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STARVATION DURING DEVELOPMENT AFFECTS METABOLISM IN DROSOPHILA

N. P. STEFANYSHYN, O. M. STRILBYTSKA, U. V. SEMANIUK, N. I. BURDYLIUK, S. V. KHARUK

Vasyl Stefanyk Precarpathian National University, Ivano-Frankivsk, Ukraine

E-mail: nadya_stefanyshyn@ukr.net

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Nutrition during early stages of development has a strong long-term impact on the adult organism in *Drosophila* and rodents [1–3]. Numerous studies showed, that the effects caused by parental diet could be transmited through generations and modulate lifespan and metabolism in their offspring [1, 4]. Epigenetic control is the most plausible mechanism to explain the effects of parental or developmental nutrition on offspring life-history traits [2, 5].

Aim. In the present work, we aimed to investigate how starvation during early stage of fly development affects carbohydrate metabolism in imago flies and their progeny of F1 generation.

Methods. Wild-type *Canton-S* strain *Drosophila melanogaster* flies were used in all experiments. Flies aged 5–6 days were subjected to two-hours eggs-laying on the standard medium composed of sucrose — 5%, yeast — 5%, agar-agar — 1%, nipagin — 0.18% and reared at 25 °C, relative humidity of 60–70% on a 12 h day/night cycle [6]. After 72 hours of development, we selected third instar larvae and placed them on Petri dishes filled with agar-agar (1%). Experimental larvae were subjected to six-hours starvation, control larvae were not subjected to starvation. Next, larvae were transferred into plastic tubes with standard medium. The four-day-old flies of the parental generation were divided into two subgroup cohorts. One cohort was frozen in liquid nitrogen for biochemical assays. The rest of the parental flies were combined for mating and egg laying. Offspring F1 larvae were allowed to develop on regular food. The 5-day-old offspring were frozen in liquid nitrogen for biochemical measurements. Flies of parental and offspring generations were used for the determination of glycogen and glucose content using the diagnostic kit Glucose-Mono-400-P according to the manufacturer's instructions.

Results represent as the mean ± SEM of 3–4 replicates per group. Asterisk indicates a significant difference between groups with $p < 0.05$ according Student's t-test. Graphing and statistical analysis were performed by using GraphPad Prism.

Results. Starvation during development significantly influenced the level of hemolymph and body glucose in imago flies of parental generation. Hemolymph glucose concentration was lower by 34% ($p = 0.008$) and 32% ($p = 0.033$) in experimental females and males, respectively, as compared to control groups (Fig. *A*). Starvation during development led to lower level of body glucose in adult parental flies of both sexes (Fig. *B*; $p = 0.015$; $P = 0.004$). Adult males F1, generated by parents that were starved during development, showed 3-fold lower glycogen content, as compared to control (Fig. *F*; $P = 0.001$).

Discussion. Here we showed that, starvation during early development modulate the metabolic profile of adult flies. Previous study showed that high-carbohydrate developmental diet led to increase in hemolymph glucose concentration in imago flies [3]. Moreover, larval starvation can determine the feeding behavior of both larvae and adult *Drosophila* [7]. Another study showed decreased level of glycogen, trehalose and free glucose under starvation of third instar larvae [8]. Our data is in a good agreement with previous studies and detect low amount of body glucose in imago males and females caused by larval starvation. Glycogen of the fly fat body is used to maintain homeostasis of glucose under starvation [8]. We found low glycogen pool in adult F1 males. This effect is caused by starvation of the parents during larval stage. Changes in offspring metabolism caused by parental nutrition may be associated with an altered chromatin state [9].

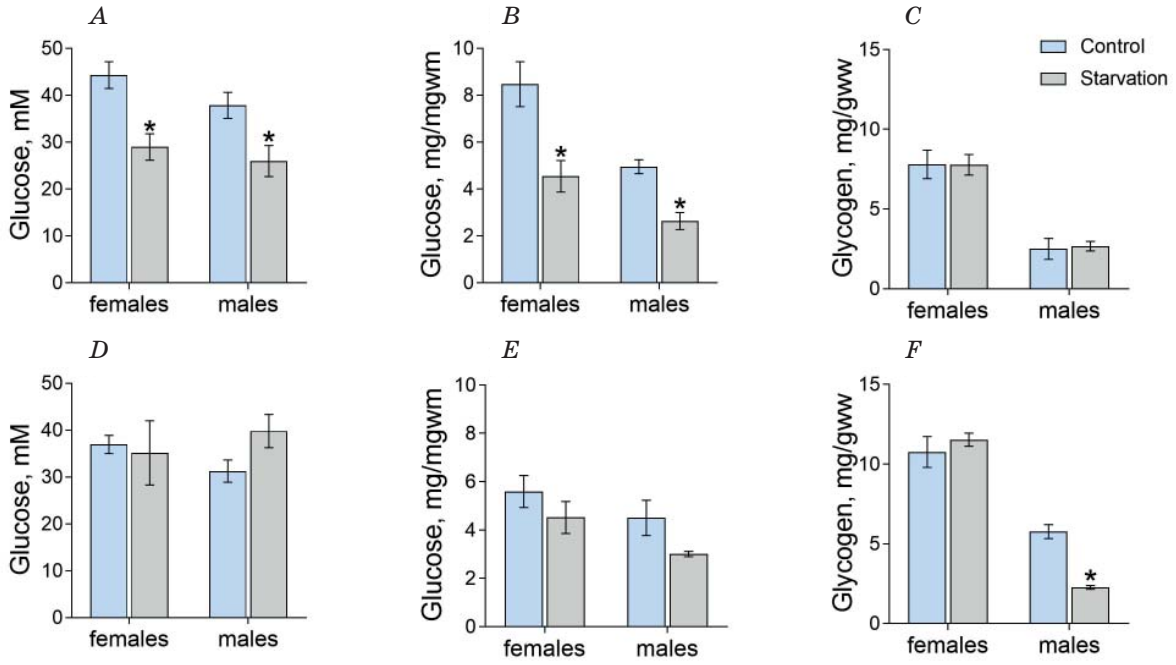

Figure. **The levels of hemolymph glucose (*A*), body glucose (*B*), glycogen (*C*) in imago flies of parental generation Drosophila which were starved for 6 hour in the third larval instar and levels of hemolymph glucose (*D*), body glucose (*E*), glycogen (*F*) in progeny of F1 generation:**
Results are represented as the mean ± SEM of 3–4 replicates per group

Conclusions. Starvation at early stage of development led to lower hemolymph glucose and body glucose level in imago flies. Moreover, parental starvation decreased glycogen pool in F1 males.

Key words: *Drosophila*; development; diet; starvation; nutrition.

Authors' contribution. O. M. Strilbytska, U. V. Semaniuk, N. I. Burdyliuk were responsible for the experimental part of the work, N. P. Stefanyshyn participated in the experimental part of the work and writing theses, S. V. Kharuk carried out graphic and statistical data processing.

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