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Effects of Starvation Selection On Nutrient Allocation and Fecundity in *Drosophila Melanogaster*

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Abstract

The life cycle of holometabolous insects is distinctly divided into three life stages: the larval, pupal, and adult stages. During the larval stage, animals accumulate energy stores in the larval fat body to be later used in the pupal and adult stages. I determined how this accumulated energy is stored in adult *Drosophila melanogaster* that have been selected for starvation for >40 generations. I assayed carbohydrates, proteins, and lipids and found that 0 day old starvation selected flies have almost four times as much lipid content, twice as much carbohydrate, and a fairly equal amount of protein versus fed control flies. The reproductive rates of the flies, measured by the number of eggs laid, were determined using a fecundity assay. I found that starvation selected flies lay significantly fewer eggs than fed control flies. Investigation of the allocation of energy stores suggests that there is a trade-off between higher storage of lipid and carbohydrate in starvation selected flies that causes decreases in fecundity.

Introduction

In the development of holometabolous insects, there are unique life stages that are deeply connected to feeding and non-feeding periods. In each stage of the growth of *Drosophila melanogaster*, the animal will adhere to specific feeding and non-feeding periods in which energy is gained and stored, so as to be used to advance and survive in the next stage of the life cycle. During the last three days of larval development, the larva’s mass will increase 200-fold where the accumulated nutrients are primarily stored in the larval fat body. This accumulation of energy is essential for the reorganization of the pupa and the survival of the early adult period.

The flies used in my research have been selected for starvation for 40 generations and should differ from wild-type animals in the amount of energy that they accumulate and how they accumulate this energy during their life cycle and maturation. I hypothesize that the starvation selected flies will store energy predominantly as lipids, a high density energy source, and that longer periods of feeding will accompany both the larval stage and adult stage of life to gather the majority of this energy. The costs and tradeoffs associated with these adaptations to the stress of starvation will be lower levels of fecundity since more energy will be focused on increasing survivability.

Methods

The flies used in these experiments have been selected for starvation resistance for over 40 generations. Each generation ~900 flies are dumped into a cage with access to water, but no food. Within ~45% are dead, the flies are provided with food, and the survivors are allowed to breed to produce the next generation. Control flies are given food at all times. There are 9 starvation-selected and three control populations. Selected flies survive nearly 10 days without food, while controls survive less than 4 days.

The protein, lipid, and carbohydrate levels of starvation-selected flies and controls were measured, immediately after the flies emerged (emerge as adult flies, 0 day old) and at 4 days old. Lipid content was measured by drying flies, weighing them, and extracting them in ether. The difference in mass between unextracted and ether-extracted flies is the lipid content. Carbohydrate levels were assayed by homogenizing flies in 1% perchloric acid with glyoxaline with amyloglucosidase, and measuring glucose with a standard blood sugar kit. Protein levels were measured with a standard biuretichrome and BCA protein assay. For the investigation on survival versus fecundity, females (0 days old) were collected and placed into separate wells of an 8 x 116cm 24-well food plate Fly Condo TM (Genesee Scientific, San Diego, California, USA, No. 59,110) containing grape agar (Genesee Scientific, San Diego, California, USA) along with two males to ensure mating. Groups of 8 females per trial were observed every 24 hours for egg deposition. The number of eggs deposited in each 24 hour period was recorded for 10 days.

Results

![Figure 1: Lipid content of starvation selected and control populations.](image1)

![Figure 2: Carbohydrate content of starvation selected and control populations.](image2)

![Figure 3: Protein content of starvation selected and control populations.](image3)

![Figure 4: Fecundity of starvation selected and control populations.](image4)

Conclusion

- Starvation resistant flies contain significantly higher amounts of carbohydrate and lipid versus fed control flies.
- Starvation resistant flies and control flies have no significant difference in protein content versus fed control flies.
- Starvation resistant flies lay a significantly lower amount of eggs per day versus fed control flies.
- There is a trade-off between higher lipid and carbohydrate content in starvation resistant flies that results in a lower fecundity as a result of selective pressure to survive.

References


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