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Impact Of Tobacco Toxins On The Lifespan Of Fruit Flies *(Drosophila Melanogaster)*

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Abstract

Tobacco, a extensively consumed plant recognized for its adverse health effects in humans, comprises various toxic compounds. Previous researches have solely delved into the impact of nicotine exposure on the reproductive and developmental aspects of fruit flies. Consequently, our investigation seeks to broaden the comprehension of the detrimental impacts encompassing all constituents of tobacco extract on the lifespan of fruit flies. Varied concentrations of tobacco extract (0.02, 0.04, 0.06, 0.08, and 0.1 g) were employed to establish a spectrum of exposure levels and the data included the number of fruit flies at each developmental stage in the new generation and the lifespan in each concentration group over the time. Our findings demonstrate a decline in population size within the first and second filial generations when transitioning from a normal condition to a high concentration of tobacco. Furthermore, our results reveal an inverse relationship between pupa size and tobacco concentration, resulting in smaller fruit flies when exposed to higher concentrations of tobacco extract. This suggests a detrimental impact of tobacco toxins on the embryonic development and overall well-being of fruit flies. The implications of our study extend to a broader understanding of potential risks associated with tobacco exposure in various organisms, including humans.

Keywords: Tobacco Toxins, Nicotine, Fruit Fly, Lifespan.

1. INTRODUCTION

Tobacco what is a widely consumed plant known for its detrimental health effects in humans, contains a multitude of toxic compounds, including nicotine, tar, and carcinogens. These toxic substances have been extensively studied in the context of human health and are strongly associated with a range of diseases, including lung cancer, cardiovascular diseases, and respiratory disorders [1].

While the health risks of tobacco consumption in humans are well-documented, it is essential to recognize that these toxic compounds can have harmful effects on various living organisms, including *Drosophila melanogaster* (fruit flies). *Drosophila melanogaster* has long served as a valuable model organism in genetics

and toxicology research due to its short lifespan, rapid reproduction, and genetic similarities with higher organisms [2].
Exposure to tobacco extract, which mimics the effects of tobacco consumption in humans, is known to introduce adverse effects in fruit flies. Nicotine, one of the principal toxic compounds in tobacco, has been shown to impact the nervous system of *Drosophila*, leading to altered behavior and physiology [3]. Furthermore, studies have revealed that nicotine exposure can affect the reproduction and development of fruit flies, leading to reduced fecundity and delayed development [4].

In addition to nicotine, other toxic compounds present in tobacco, such as polycyclic aromatic hydrocarbons (PAHs) and heavy metals, are known to be detrimental to a wide range of organisms. PAHs are mutagenic and carcinogenic, and their presence in tobacco can result in DNA damage and genetic mutations in exposed organisms [5].

This study aims to extend our understanding of the adverse effects of tobacco extract on *Drosophila melanogaster*. By examining the impact on the lifespan, developmental stages, and overall survival of fruit flies, we can gain valuable insights into the broader implications for living organisms when exposed to these toxic compounds.

2. MATERIALS AND METHODS

In the pursuit of understanding the intricate interplay between tobacco exposure and nutritional conditions on the life stages of Drosophila melanogaster, a meticulously designed experiment was executed. The following procedures outline the comprehensive methods employed:

Tobacco Infusions:
Six distinct portions of finely ground tobacco, weighing 0.02g, 0.04g, 0.06g, 0.08g, 1.0g, and a control with 0g, were individually mixed with 0.5ml of pure water. This process resulted in the creation of unique tobacco infusions, serving as pivotal variables in the subsequent stages of the experiment.

Formulation of Liquid Food Component:
To establish a standardized nutritional environment, 18 vials were designated for the liquid food component. The meticulously crafted food mixture comprised Agar (1.92g), Glucose (10.835g), Sucrose (5.415g), Corn flour (3.32g), High activity dry yeast (5.145g), Absolute ethanol (5.14 ml), and pure water, adjusting to a final volume of 200 ml. Each vial received a specific tobacco infusion from the prior step, creating a diverse range of experimental conditions.

Allocation and Transfer of Fruit Flies:
Drosophila melanogaster specimens were randomly and evenly distributed into 18 portions, with each group subsequently transferred into the vials containing the liquid food component and the specific tobacco infusion. This strategic allocation ensured an unbiased representation of the fruit fly population across the experimental conditions.

Observations and Recordings:
A meticulous observation protocol was implemented throughout the experimental period, extending until Day 17. The recorded parameters encompassed mortality rates, pupal counts, adult counts (commencing from Day 14), and the size of pupae on Day 17. The experiment was conducted under controlled conditions, maintaining a standardized culture medium, temperature, humidity, air pressure and light-dark cycles to ensure the accuracy of the experiment

3. RESULT

The investigation and observation into the impact of varying concentrations of tobacco on Drosophila melanogaster revealed intriguing patterns and correlations across multiple parameters. Which gave us some evidence about the influence of the tobacco on the health of fruit fly.

Throughout the monitoring of the parent generation's mortality (Table 1), the differences in the average death numbers within three repetitions were consistently within 2 for each day, whether in pure vials or those with

higher concentrations of tobacco， which represent tobacco don't have significant effect on the health of the parent generation through eating.

Also, what's also worth noting is that the spawning rate of fruit flies based on different concentration are not direct proportional to the concentration of the tobacco, for example the average number of pupae of the concentration 0.02 is even lower than the the average number of pupae of the concentration 0.08, The average number of pupae of concentration 0.04 on Day 13 is same as the average number of pupae of concentration 0.06. which didn't give a strong evidence that tobacco can effect the spawning rate of the fruit flies.
In summary, the effect of tobacco on the health and the spawning ability of parent generation of fruit flies is not obvious and significant.

In the initial days of the experiment, fruit flies in different generations displayed stability. Interestingly, the lowest concentration of tobacco extract correlated with an increased population size, resulting in a substantial count of 38 fruit flies in the control group. Conversely, the highest concentration of tobacco extract exhibited the least successful hatching rate, with only 2 survivors.

Table 1. The lifespan of fruit flies during 1~13days of study.

Days 1-4	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**0death**	**0death**	**0death**	**0death**	**0death**	**0death**
2	**0death**	**1death**	**0death**	**1death**	**0death**	**0death**
3	**0death**	**0death**	**0death**	**0death**	**0death**	**0death**
Day5	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**0death**	**3death**	**0death**	**0death**	**2death**	**0death**
2	**1death**	**0death**	**0death**	**1death**	**2death**	**0death**
3	**1death**	**0death**	**0death**	**0death**	**0death**	**0death**
Day6	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**0death**	**1death**	**0death+1pupas**	**1death**	**3death**	**0death+1pupas**
2	**1death**	**0death**	**2death**	**0death**	**0death**	**1death**
3	**2death**	**1death**	**0death**	**0death**	**0death**	**1death**
Day7	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**0death**	**1death**	**1death**	**1death**	**3death**	**0death+1pupas**
2	**2death**	**0death**	**2death+2pupas**	**0death**	**0death**	**1death**
3	**2death**	**1death**	**0death**	**0death**	**0death**	**1death**
Day8	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**0death**	**1death+1pupas**	**1death**	**1death**	**3death+1pupas**	**1death**
2	**2death**	**0death**	**2death+2pupas**	**0death**	**0death+1pupas**	**1death+2pupas**
3	**2death**	**1death**	**0death+2pupas**	**0death**	**0death**	**1death**
Day9	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**0death**	**1death+3pupas**	**1death+4pupas**	**1death+3pupas**	**3death+3pupas**	**1death**
2	**2death+2pupas**	**0death**	**2death+5pupas**	**0death+1pupas**	**0death+1pupas**	**1death+7pupas**
3	**2death**	**1death+1pupas**	**0death+2pupas**	**0death+2pupas**	**0death+2pupas**	**1death+3pupas**
Days 10-13	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**0death**	**1death+6pupas**	**1death+5pupas**	**1death+5pupas**	**3death+6pupas**	**1death**
2	**2death+1pupa**	**0death+1pupa**	**2death+6pupas**	**0death+4pupas**	**0death+2pupas**	**1death+15pupas**
3	**2death**	**1death+4pupas**	**0death+7pupas**	**0death+2pupas**	**0death+3pupas**	**1death+5pupas**

Moving to the population dynamics and pupa size (Table 2), our recorded data demonstrated a clear decline in population size with an increase in tobacco concentration. This decrease was accompanied by a negative correlation between pupa size and tobacco concentration. Shifting from pure food to higher concentrations of tobacco extract resulted in smaller pupae, indicating a potential influence on body size. Smaller fruit flies were distinctly observed in higher concentrations of the tobacco extract.

Table 2. The lifespan of fruit flies during 13~17 days of study.

Day14	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**0adults**	**2adults**	**0adults**	**0adults**	**0adults**	**3adults**
2	**1adults**	**0adults**	**2adults**	**1adults**	**0adults**	**7adults**
3	**1adults**	**0adults**	**0adults**	**0adults**	**0adults**	**0adults**
Total	**2adults**	**2adults**	**2adults**	**1adults**	**0adults**	**10adults**
Day15	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**3adults**	**0adults**	**0adults**	**0adults**	**0adults**	**5adults**
2	**0adults**	**1adults**	**0adults**	**1adults**	**0adults**	**18adults**
3	**1adults**	**0adults**	**0adults**	**2adults**	**0adults**	**3adults**
Total	**4adults**	**1adults**	**0adults**	**3adults**	**0adults**	**26adults**
Day16	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
1	**3adults**	**4adults**	**1adults**	**1adults**	**0adults**	**5adults**
2	**1adults**	**2adults**	**3adults**	**2adults**	**1adults**	**26adults**
3	**5adults**	**1adults**	**2adults**	**2adults**	**1adults**	**4adults**
Total	**9adults**	**7adults**	**6adults**	**5adults**	**2adults**	**35adults**
Day17	**0.02**	**0.04**	**0.06**	**0.08**	**0.1**	**Pure**
Total	**12adults**	**11adults**	**8adults**	**8adults**	**2adults**	**38adults**

The effects on pupa growth were further highlighted in the data presented in Table 3 and visually represented in Figure 1.

Table 3. Pupa size based on different tobacco concentration on Day 17.

Tobacco Concentration	**Pupa size (mm)**
Pure	**2.9 - 3.2**
0.02	**2.5 - 2.7**
0.04	**2.2 - 2.6**
0.06	**2.1 - 2.4**
0.08	**1.8 - 2.3**
0.1	**1.3 - 1.6**

A significant reduction in pupa size was evident with higher concentrations of tobacco extract. The negative relationship between tobacco concentration and pupa size, as depicted in Figure 1, indicated that smaller pupae were associated with higher concentrations. The early stages of accelerated growth were followed by a subsequent slowdown, coinciding with an increase in mortality rates.

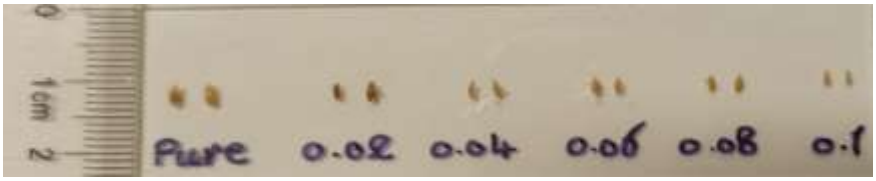

Figure 1. Pupa size in different concentrations on Day 17

Post-experiment observations revealed that many pupae did not successfully transition into adulthood, indicating adverse effects associated with higher concentrations of tobacco extract. The observed increase in mortality rates further suggested potential long-term consequences on the developmental trajectory of Drosophila melanogaster.

4. DISCUSSION

Our comprehensive dataset, encompassing the developmental stages and survival rates of fruit flies across various concentrations of tobacco, provides profound insights into the detrimental impact of tobacco toxins on embryonic development and overall health. Our results substantiate our initial hypothesis, highlighting the discernible effect of tobacco on body size during the crucial embryonic period.

In particular, our findings emphasize the significant influence of tobacco on the reproductive qualities of fruit flies, aligning with previous research [4]. The observed higher impact on offspring quality suggests that hazardous substances in tobacco may traverse the digestive system, reaching the genital system [6]. This, in turn, may affect cellular activity, division, and subsequently, the health of offspring [7], especially the conditions of new larvae [8]. For males, the effects may extend to sperm activity [9], while in females, a discernible decrease in egg quality is evident. Although the simple genetic structure of fruit flies hints at possible changes induced by hazardous substances, concrete evidence in this regard remains unestablished.

The choice of Drosophila melanogaster as a model organism, known for its appropriateness in genetic studies [10], opens avenues for indirect implications on human functions. While the parallels between the effects of tobacco on fruit flies and humans are promising, it's crucial to acknowledge the simplicity of our experiment. Future investigations should delve deeper into potential genetic alterations in fruit flies due to hazardous substances.

However, acknowledging the relevance of our findings to human health, it is imperative to recognize a limitation in our experimental design. Our oversight lies in the mode of tobacco exposure; we neglected to consider that humans primarily intake tobacco through inhalation rather than ingestion. This distinction underscores the need for refinement in experimental approaches to mirror the human context more accurately.

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