



## The effect of muesli on fertility in *Drosophila melanogaster*

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### Abstract

Fertility is the ability of an organism to produce offspring, while developmental time refers to the duration required for growth and maturation. In the present study, *Drosophila melanogaster* were cultured in wheat cream agar media supplemented with 10g, 20g, and 30g of muesli to evaluate the effect of muesli on fertility. The flies reared in 10g muesli media showed comparatively lower fertility than those raised in 20g and 30g media. Among all treatments, the 30g muesli media supported the highest fertility, whereas the control wheat cream agar media showed the lowest reproductive rate. These observations indicate that nutritional enrichment through muesli supplementation can influence the fertility and developmental performance of *D. melanogaster*.

**Keywords:** Nutrition, muesli, *D. melanogaster*, fertility

### Introduction

Biological processes associated with reproduction play a major role in determining the fitness of organisms. Fitness includes factors such as reproductive success, fecundity, survival, longevity, and mating efficiency. Among the many factors influencing fitness, nutrition is considered highly significant because it affects both growth and reproductive performance. Nutrients such as carbohydrates, proteins, fats, vitamins, and minerals contribute to metabolic balance and overall health.

Reproduction is one of the most essential biological processes responsible for the continuation of species. Various physiological and environmental factors directly influence reproductive success, including fertility, fecundity, longevity, developmental rate, and mating behavior. Among these factors, nutrition plays a critical role in determining the overall fitness and reproductive potential of organisms. Proper nutrition supports growth, energy metabolism, cellular repair, and reproductive activities, whereas nutritional imbalance may negatively affect development and fertility.

Muesli is a nutritious food mixture generally composed of oats, grains, nuts, dried fruits, and seeds. It is considered a balanced dietary supplement because it contains carbohydrates, proteins, healthy fats, fibers, vitamins, and minerals. Due to its rich nutritional profile, muesli is commonly consumed to improve energy levels, support body growth, and maintain overall health. The combination of multiple nutrients in muesli may positively or negatively influence biological functions depending on the concentration used.

The present study was conducted to investigate the effect of different concentrations of muesli on the fertility of *Drosophila melanogaster*. Experimental media containing 10 g, 20 g, and 30 g of muesli were prepared to analyze how varying nutrient levels affect reproductive performance and development in fruit flies. The study aims to understand whether moderate nutritional supplementation enhances fertility while excessive supplementation may reduce reproductive efficiency.

### Establishment of stock

Oregon K strain of *D. melanogaster* used in the study was collected from *Drosophila* stock Centre. Department of studies in Zoology, University of Mysore, Mysuru 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 and 12 hours light cycles and temperature  $22 \pm 1^\circ \text{C}$ .

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, 10g of agar boiled in 1000ml distilled water and 7.5 ml of propionic acid added to it.

**30g of Muesli powder media:** is prepared from 100g of jaggery, 80 g of wheat cream rava, 30g of Muesli powder, 10g of agar boiled in 1000ml of distilled water and 7.5 ml of propionic acid added to it.

**20g of Muesli powder media:** is prepared from 100g of jaggery, 90g of wheat cream rava and 20g of Muesli powder, 10g of agar boiled in 1000ml of distilled water and 7.5 ml of propionic acid added to it.

**10g of Muesli powder media:** is prepared from 100g of jaggery, 70 g of wheat cream rava, 10g of Muesli 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 starvation resistance experiment in *D. melanogaster*

### Materials and Methods

The Muesli was purchased from Loyal World Supermarket, 1011, Udayaravi road, KuvempuNagara, Mysuru, Karnataka 570023, India. This Muesli was used to prepare the experimental media.

## Experimental procedure

From the wheat cream agar, 10 g muesli media, 20g muesli media and 30g muesli media bottle, mated male and female flies were taken from their respective media. These flies were aged for 5days. Then they were transferred to control media bottle once in seven days until their death. Total number of progeny produced by each mated pair was recorded as fertility. A total of fifteen pairs were made separately for each of the wheat cream agar media and 10 g muesli media, 20 g muesli media and 30g muesli media.

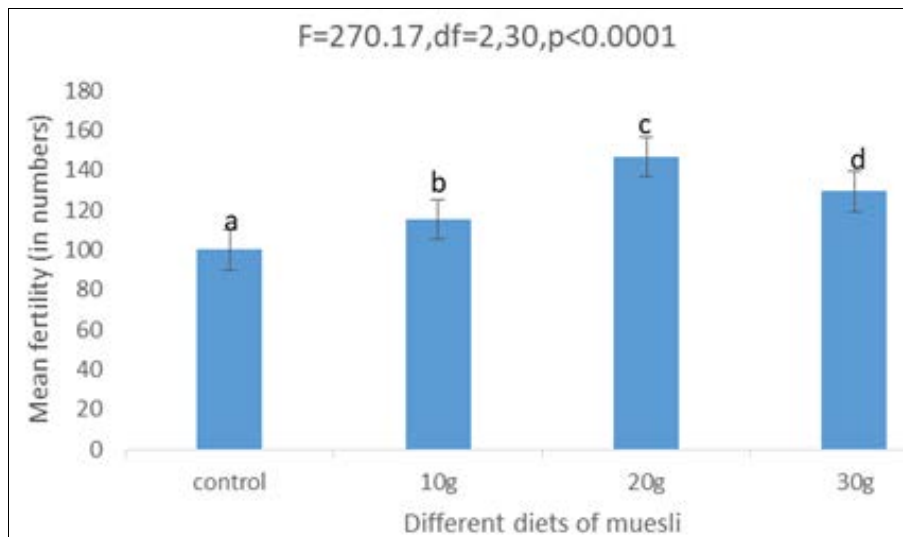
## Results

### Effect of the Muesli on the Fertility of the *D.melanogaster*

**Figure 1** revealed the fertility of *Drosophila melanogaster* was analyzed by culturing the flies in different dietary media consisting of wheat cream agar, 10 g muesli media, 20 g muesli media, and 30 g muesli media. The mean fertility values obtained from the experiment indicated clear variations among the different nutritional treatments. Among all the experimental groups, flies reared in 20 g muesli media showed the highest fertility rate, producing the greatest number of offspring. The flies cultured in 30 g muesli media exhibited the second-highest fertility rate, indicating that increased nutrient supplementation supported reproductive performance to a certain extent. Flies

maintained in 10 g muesli media showed moderate fertility when compared with the other muesli concentrations. In contrast, the wheat cream agar media demonstrated the lowest fertility rate among all groups, suggesting that the absence of additional nutrient supplementation negatively affected reproductive output.

The observed differences in fertility indicate that the nutritional composition and concentration of muesli significantly influenced reproductive success in *D. melanogaster*. A balanced increase in nutrients appeared to enhance reproductive activity and offspring production. However, variations among the concentrations suggest that fertility responses depend on the amount of nutritional supplementation provided in the culture media. The experimental data were statistically analyzed using one-way ANOVA followed by Tukey's post hoc test. The statistical analysis revealed significant differences in fertility among flies cultured in wheat cream agar, 10 g muesli media, 20 g muesli media, and 30 g muesli media. The post hoc analysis confirmed that each dietary treatment differed significantly from the others with respect to fertility performance. Overall, the findings demonstrate that muesli supplementation positively affected fertility in *Drosophila melanogaster*, with 20 g muesli media producing the most favorable reproductive outcome.



**Fig 1:** Effect of the muesli on the fertility in *D.melanogaster*

## Discussion

Fertility in female *Drosophila melanogaster*, including egg production and reproductive performance, is strongly influenced by nutrient availability and dietary composition. Previous studies by (Armstrong and Partridge) reported that early nutritional intake plays an important role in determining adult physiology, reproductive fitness, lifespan, and stress tolerance in fruit flies. Nutritional imbalance during developmental stages can reduce fecundity, body size, and reproductive efficiency, whereas balanced nutrient supplementation enhances reproductive success and developmental stability.

In the present study, the fertility of *D. melanogaster* was evaluated using wheat cream agar media and media supplemented with different concentrations of muesli (10 g, 20 g, and 30 g). The findings demonstrated that flies cultured in 20 g muesli media exhibited the highest fertility

rate and produced the greatest number of offspring. The flies maintained in 30 g muesli media showed the second-highest fertility, followed by those reared in 10 g muesli media. In contrast, flies cultured in wheat cream agar media displayed the lowest fertility rate. These results suggest that moderate nutritional enrichment through muesli positively enhances reproductive performance in *D. melanogaster*.

Muesli contains a balanced combination of carbohydrates, proteins, dietary fiber, vitamins, minerals, nuts, and grains, all of which contribute to energy metabolism and reproductive development. Studies by (Goester and Grangeteau) demonstrated that protein-rich nutritional environments improve mating success and increase offspring production in *Drosophila*. Similarly, the present findings indicate that the nutrient-rich composition of muesli may support ovarian activity, egg formation, and larval development, ultimately leading to improved fertility.

Research conducted by (Chapman, Lee, and Skorupa) also confirmed that diets containing balanced protein and carbohydrate levels significantly influence reproductive fitness in fruit flies. Nutritional deficiency, particularly low protein and carbohydrate intake, has been associated with reduced egg production and poor reproductive output. The present study supports these observations, as the wheat cream agar media lacking additional nutritional supplementation resulted in the lowest fertility among all treatment groups.

Furthermore, earlier investigations by (Lushchak) reported that carbohydrate sources and nutrient ratios directly affect ovarian function and egg-laying capacity in *Drosophila melanogaster*. Variations in the balance of carbohydrates and proteins can alter fecundity and developmental physiology. In agreement with these findings, the present study suggests that the concentration of muesli in the media significantly affected fertility patterns. The 20 g muesli media provided the most suitable nutritional balance for reproductive success, while excessive or lower concentrations produced comparatively reduced fertility rates.

Overall, the study demonstrates that dietary supplementation with muesli has a substantial effect on the fertility of *Drosophila melanogaster*. Among the tested concentrations, 20 g muesli media proved to be the most effective in enhancing reproductive performance, followed by 30 g and 10 g muesli media, whereas wheat cream agar media showed the least reproductive efficiency. These findings highlight the importance of balanced nutrition in regulating fertility, fecundity, and developmental fitness in fruit flies.

### Conclusion

In our studies we found that flies fed with 20g muesli media produced more number of offsprings and 30g, 10g media produced average number of offsprings and wheat cream agar media produced less number of offspring. Thus, this study indicates that nutrition alters the fertility in *D. melanogaster*.

### Acknowledgement

The authors sincerely acknowledge the Chairperson, Department of Studies in Zoology, University of Mysore, Manasagangotri Mysuru, for her valuable support. We are also grateful to our guide Dr. M.S. Krishna Professor, Department of Studies in Zoology, University of Mysore, Manasagangotri Mysuru, to his guidance, suggestions and support. And also grateful to the *Drosophila* Stock Centre, a National Facility at the University of Mysore, for providing essential facilities for carrying out the major project work. Additionally, we extend our heartfelt thanks to Miss. Chandana R for her assistance with the statistical analysis.

### References

1. Akins A, Day J, Quillin A, Delventhal R. *Drosophila melanogaster* negatively impacts female fertility. Eukaryon, Lake Forest College, 2020, 18.
2. Anitha, Krishna MS. Effect of Male Diet on Accessory Gland Protein and Sperm Traits in *D. melanogaster*. Advances Botany, 2020;8:506-511.
3. Armstrong AR. *Drosophila melanogaster* as a model for nutrient regulation of ovarian function. Society for reproduction and Fertility, 2020;159(2):R69-R82.
4. Baskan A, Sezen B. Knowledge levels, opinions and attitudes of individuals going to the gym about supplements. evista De Gestão E Secretariado (GeSec) São Paulo, Revista De Gestão E Secretariado, 2023;14(10):17845-17857.
5. Campbell B, Kalman D, Greenwood M, Antonio J. Muscle Mass and Weight Gain Nutritional Supplements. Nutritional Supplements in Sports and Exercise, 2008;1:189-223.
6. Chapman T, Partridge L. Female fitness in *Drosophila melanogaster*: an interaction between the effect of nutrition and of encounter rate with males. Proceedings of the Royal Society of London. Series B: Biological Sciences, 1996;263:755-759.
7. Grangeteau C, Yahou F, Everaerts C, Dupont S, Farine JP, Beney L, et al. Yeast quality in juvenile diet affects *Drosophila melanogaster* adult life traits. Scientific Reports, 2018;8:13070.
8. Janicke T, David P, Chapuis E. Environment-dependent sexual selection: Bateman's parameters under varying levels of food availability. American Naturalist, 2015;185(6):756-768.
9. Kingsolver JG, Huey RB. Size, temperature, and fitness: Three rules. Evolutionary Ecology Research, 2008;10:251-268.
10. Klepsatel P, Knoblochová D, Girish TN, Dirksen H, Gálíková M. The influence of developmental diet on reproduction and metabolism in *Drosophila*. BMC Evolutionary Biology, 2020;20:93.
11. Kunz K, Uhl G. Short-term nutritional limitation affects mating behaviour and reproductive output in dwarf spiders. Ethology, 2015;121(9):874-881.
12. Lee KP, Simpson SJ, Clissold FJ, Brooks R, Ballard JW, Taylor PW, et al. Lifespan and reproduction in *Drosophila*: new insights from nutritional geometry. PNAS, 2008;105:2498-2503.
13. Lushchak OV, Gospodaryov DV, Rovenko BM, Yurkevych IS, Perkhulyn. Specific dietary carbohydrates differentially influence the life span and fecundity of *Drosophila melanogaster*. Journals of Gerontology: Series A, Biological Sciences and Medical Sciences, 2014;69:3-12.
14. Memet D, Weliakim A, Wolach B. Proteins and amino acid supplementation in sports: Are they truly necessary. The Israel Medical Association Journal, 2005;7(5):321-329.
15. Min KW, Jang T, Lee KP. Thermal and nutritional environments during development exert different effects on adult reproductive success in *Drosophila melanogaster*. Ecology and Evolution, 2020;11:443-457.
16. Nunney L, Cheung W. The effect of temperature on body size and fecundity in female *Drosophila melanogaster*: Evidence for adaptive plasticity. Evolution, 1997;51:529-535.
17. Partridge L, Mackay TFC, Aitken S. Male mating success and fertility in *Drosophila melanogaster*. Genetics Research Cambridge, 1985;46:279-285.
18. Simpson SJ, Raubenheimer D. The Nature of Nutrition: A Unifying Framework from Animal Adaptation to Human Obesity. Princeton University Press, 2012.
19. Skorupa DA, Dervisevendic A, Zwiener J, Pletcher SD. Dietary composition specifies consumption, obesity,

- and lifespan in *Drosophila melanogaster*. *Aging Cell*, 2008, 478-490.
20. Turner ME, Anderson WA. Multiple mating and female fitness in *Drosophila melanogaster*. *Evolution*, 1983;37:714-722.
  21. Tolwinski NS. Introduction *Drosophila: A Model System for Developmental Biology*. *Journal of Developmental Biology*, 2017;5(3):9.
  22. Bircher-Benner M. *Muesli: Healthy Nutrition and Natural Diet Therapy*. Zurich Health Publications, 1900.
  23. McKeivith B. Nutritional aspects of cereals and muesli products. *Nutrition Bulletin*, 2004;29(2):111-142.
  24. Slavin JL. Whole grains, oats, and muesli in human health and disease prevention. *Journal of the American College of Nutrition*, 2004;23(6):451-455.
  25. Gropper SS, Smith JL. *Advanced Nutrition and Human Metabolism*. Cengage Learning, 2018.
  26. Roberfroid MB. Dietary fiber, whole grains, and prebiotic effects of cereal-based foods including muesli. *British Journal of Nutrition*, 2007;98:1-63.