IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

The Effect of Ensure® Nutritional Supplement Increases Fertility in *Drosophila melanogaster*.

Yashaswini. S.P., Tanmayi Kishore, Ashwini .M., Aishwarya. K.C., Suma. S, Shilpashree. B.M.
Corresponding Author: M.S. Krishna*

Department of Studies in Zoology, Drosophila Stock Centre, University of Mysore, Manasagangotri, Mysuru-560006, Karnataka, India.

ABSTRACT

One of the most significant environmental factors affecting *Drosophila* growth and development is nutrition. Quantity and quantity of nutrients in a portion of food significantly impact the growth development, reproduction, health, and survival of the organism. Ensure® is a nutrient-rich supplement with high protein and carbohydrates and high calorific value. In the present study, we demonstrate that the effect of the Ensure® nutrition supplement showed increased Fertility in *Drosophila melanogaster.* The fertility study also revealed that a significant variation in fertility was noticed between the wheat cream agar and other treated media. The progeny production was the least in the flies fed with mixed media, whereas the highest was observed in Ensure® treated flies.

INDEX TERMS: Nutrition, Progeny, Diets, Fertility, *Drosophila melanogaster.*

INTRODUCTION:

Diet is one significant extrinsic factor that might impact an organism's ability to survive, thrive, and develop .There are two types of diet-related effects on an organism's life history traits: quantity, which is dictated by food availability, and quality, which is defined by food's nutritional value. It has been demonstrated that altering an animal's diet can extend its life, even for flies. (Sisodia and Singh , 2012).

Ensure® is a complete, balanced nutrition with all essential nutrients. Ensure® provides good nutrition to help keep strong and healthy and also helps malnourished adults to improve their nutritional status and body weight. The Ensure® contains 32 nutrients which makes people strong and active. And it also provides high-quality protein. Ensure® has a balanced macronutrient ratio supporting optimum protein utilization. Two servings, Ensure® meets 80% of the RDA for calcium to support strong bones. By nature, it is free of gluten and it can be

consumed after reconstituting either along with water or with milk. Ensure® is primarily indicated for immunological function, weight loss, muscle hypertrophy, and low-residue diets.

Everything directly related to reproduction in biology plays a major role in determining fertility. It encompasses latency, production, fecundity, viability, longevity, and the interval between matings. When fertility is defined broadly, it is claimed that these mechanisms together determine the fertility component of fitness. (Turner and Andersson, 1983). The sexual activities of several Drosophila species have been the subject of numerous research, with particular attention paid to the basic patterns of courtship, genetic regulation, the role of stimuli, and the contribution of the sexes to differences in mating activity and recurrent mating. (Parsons, 1973); (Singh and Banerjee, 1998). The contribution of fertility differences to selection has been demonstrated using a variety of *Drosophila* species (Turner and Andersson, 1983). 51Certain factors, such as age and male size, have been shown to impact fertility in various *Drosophila* species. Another significant element that is known to have an impact on fertility is diet. It has been shown that the availability of additional nourishment affects mate preference and sexual selection (Janicke et al., 2015; Kunz and Uhl, 2015). According to diet studies (Lee et al., 2008; Maklakovet al., 2009; Pirk, Boodhoo, Human and Nicolson, 2010; Solon-Biet et al., 2015), lifetime fecundity is included in the ideal diet. However, the ideal proportion of each macronutrient—fat, protein, and sugar—varies depending on the species and sex. A helpful model to comprehend the nutritional foundation of reproductive fitness is provided by D. melanogaster.

Animals become capable of identifying traits in potential mates that indicate high fitness and reproductive potential (Andersson, 1994; Maynard-Smith and Harper, 2003). Current research indicates that diet composition, rather than calorie composition which causes the reported benefits (Reddison, 2009). This may not come as a surprise considering that various diets (Fricke et al., 2008; Maklakov et al., 2008; Vargas et al., 2010, Gosden and Chenoweth, 2011) frequently maximize certain allocation decisions, such as those focused on survive vs. reproduction, and that different physiological and sex-specific tasks necessitate certain nutrients. Natural selection is likely to favor biological mechanisms that quickly alter allocation decisions in their potential mates because diet composition can vary greatly over the course of an individual's lifetime.

MATERIALS AND RESEARCH METHODOLOGY :

The Ensure® protein powder was purchased from the Medplus pharmacy shop, in Sriramapura, Mysuru, Karnataka, India. This Ensure® protein powder is used to prepare the experimental media.

Establishment of Stock :

To establish the experimental stock, the Drosophila melanogaster Oregon K strain was obtained from the Drosophila Stock Center, Department of Studies in Zoology, University of Mysore, Manasagangotri, Mysuru. To cultivate the flies, wheat cream agar media (100g jaggery, 100g wheat powder, 10g agar boiled in 1000 ml distilled water, and 7.5 ml propionic acid added to prevent fungal growth) was used. The flies were kept in a laboratory setting with 70% humidity, a 12:12 photoperiod (dark and light cycles), and a temperature of 22º_+ 1 degrees Celsius. We carried out our experiment with these flies.

Establishment of experimental stock:

The experimental stock of flies was established using various diet mediums using the flies produced in the above manner.

Wheat cream agar media: 100 grams of jaggery and 100 grams of semolina (powder made from wheat rava) were used to make the medium. 100ml of distilled water, 10 grams of agar, and 7.5ml of propionic acid;

Ensure® powder media:7.5 ml of propionic acid was added to 100g of jaggery, 100g of Ensure® powder, and 10g of agar that had been boiled in 1000ml of distilled water to create the Ensure® powder media;

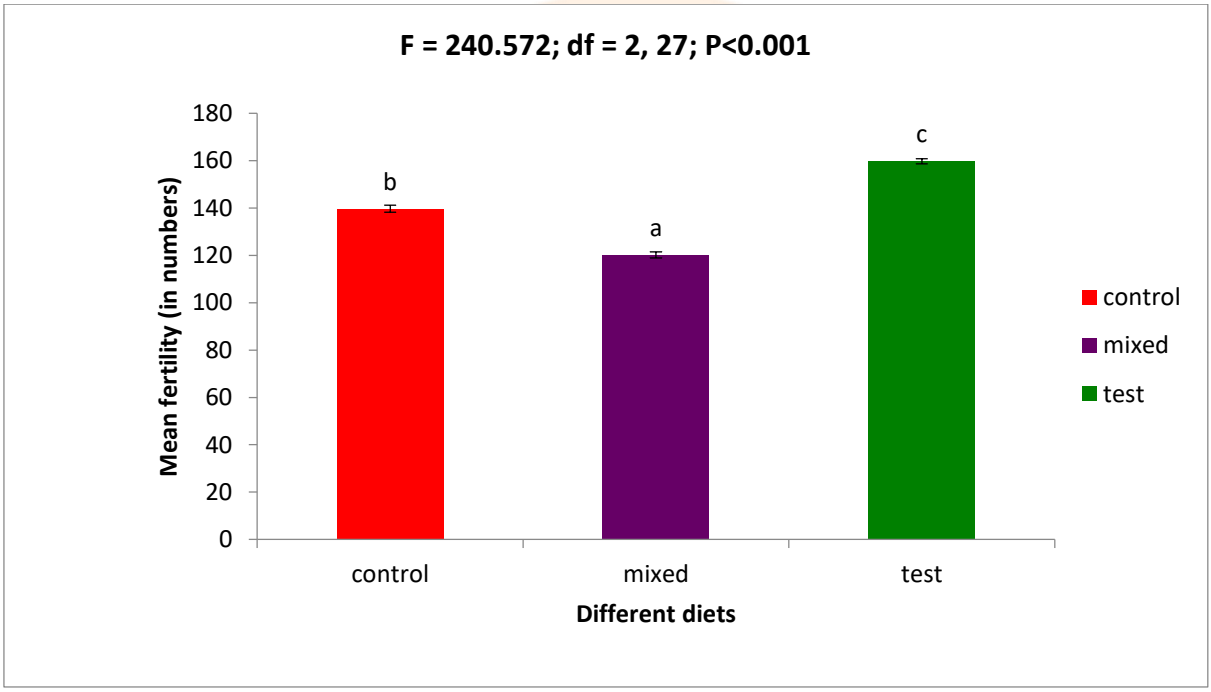
The Mixture or Intermediate media, (wheat cream + Ensure® powder media) (1:1): A mixture of 100 grams of jaggery, 50 grams of semolina (wheat cream powder), 50 grams of Ensure® powder, and 10 grams of agar are cooked in 1000 ml of distilled water with the addition of 7.5 ml of propionic acid.

FERTILITY EXPERIMENTAL PROCEDURE:

The virgin female and male flies were taken out of the control, mixture, and treatment. After allowing them to mate, the mated pairs were moved to a vial with the control medium. The number of progeny that emerge from each vial of food once every seven days for 30 days was recorded. Total of ten pairs for each of the media was studied. The total number of progeny obtained were recorded.

RESULTS AND DISCUSSION:

Figure 01: Effect of Ensure® nutritional supplement on fertility of *D.melanogaster.*



The different letters on the bar graph indicate the significant variation between the different diets by Tukey's post-hoc test at 0.05 level.

Figure 01. shows the mean value of fertility in flies fed with control, mixed, and test media. According to data obtained showed that flies raised in test media had significantly greater fertility compared to the flies fed with control and mixed media. Whereas, fertility was found to be least in flies in mixed media. The experimental data was subjected to the one-way ANOVA followed by Tukey's Post hoc test, which revealed a significant variation in the fertility between the flies of different diets.

In species of *Drosophila,* male attractiveness can be measured using components such as courtship behavior i.e., mating latency, and copulation duration levels of activities during courtship, which can be used to measure the attractiveness of the male. Males who show greater activities during courtship are more attractive (Hegde and Krishna 1997). Nutrition is necessary for an organism's growth, development, reproduction, ability to withstand starvation, and overall survival. The organism's ability to reproduce will, however, depend on quality and quantity. In the species of *Drosophila,* courtship behavior involves a series of male and female activities which culminate in copulation duration. Further, during copulation mating males transfers accessory gland proteins to the mated males. These materials help in post-physiological changes in mated females and they are also responsible for the production of eggs and fertile offspring.

Figure 01. shows the mean value of fertility in flies fed with control, mixed, and test media. According to data obtained showed that flies raised in test media had significantly greater fertility compared to the flies fed with control and mixed media. Whereas, fertility was found to be least in flies in mixed media. The experimental data was subjected to the one-way ANOVA followed by Tukey's Post hoc test, which revealed a significant variation in the fertility between the flies of different diets.

Fertility is one of the important character that influences fertility. The variation in the fertility often flies raised in the three different diets was observed. It was found that Ensure® media had a significantly greater fertility because of quality and quantity of diet influence maternal reproductive output. The lowest fertility rate is the mixed diet which had the intermediate fertility rate. The fertility rate of all three diets is as follows Ensure®> control > mixture. Suggesting dietary components of diets affected fecundity and fertility (Anitha and Krishna,2020). The earlier studies on *D.melanogaster* also showed that the high sucrose diet reduced fertility and protein enriched diet resulted higher fertility rate (Ramesh *et al.*2005*,).* The variation in the nutrients an organism has consumed has been demonstrated to have an impact on the fitness of the organism (Sisodia and Singh,2012). In species of Drosophila studies have also revealed that variation in male age (Prathibha *et al*.2011), female age (Somashekar et al., 2011), and variation in the Ensure® factors such as temperature, (Santhosh et al., 2015), light also affect reproductive fitness of the flies. in the present study, the age of males and females, temperature, and light were kept constant. This shows that there is no effect of age, temperature, and light on the variation in fertility.

CONCLUSION-

Hence from our study in *D.melanogaster* we can conclude that the nutrition is one of the key factors influenced on the fertility of the organism. The Ensure® diet increases the production of the progeny than the wheat cream agar and mixed diet.

ACKNOWLEDGEMENT-

The authors would like to thank the Chairman Department of Studies in Zoology, University of Mysore, Manasagangotri, Mysuru, and also extended the gratitude to *Drosophila* stock centre, National facility, University of Mysore for providing the facilities to carry out the major project work.

REFERENCE:

1.Andersson M. Monographs in behavior and ecology: sexual selection. Princeton University Press. 1994, 599.
2.Anitha Krishnan, Krishna Mysore. Effect of Male Diet on Accessory Gland Protein and Sperm Traits in D.melanogaster. Advances in Zoology and Botany,2020:8:506-511.
3.Banerjee R, Singh BN. Population and behaviour genetics of Drosophila bipectinata. Proc. Indian Nat. Sci. Acad. B,1997:63:399-410.
4.Chandrasekara A, Shahidi F. Bioaccessibility and antioxidant potential of millet grain phenolics as affected by simulated in vitro digestion and microbial fermentation. Journal of Functional Foods,2012:4:226- 237.
5.Ewing AW. Body size and courtship behaviour in Drosophila melanogaster. Anim. Behav,1961:9:93-99. 6. Fanson BG, Taylor PW. Protein: carbohydrate ratios explain life span patterns found in Queensland fruit fly on diets varying in yeast:sugar ratios. Age, 2011.
6.Fricke C, Bretman A, Chapman T. Adult male nutrition and reproductive success in Drosophila melanogaster. Evolution,2008:62:3170–3177.
7.Fulker. Mating speed in male Drosophila melanogaster. Psychogenetic analysis. Science,1966:153:203-205.
8.Gosden TP, Chenoweth SF. On the evolution of heightened condition dependence of male sexual displays. J Evol Biol,2011:24:685–692.
9.Guruprasad BR, Hegde SN, Krishna MS. Positive correlation between male size and remating success in few populations of D. bipectinata, Zoological studies,2008:47:75-83
10. Hegde SN, Krishna MS. Body size and fitness characters in Drosophila malerkotliana Current Science,1999:77(1):178-1790011-3891.
11. Hegde SN, MS Krishna. Size-assortative mating in Drosophila malerkotliana. Anim. Behav,1997:54:419-426.
12. Janicke T, David P, Chapuis E. Environment-dependent sexual selection: Bateman's parameters under varying levels of food availability. American Naturalist,2015:185(6):756e768.
13. Krishna MS, SN Hegde. Body size, mating success and advantage of large flies in Drosophila bipectinata species complex. Indian J. Exp. Biol,1999:35:1341- 1347.

14. Krishna MS, SN Hegde. Influence of body size in mating success in three sympatric species of Drosophila. Ital. J. Zool,2003:70:47-52.

15. Kunz K, Uhl G. Short-term nutritional limitation affects mating behaviour and reproductive output in dwarf spiders. Ethology,2015:121(9):874e881.

16. Lee KP, Simpson SJ, Clissold, FJ, Brooks R, Ballard JWO, Taylor PW, et al. Lifespan and reproduction in Drosophila: New insights from nutritional geometry. Proceedings of the National Academy of Sciences of the United States of America,2008:105(7):2498e2503.

17. Prathibha M, Krishna MS, Jayaramu SC. Male age influence on male reproductive success in Drosophila ananassae (Diptera: Drosophilidae), Italian Journal of Zoology,2011:78(2):168-173.

18. Maklakov AA, Hall MD, Simpson SJ, Dessmann J, Clissold FJ, Zajitschek F. et al. Sex differences in nutrient-dependent reproductive ageing. Aging Cell,2009:8(3):324e330.

19. Manach C, Mazur A, Scalbert A. Polyphenols and prevention of cardiovascular diseases. Current Opinion Lipidology,2005:16:77-84.

20. Maynard-Smith J, Harper D. Animal signals. Oxford University Press., 2003, 176.

21. McLain DK. Prolonged copulation as a postinsemination guarding tactic in a natural population of the ragwort seed bug. Animal Behaviour,1989:38:659e664.

22. Miller G. Whole grain, fiber and antioxidants. In: Spiller, G.A. (ed). Handbook of dietary fiber in Human Nutrition. Boca Raton, FL: CRC Press, 2001, 453-460.

23. Millington JW, Biswas P, Chao C, Xia YH, Wat LW, Brownrigg GP, et al. A low-sugar diet enhances Drosophila body size in males and females via sexspecific mechanisms. Development,2022:15:149(6):dev200491.

24. Monclús, Prevosti. The relationship between mating speed and wing length in Drosophila subobscura. Evolution,1971:25:214-217.

25. Parker GA. Sperm competition and its evolutionary consequences in the insects. Biological Reviews of the Cambridge Philosophical Society,1970:45:525e567.

26. Parsons PA. Behavioral and ecological genetics: a study in Drosophila. Oxford, UK: Clarenden Press, 1973, 164–165.

27. Partridg L, A Hoffmann, JS Jones. Male size and mating success in Drosophila melanogaster and Drosophila pseudobscura under field conditions. Anim. Behav,1987:35:468-476.

28. Pathak P, Prasad BG, Murthy NA, Hegde SN. The effect of Emblica officinalis diet on lifespan, sexual behavior, and fitness characters in Drosophila melanogaster. Ayu,2011:32(2):279.

29. Piper MD, Partridge L, Raubenheimer D, Simpson SJ. Dietary restriction and aging: a unifying perspective. Cell Metab,2011:14:154–160.

30. Pirk CW, BoodhooC, Human H, Nicolson SW. The importance of protein type and protein to carbohydrate ratio for survival and ovarian activation of caged honeybees (Apis mellifera scutellata). Apidologie,2010:41(1):62e72

31. Prakash S. Association between the mating speed and fertility in Drosophila robusta.Genetics,1967:57:655-663.

32. Ramesh BY, Neethu B K, Harini BP. Carbohydrate and protein are an attribute to enhance the life-history determinants in Drosophila Int. J. of Adv. Res, 2014, 2.

33. Santhosh HT, Krishna MS. Effect of rearing temperature on offspring fitness in Drosophila bipectinata. Asian Journal of Biological and Life Sciences,2015:4(1):13-9.

34. Santhosh HT, Krishna MS. Relationship between male age, accessory gland, sperm transferred, and fitness traits in Drosophila bipectinata. Journal of Insect Science,2013:13(1):159.

35. Santos M, Ruiz A, Barbadilla A, Quezada-Diaz JE, Hasson E, Fontdevila A. The evolutionary history of Drosophila Buzzatii. Larger flies mate more often in nature. Heredity,1988:61(14):255-262.

36. Scalbert A., Manach C, Morand C, Remesy C, Jimenez L. Dietary polyphenols and the prevention of diseases. Critical Reviews in Food Science and Nutrition,2005:45:287-306.

37. Schultzhaus JN, Nixon JJ, Duran JA, Carney GE. Diet alters Drosophila melanogaster mate preference and attractiveness. Animal Behaviour,2017:123:317-27.

38. Simpson SJ, Raubenheimer D. Macronutrient balance and lifespan. Aging (Albany NY),2009:1:875–880. Sisodia S, BN Singh. Size dependent sexual selection in Drosophila ananassae. Genetica,2004:121:207-217.

39. Solon-Biet SM, Walters KA, Simanainen UK, McMahon AC, Ruohonen K, Ballard JWO, et al. Macronutrient balance, reproductive function, and lifespan in aging mice. Proceedings of the National Academy of Sciences of the United States of America,2015:112(11):3481e3486.

40. Somashekar K, Krishna MS, Hegde SN, Jayaramu SC. Effects of age on female reproductive success in Drosophila bipectinata. J Insect Sci,2011:11:132.

41. Spiess EB. Mating propensity and its genetic basis in Drosophila. In essay in evolution and genetics in honour of the Dobzhansky. Hecht MT, Streere WC, editors. New York: Appleton-Century- Crafts, 1970, 315-79.

42. Thornhill R, Alcock J. The Evolution of Insect Mating Systems. Boston: Harvard University Press, 1983.

43. Turner ME, Anderson WA. Multiple mating and female fitness in Drosophila melanogaster. Evol,1983:37:714- 72.

44. Vargas MA, Luo N, Yamaguchi A, Kapahi P. A Role for S6 Kinase and Serotonin in Postmating Dietary Switch and Balance of Nutrients in D. melanogaster. Curr Biol,2010:20:1006–1011.