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The Effect of Mass Gainer on the Sex Ratio in *Drosophila melanogaster*

[1]Harshita L, [2]Anusree KA, [3]Asniati Jabbar, [4]Aysha Barira HM, [5]Sadiya Sultana T and *[6]Krishna MS

[1, 2, 3, 4, 5, *6]Department of Zoology, University of Mysore, Manasagangotri, Mysuru, Karnataka, India.

Abstract

The diet is one of the key factors that influence the reproductive success and offspring sex ratio of an organism. In the present study the flies of *D. melanogaster* are cultured in the wheat cream agar media, 20g mass gainer media and 10g mass gainer media to understand the effect of mass gainer on the sex ratio in *D. melanogaster.* The results showed that the female offspring were produced more than the male offspring in all the three diets. The 10g mass gainer treated flies produced significantly more female and more male offspring compared to the wheat cream agar diet which produced the less females and male offspring as well as 20g mass gainer treated flies shown the average production of male and female offspring. Thus, suggests that the nutrition alters the offspring sex ratio in *D. melanogaster*.

Keywords: Offspring, diet, mass gainer, sex ratio, *D. melanogaster*

Introduction

Animal sex ratio is known to be altered by a variety of genetic and environmental factors. Male: female ratios may deviate from the theoretical 1:1 ratio due to variables affecting the primary sex ratio or mechanisms at work after fertilization that affect the secondary sex ratio. Surprisingly little study has been done to investigate how the environment affects the sex ratio. As a result, the sex ratio is 1:1 in many organisms, such as insects (Prakash, 2008) [9].

In insects with separate sexes, the sex ratio is the proportion of male or female progeny produced. The proportion of females indicates reproductive potential of a population. Normally, in a randomly mating population, sex ratio varies around 1:1 because of the segregation of sex chromosomes during gametogenesis (Rawlings and Maudlin, 1984; Werren and Godfray, 1995; Hoy, 2004) [10, 17, 4] and this 1:1 sex ratio generally indicates stabilizing selection on males and females (Schowalterl, 1996) [11]. This ratio maximizes the availability of males to females, and hence maximizes genetic heterogeneity (Schowalter, 2016) [11]. In the absence of manipulation, the sex ratio is constant (Cherian *et al*, 2016).

The majority of earlier research on this subject concentrated on the amounts of food available to reproducing females and found strong maternal-allocation responses to experimental manipulations of resource quantity in ways that were likely to affect both maternal and offspring fitness (Meijer and Langer, 1995; Selman and Houston, 1996; Williams, 1996; Rutstein *et al*., 2005) [13].

Food availability can affect patterns of sex allocation relative investment into males and females (Rosenfeld and Roberts, 2004; Robertson *et al,* 2006), in addition to more visible features like offspring size and number.

D. melanogaster was used as a model organism in this study. The organism was chosen in this study because of some reasons. First, *Drosophila* is an organism that produced consistently high numbers of offspring. Second, this organism is recorded as rapid breeder with a lot of eggs and short life cycle. Third, this organism has often been as model organism in many studies examining various problems in biology. (Neethu *et al*., 2014).

Mass gainer is a dietary supplement available in powdered form used to help gain weight which is loaded with calories through carbohydrates and proteins with varying amount of fats, vitamins, minerals, amino acids, and other nutrients. Real Mass Gainer provides 16g of protein in one scoop, sourced from a blend of (whey concentrate, whey protein isolate, milk protein concentrate, milk powder, and soy protein isolate), maltodextrin, starch, complex carbohydrates, and BCAAs (branched chain amino acids) to support muscle protein synthesis and recovery. Each serving of our Mass Gainer powder delivers an all-inclusive dose of mass-building proteins, carbohydrates, and other vital nutrients. However, effect of mass gainer on sex ratio has not been studied, therefore present study has been undertaken.

Materials and Methods

The mass gainer was purchased through Flipkart App from A207, Lane No. 9, No. 4, Mahipalpur, Delhi, 110037, India. This mass gainer used to prepare the experimental media.

Establishment of Stock

Experimental Oregon K strain of *D. melanogaster* used in the study was collected from *Drosophila* stock center. Department of studies in Zoology, University of Mysore,

***Corresponding Author:** Krishna MS

Mysore and this stock was cultured in bottles containing wheat cream agar media [100g of jaggery,100g of wheat cream rava,10g of agar was boiled in 1000 ml distilled water and 7.5 ml of propionic acid was added]. Flies were maintained in laboratory conditions such as humidity of 70% and 12 hours dark 12 hours light cycles and temperature 22° C ± 1° C.

Establishment of Experimental Stock

The flies obtained as above were used to establish the experimental stock with different diet media [Wheat cream agar media: Wheat cream agar media was prepared from 100g of jaggery, 100g of wheat cream rava powder, 10g of agar boiled in 1000ml distilled water and 7.5 ml of propionic acid added to it.

10g of Mass Gainer Media: is prepared from 100g of jaggery, 90g of wheat cream rava and 10g of mass gainer powder, 10g of agar boiled in 1000ml of distilled water and 7.5 ml of propionic acid added to it.

20g of Mass Gainer Media: is prepared from100g of jaggery, 80g of wheat cream rava, 20g of mass gainer powder, 10g of agar boiled in 1000ml of distilled water and 7.5 ml of propionic acid added to it]. The flies emerged from the wheat cream agar media and other experimental treated media under the same laboratory conditions as mentioned above were used to study the sex ratio experiment in *D. melanogaster*.

Sex Ratio Experiments

The virgin male and female flies were collected from the wheat cream agar, 10g mass gainer and 20g mass gainer diets. Allow them to mate for five days. After mating, these mated pairs were transferred to culture bottles containing control media and transferred once in seven days until their death. And the male and female offsprings emerged from each diet were noted down and experiments were continued until the death of the flies. A total of fifteen pairs were made separately for each of the wheat cream agar, 10g mass gainer and 20g mass gainer.

Result

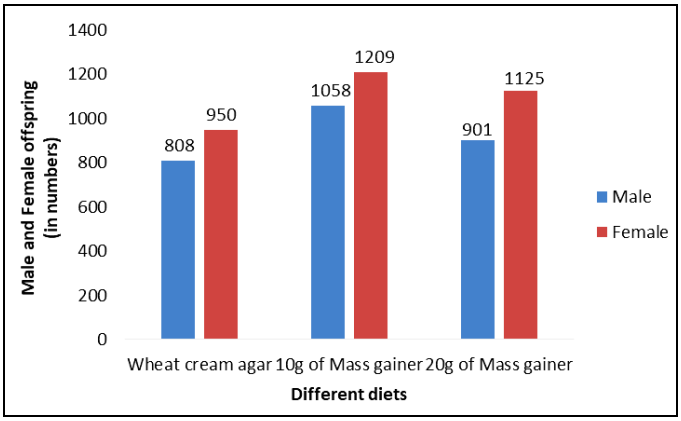

Fig 1: The graph shows that control and mass gainer treated (20g and 10g concentration) offspring sex ratio (Male and female) in *D. melanogaster*.

The figure 1 suggests that the female offspring were produced more than the male offspring in all the three diets. When the data subjected to the Chi square analysis showed the no significant variation between the male and female sex ratio in all the three diets.

Table 1: Effect of control and mass gainer treated flies on offspring sex ratio in *D. melanogaster*

Treatment	No. of Adults	No. of Male	No. of Female	F:M Ratio
Wheat cream agar	1758	808	950	1:0.85
10g of Mass gainer	2267	1058	1209	1:0.87
20g of Mass gainer	2026	901	1125	1:0.80

Table 2: Effect of control and mass gainer treated flies on offspring sex ratio in *D. melanogaster*

Treatment	No. of Adults	No. of Male	No. of Female	M:F Ratio
Wheat cream agar	1758	808	950	1:1.17
10g of Mass gainer	2267	1058	1209	1:1.14
20g of Mass gainer	2026	901	1125	1:1.24

Table 3: Effect of control and mass gainer treated flies on offspring sex ratio in *D. melanogaster*

Treatment	F:M Ratio	Chi Square Value	Significance
Wheat cream agar	1.17:0.85	5.734	P>0.05
10g of Mass gainer	1.14:0.87	5.030	P>0.05
20g of Mass gainer	1.24:0.80	12.38	P>0.05

Discussion

There are several studies which reveals that the physical factors like temperature, photoperiod effects on the sex ratio in insects including *D. melanogaster* but as per our knowledge of information our study is the first report on the effects of mass gainer on the sex ratio in *D. melanogaster*. Mass gainer, often known as a "weight gainer," is a powder that is intended to replace meals with the goal of gaining muscle mass. In order to encourage an energy surplus and the synthesis of muscle protein, the majority of mass gainers are high in fat, protein, and carbohydrates. In order to speed up recuperation, mass gainers may also include additional muscle-building components like beta-hydroxymethylbutyrate (HMB) and creatine monohydrate. Mass gainer is a powdered supplement that combines carbohydrates and protein which is usually used to increase body mass (Campbell *et al*, 2008).

In the present study, the (figure 1) results revealed that the female offspring were produced more than the male offspring in all the three diets. This is because the quality and quantity of the diet influences on the variation in the sex of the offspring. Several studies have been demonstrated that diet quantity and quality influences maternal reproductive output and sex of the organism. According to Yazgan (1972) [18], the increase in amino acids in the diet increases the number of female individuals of Pimple thirunallar (endoparasitoid). Parent flies prefer the production of a particular sex in their progeny that increases the possibilities of survival for that species, by assisting them in reproduction or decreasing the competition for mates, habitats and resources. Besides these factors, sometimes the sex of the offspring also depends upon the health of the mother (Trivers and Willard, 1973) [15].

Compelling studies have shown that according to environmental factors were known to alter sex ratio in *D. melanogaster* (Yander, 1965) the results, while environmental temperatures have some influence on appropriate sex ratios, they are mostly controlled by genetics. At each temperature, each genotype appeared to have its own usual sex ratio, which frequently deviated greatly from a 1:1 ratio. This confirm earlier studies of nutrition effect on offspring sex ratio they shown that food quantity (i.e., maternal feeding rate) affects maternal reproductive output in reptiles, but the effects of dietary quality have largely gone unnoticed (Ballinger 1977; Seigel and Fitch 1985; Du 2006) [12]. Thus, these studies reveal that reproductive females' diet quality affects not just their ability to reproduce, but also the size and sex of their offspring. Therefore, the reaction norms that relate the quality of a maternal nutrition to her ability to reproduce may have significant fitness implications. The low-quality diet's detrimental effects on maternal health and the quantity of clutches generated imply that the females receiving this treatment had little energy available for reproduction. Furthermore, females on the low-quality diet started having offspring almost a month after those on the high-quality diet had already given birth to their initial generation. This is likely because the females on the low-quality diet needed more time to gather adequate energy for transmission production in the face of low nutrient availability. Despite the fact that they laid less eggs overall, the females who consumed the poor diet did so at a substantially higher egg size than those who consumed the high-quality diet. Even after studies were adjusted for clutch size, it is interesting to note that this pattern remained proving that investment per egg increased without a decrease in egg number. This pattern shows that the way reproductive females devote their energy to reproduction is influenced by the quality of their nutrition. Our findings are comparable to those that were previously published for insects (Fischer *et al*, 2006).

Therefore, present study revealed that in both 10g mass gainer and 20g mass gainer female offspring were produced greater than those of male offspring (Figure 1; Table1-3). This shows the nutrition is an important factor affecting sex ratio variation in *D. melanogaster*. Further studies have also shown that offspring sex ratios were strongly affected by maternal diet, the date of oviposition and their interaction (Table1-3). In general, females fed the high-quality diet produced female-biased sex ratios and those on the low-quality diet produced male-biased sex ratios. Thus, this study suggests nutrition alter sex ratio in *D. melanogaster*.

Conclusion

In our studies we found that flies fed with 10g mass gainer and 20g mass gainer produced more female than those of male offspring which indicates that nutrition alters the sex ratio in *D. melanogaster.*

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