International Journal of Experimental Research and Review (IJERR)

ISSN: 2455-4855 (Online) ***Original Article***

Received: 7th July, 2017; **Accepted:** 19th July, 2017; **Published:** 30th August, 2017

DOI: https://doi.org/10.52756/ijerr.2017.v12.005

DNA and life cycle in *Drosophila melanogaster*: a nutritional-molecular connection

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Abstract

Nutrition plays a key role in different organisms to carry out life processes at different phases of life cycle. Furthermore, specific types of food are needed to build DNA. They are further required to synthesize genes/hormones etc. Thus to evaluate the nutritional-DNA correlation in *Drosophila* sp. for differential life cycle events and fecundity, different nutrients medium were chosen and the phases of life cycle of *Drosophila* sp were assessed along with quantification of isolated DNA collected from flies of each set. All the data were compared against control set C containing banana. Other experimental set consisted of nutrient mediums like glucon-D (A1), rice (A2), sugar (A3), butter/ghee (A4), paneer (A5) and mango (A6) mixed with banana. All the life cycle stages/phases i.e., egg to larva (P1), larva to pupa (P2) and pupa to adult fly (P3) were studied. Results revealed addition of rice (A2) reduces the moulting time significantly at P1 to P2 stage when compared to control-C; whereas mango (A6) reduced the time taken to reach P2 to P3 stage. However, the DNA content of flies collected from A2, A3 and A6 set were higher than those collected from other sets. Therefore, the overall result clearly supports the fact that preference of carbohydrate was greater than other nutrients, however, an optimum level of total carbohydrate content was preferred for better survival and growth which possibly enhances the genomic DNA synthesis and aid in accelerating the production of several genes/ hormones involved in moulting of *Drosophila* sp.

Keywords: Carbohydrate, *Drosophila* sp., DNA, moulting.

Introduction

Drosophila melanogaster has been the model of choice for several geneticists over ages. These flies are cultured in huge numbers for experimental purpose at optimum laboratory conditions at different nutritional medium. They are known to be very sensitive on the type of food provided during their rearing which might play role in determining their fecundity, moulting tie, etc. Additionally, preferences of different food are known to vary at different life cycle stages of *Drosophila* sp. which are regulated by specific genes (Higa and Fuyama, 1993; Ryuda et al., 2008). Mutation in the food selectivity genes may alter the nutritional preferences, which may shift from

carbohydrate to protein preference, or gradually alter the food selection from their larval stage through pupae to adult life forms. Therefore, it becomes necessary to seek whether any particular food source plays the key role in shortening or lengthening their life cycle thereby altering their moulting time therein. Earlier, we reported that genomic DNA might play an important role in food preferences in insects viz. ants (Chakrovorty et al., 2017) i.e., DNA regulates the selection of carbohydrate over protein or vice versa depending on the genomic DNA content in different types of ants. This particular result in ants and literature survey about fruit flies together led us to verify whether DNA has any role in modulating the moulting time for adult flies to emerge and enhance/diminish the fecundity in *Drosophila* sp. Further, it becomes essential to verify whether if the DNA content of these flies vary with different phases of their life cycle thereby acting as a modulator of nuclear genes and reproductive hormone synthesis. Therefore, in the present piece of work we present a preliminary study which was conducted using several food sources of different origin, mainly consisting of various carbohydrates, fruits, protein and lipid to address these objectives: i) whether any of these food source(s) elevate/ diminish the time of moulting, ii) whether DNA level in each food source fed flies were constant or varied with different food source and finally, iii) to correlate the DNA content with that of food source in regulating the moulting time of *Drosophila* sp.

Materials and method

Components and Food items

All the glass jars were purchased from the local market of the locality. Pieces of used handkerchiefs were used to cover those jars. All food materials used as food medium was collected from local fruit markets and grocery shops.

Experiment Method

To study and observe the food preference and reproductive activity of *Drosophila melanogaster* a site was chosen, resembling the natural habitat, inside the premises of Dum Dum Motijheel College, Kolkata, India. The mean number of flies at initial stage was counted in control and experimental sets daily by taking pictures using Nikon digital camera. Thereafter, the full fledged experiments was set after standardizing the optimum time and food quantity for flies to sit on the items in jars. The experiment was repeated three times in the interval of 7 days in June 2017, July 2017 and in August 2017. Information and data of all experiments were recorded in the practical notebook.

Assessment of Reproduction and Life Cycle Activity of Drosophila

Different set of experimental food medium like glucose-D (A1), rice (A2), sugar (A3), ghee (A4), paneer (A5) and mango (A6) were added in each glass jar along with basic ingredient of smashed ripened banana except for one set containing smashed ripened banana only serving as control (C) set. The food items thus chosen were either lipid/ protein/carbohydrate which would serve the purpose of food preference test of fruit fly, if any for a period of 7 days. The number of days of different life phases (egg to larvae, larvae to pupae and pupae to adult, adult to egg laying stage) were observed.

DNA isolation and spectrophotometric analysis

The DNA was isolated from equal number of fruit flies from each set of food items using the standard protocol described by Gadau (2016). Further, the extracted DNA was measured spectrophotometrically at 260 nm and arbitrary density was quantified.

Statistical analysis

The data were statistically analyzed. All the data provided in the present work are the mean values of three independent experiments after analysing them statistically using Student's 't'-test.

Results

Alteration in stages of life cycle and fecundity

The stages/phases of life cycle varied differently at different nutritional medium when compared to control set (A1-banana). However, a marked significant difference was observed in case of A2 set, (banana + rice) in the phase2 stage (larva to pupa formation) of life cycle. A significant reduction in time taken for phase 2 moulting was clear. Additionally, phase3 stage (pupae to adult fly emergence) was promoted in A6 set (banana + mango) by reducing the emergence time (Figure 1).

However, A3 set containing sugar and A4 set containing mixed ghee/butter could not attract any fly as compared to control and other experimental sets. Therefore, their life cycle stages was considered as null in each case till the end of the experiments and considered non significant as well (Figure 1).

Assessment of DNA content

The DNA content of fruit flies collected from A2, A3 and A6 set separately was significantly higher than that of control set and other experimental set of fruit flies as revealed from spectrophotometric studies (Figure 2).

Discussion and Conclusion

The overall result of the present study clearly represent that *Drosophila* sp. preferred carbohydrates over protein or lipid containing food medium. Carbohydrate is the richest source of energy for all life forms and this energy act as the driving life force to perform different life processes. The regulatory performance traits, which include production of egg, larval growth, moulting and emergence, etc. are highly energy-demanding events. Thus a rich store of energy is required for fuelling such processes. Therefore, the carbohydrate preference of the flies remain significant in this aspect that they get their energy supply/reserve from carbohydrates to carry out their energy driven life processes.

The reproductive adult stages are known to store energy as reserves which are acquired by the larval stage. Furthermore, the early phase of larval instar use energy at optimal level in the form of food intake from the surrounding nutritional environment; and prior to moulting, this energy store is utilized for formation of the new cuticle and the emergence from the old one during the course of moulting (Higa and Fuyama, 1993; Ryuda et al., 2008). Our result clearly showed that an optimum level of carbohydrate containing food items, like rice and mango having 15 to 30g carbohydrate content respectively, was preferred more over higher amount of carbohydrate containing food, i.e., sucrose containing 100g of carbohydrate, in modulating the moulting time of the fruit flies significantly leaving behind. This important observation might play role in altering the internal hormonal balance towards early/late moulting, whichever the condition may be.

Deoxyribose, a carbohydrate, is a component of DNA and thus to understand the effect of intake of carbohydrate rich diet in the genomic DNA content of the fruit-flies, the DNA spectral analysis was conducted after isolating DNA from each set. The observed data revealed that the genomic DNA content of the carbohydrate preferred fruit flies increased significantly in comparison to protein or lipid containing food items.

Therefore, this preliminary study opens up a new arena of research, that links between DNA and carbohydrate content which alters the moulting time of the flies. Therefore, a clear "nutritional-molecular connection" thus observed might inculcate the urge of other researchers for further research to pave the pathway to identify

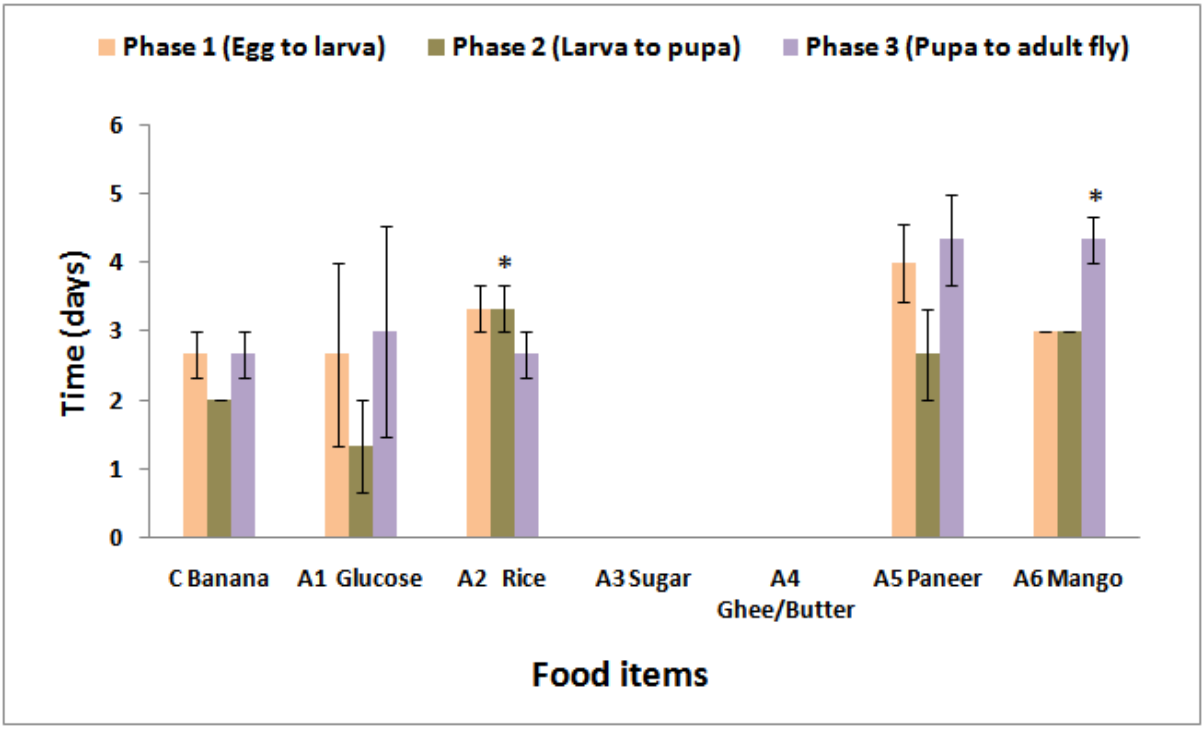

Fig. 1. Graphical representation of different food items induced alteration of life cycle stages.

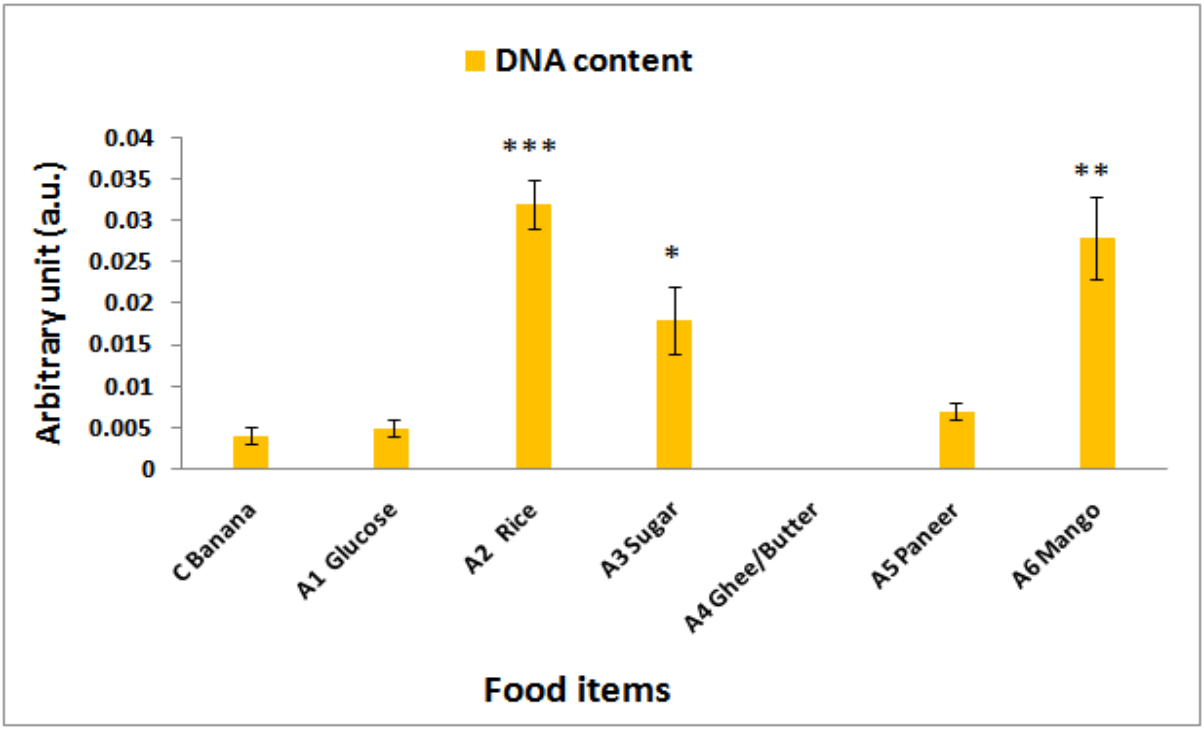

Fig. 2. DNA content of fruit flies collected from control and experimental sets after being fed in different food medium.

the role of DNA to switch on other genes and hormones in different regulative performances of the fruit flies at different phases of their life cycle.

Acknowledgement

Grateful acknowledgements are made to the Principal, Dum Dum Motijheel College, for providing the infrastructure and departmental funding.

Conflict of interest

None to declare

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