The Effect of UV Radiation and Treatment to Orange (*Citrus sinensis* L. Osbeck) Fruit Feeding on the Survival Rate and Colony Sex-ratio of Fruit Fly (*Drosophila melanogaster* Meigen, 1830)

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ABSTRACT
Ultraviolet (UV) is a form of physical stress that forces living organisms to respond to the challenge of DNA alteration. UV light causes oxidative stress by causing the creation of reactive oxygen species (ROS). Antioxidants are substances that can interfere with the production of reactive oxygen species (ROS). Vitamin C in fruits such as oranges and bananas is a type of antioxidant. The fruit fly (*Drosophila melanogaster*) is an example of an insect that has played a significant role in genetics development. The goal of this study is to see how orange, as a supplementary food media, affects the survival rate and sex ratio of a fruit fly colony following UV exposure. The method utilized to cultivate fruit flies is the approach developed by Hodson and Chiang (1948). The UV and non-UV treatment groups were separated in the experiment. Each treatment was split into two groups: banana fruit feeding (control) and banana fruit feeding with orange as a supplemental feed. In three days, UV radiation was applied for two hours per day. Observations were done on the colony's survival rate and sex ratio. The survival percentage of the non-UV treated banana fruit feeding group, which served as a control, was 66.20 %, which was lower than the orange-supplemented group (70.13 %). Under UV irradiation, the survival rate in the standard medium (banana) was 21.44 %, whereas it was 62.88 % in the orange-supplemented group. The data were then statistically evaluated, and it was shown that there was no significant change in the sex ratio between the colonies from all treatments. This suggests that UV radiation had no effect on the sex ratio. In conclusion, UV radiation has the ability to act as a physical stressor on the fruit fly colony's survival rate, but has no influence on the sex-ratio. Under UV-treated conditions, orange as a supplemental feeding media has the ability to protect colony life.

***Keywords**: Drosophila melanogaster, Orange fruit, Sex ratio, Survival rate, UV.*

1. INTRODUCTION

Electrically charged things produce physical fields that emit UV light and other types of electromagnetic radiation. Radiation from numerous sources, both natural and artificial, poses a constant threat to all that lives. The gradual increase of UV can drive the generation of oxygen radicals and trigger oxidative stress in organisms [1], therefore naturally occurring sources of UV have become one of the things to be concerned about. UV was employed in this study to see what influence it has on the ecology, particularly on insect pests that are found in UV-exposed environments due to increased consumption. To better understand and assess the consequences, researchers looked at the effects on the survival rate and reproductive organ of fruit flies (*Drosophila melanogaster*). UV radiation is expected to affect both germ cells and somatic cells

during cell division since cell division is a radiation-sensitive process [2], [3].

In insects with separate sexes, the sex ratio is the percentage of male or female offspring produced. The reproductive potential of a population is determined by the proportion of females in the population. The sex ratio in a randomly mated population generally fluctuates about 1:1 because of sex chromosomal segregation during gametogenesis [4], [5], and this 1:1 sex ratio normally suggests stabilizing selection on males and females [6].

D. melanogaster is used as a radiation object in this study because it offers a number of benefits, including ease of care and universal dispersion (easy to find). Fruit flies also have a short life cycle (9 days), with spermatogenesis taking place between the ages of 3 and 5. The process of cell division (meiosis) during spermatogenesis will be disturbed if a fruit fly is irradiated at the age of 3-5 days [7].

The goal of this study is to see how UV light affects the survival rate and sex ratio of a fruit fly colony (*Drosophila melanogaster*). In addition, after being exposed to UV light, the banana and its various feed media combinations were evaluated to see if there were any potential options for recovery. The special value of this study as a fundamental research project is that it provides information on the UV protection offered by antioxidant-rich fruits, one of which is vitamin C. The overall value, on the other hand, is to give knowledge about scientific advancements in the field of UV radiation recovery that can be applied in society, notably in the field of UV-light-based insect pest control.

2. MATERIALS AND METHODS

Fruit Fly culture was received from the Laboratory of Genetics and Breeding, Faculty of Biology, Universitas Gadjah Mada for this work. The culture consisted of a wild-type phenotype that had been adapted to banana as a standard medium. The acquired culture was used as the primary source of model population in a jar bottle. Apples, bananas, cassava, and sodium benzoate were blended until smooth to make the feed extract medium. After smoothing the mixture, it was separated into ten bottles. For each bottle, ten adult fruit flies (5 male and 5 female) were distributed from the original culture. Rearing lasted for one month.

2.1. Isolation of Male and Female Virgin

The pupae acquired from early cultures were used to segregate male and female virgin fruit flies. Pupae were placed in 24 jar bottles for sexing and kept until they reached the imago stage. The fruit flies were kept in various mediums depending on the research procedure. Each isolation yielded both a male and a female. They were both virgins and the same age.

2.2. Cultivation of Drosophila melanogaster

Hodson and Chiang (1948) created the method that was used. The cultivation was carried out in a container that was not too large in order to make it easier to use and save space. In addition, the risk of contamination and escape was reduced as a result of this. The disinfection of the culture jar bottles was achieved by spraying 96% alcohol on the bottles' surfaces and then drying them with a tissue..

2.3. Preparation of UV-light Experiment Sets And Presentations

UV light was used to irradiate the samples (Bossecom TL 2; 10 watt). Unpaired *D. melanogasters* were exposed for three days and two hours each day (12.00 - 14.00 Western Indonesia Time), then for two days with the same dose after they were paired. The number of individuals from each stage of the F1 generation (larvae, pupae, and imago) were eventually counted and tallied. The control group was raised in its own room, with the number of individuals from each stage (larvae, pupae, and imago) tallied and tabulated. The experiments were carried out in triplicates.

2.4. Measurement of sex ratio in the laboratory-reared populations

When the adults emerged from each treatment bottle, they were sexed. The proportion of males (M) to females (F) in each sample or the total adult population was calculated and reported as the sex ratio.

2.5. Data Analysis

The following formula (Equation (1)) was used to examine the data collected from the survival rate per life phase (NCI, 2019) :

$$Survival\ rate = \frac{Number\ of\ imago}{Number\ of\ larvae} \text{x}100\%$$
$$UV\ supression = 100\% - survival \quad (1)$$

A one-way ANOVA and a Tukey test were used to evaluate the data. A T-test was also performed on the sex ratio data, with a significance level of P less than or equal to 0.05.

3. RESULTS AND DISCUSSION

The survival rate is defined as the percentage of live animals in a test group who are treated and can survive for a set amount of time [8]. The survival rate of fruit flies in this study is defined as the proportion of imago

that survives after being exposed to UV radiation for a specific amount of time.

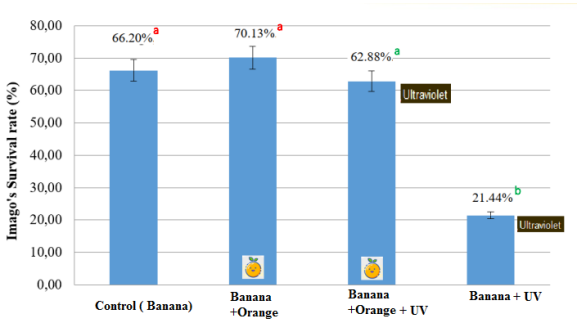

Figure 1. Survival rate of fruit flies in one life cycle

UV radiation was found to be capable of preventing the fruit fly imago from surviving. The survival rate was 66.20 % in the control group (banana fruit feeding), and 70.13 % in the orange treatment. The survival rate under UV radiation in ordinary medium was 21.44 %, but it was significantly higher with orange treatment, at 62.88 % (Fig. 1). The banana medium with orange treatment (without UV) had the best survival rate of 70.13 %, followed by the control (normal medium), radiation treatment with two types of medium (UV+Banana+Orange), and finally the UV-Banana Medium. The medium with Banana+UV was the only treatment with a significant difference compared to the other treatments, according to the statistical analysis using One Way ANOVA (significant difference at 5% level) and Tukey test. When exposed to UV light, the medium Banana+Orange showed a higher survival rate than the normal medium. This indicated that the orange's supplementary nutrition (vitamin C) has an effect because it is higher than the banana, as seen in Table 1. When compared to a control on standard media, this could result in better reactivation on survival rate under UV radiation exposure.

The UV suppression that resulted also revealed that it had variable degrees of effect on each stage of D. melanogaster. UV radiation was found to have a negative impact on colony development and survival at all stages of life. In this scenario, it can be agreed that the vitamin C-rich feed (Table 1) should be consumed to its full potential in order to provide improved survival protection and reactivation for the fruit flies following UV exposure.

Table 1. Vitamin C content (mg/100g) of Banana and Orange Fruits.

Fruit	Vit. C (mg/100g)
Banana	21.55 ± 2.021
Orange	27.96 ± 2.024

To battle ROS, which is a result of metabolism, vitamin C, a non-enzymatic antioxidant, and the body's antioxidants in the form of enzymatic antioxidants work together. This is possible because, in comparison to the normal medium, it was found that it could not optimally reactivate to combat the growing rate of ROS in their bodies after UV exposure. It eventually has an effect on growth and development by altering the molecules involved in these processes [9].

Tabel 2. Sex ratio of Fruit flies reared at different media culture and UV treatment

Treatment	Sex ratio (M/F)
Control (Banana)	0.74 ± 0.72[a]
Banana + Orange	0.85 ± 0.46[a]
Banana + Orange + UV	0.79 ± 0.76[a]
Banana + UV	0.73 ± 1.12[a]

*) same letter on the same column means there is no significant difference.

Table 2 shows the sex ratios of adults created in the lab under four distinct treatments. The sex ratio did not differ significantly across all treatments. UV radiation had no effect on the sex ratio of fruit flies colonies in two types of media cultures, according to the findings. However, both intrinsic and extrinsic factors can influence the sex ratio. Intrinsic factors include genetics, behavior, and physiology, whereas extrinsic factors include biotic and abiotic factors such as temperature, photoperiod, humidity, light condition, and the type, quantity, and quality of host or prey [10], [11].

It's worth noting that the state of the environmental variables in laboratory incubation and treatments does not appear to alter considerably, implying that the sex ratio is unaffected. Sudaryadi *et al.*, 2019 have found that physical stressors, such as EMF radiation, can reduce fruit fly survival rates and alter the shape of their reproductive organs [12]. The sex ratio reflects the ability of fruit fly colonies to survive under each treatment based on these data. Meanwhile, changes in the sex ratio during an insect's life cycle indicate the potential reproduction rate and give suggestions about mating time and location, as well as dispersion timing in relation to mating and reproduction [13]. Sex ratios have an impact on the ecology and evolution of mating systems, reproductive techniques, and insect population genetics (Werren & Godfray 1995). As a result, understanding a species' sex ratio throughout its life cycle is vital and valuable, particularly in predicting the time and size of pest outbreaks and determining the best pest control technique.

Based on these results, it can be concluded that the fruit fly's survival rate has been observed to be suppressed by UV radiation. It was 66.20 % in the banana control treatment and 70.13 % in the orange treatment. It was 21.44 % in the banana feeding group after UV treatment, and 62.88 % when paired with orange. Orange fruit, as a supplement, has the capability to safeguard and reactivate the fruit fly colony life under

UV-treated conditions. The sex ratio of the fruit fly colony is unaffected by UV radiation treatment.

AUTHOR'S CONTRIBUTIONS

The research was designed by I.S. Y.M. and N.K. The data was collected by I.S. Y.M. and N.K. The paper was written by I.S. and N.K. The paper was proofread and revised by I.S.

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CONFLICT OF INTEREST

The authors state that this paper does not cause them any conflicts of interest.

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