Soc. B. Letters* **275**, 1675-1683 (2008).
10. Soleimani, *INT. J. RADIAT. RES. Letters* **13**(4), 364-368 (2015).