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The effect of Tempeh Fermentation on high-glucose-induced toxicity in Caenorhabditis elegans

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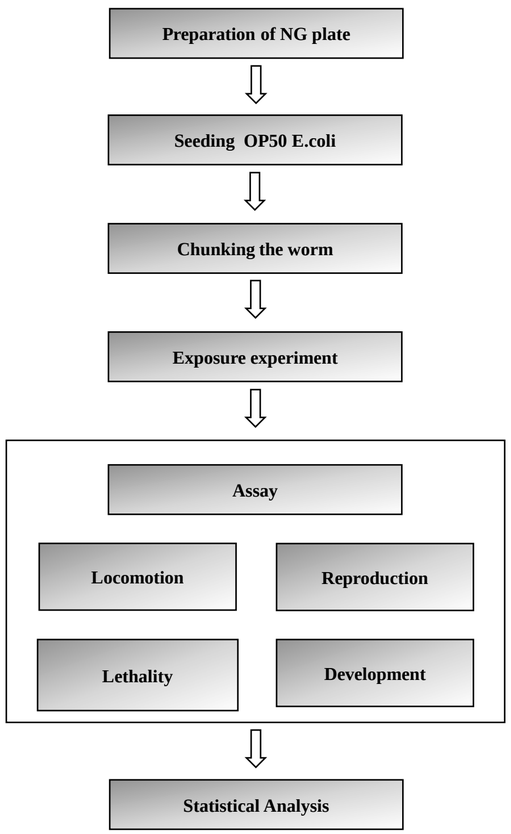
Introduction

Type II diabetes (T2D) arises through insulin resistance and a progressive decrease in insulin secretion, which may be partly related to pancreatic beta-cell function decline, obesity, and eventual hyperglycemia. Type II diabetes affecting more than 425 million people in the world and over million people suffering from T2D.

Tempeh is a traditional Indonesia food made from soybeans with a Rhizopus mold. Tempeh is becoming popular healthy food hitting the trend around the world. Just like tofu, Tempeh is a good source to provide protein, dietary fiber and vitamins, even reduce hunger and increase weight loss. There are many different types of tempeh. Different kinds of tempeh have different characteristics and nutritional changes which might yield different results. To further investigate the effects of this laboratory-made tempeh fermentation on diabetes, an analysis of serum biochemical parameters was made between the pre- and the post-tempeh treatment.

The nematode of *Caenorhabditis elegans* (*C. elegans*) had been established as a non-mammalian model animal. Due to the properties of inexpensive, facile maintenance, short lifespan, rapid reproduction cycles, high degree of molecular conservation, well-described genetic, genomic tools, simple nervous system, and sensitivity to environmental toxicants, *C. elegans* has been used to in both biomedical and environmental toxicity testing through several parameters, including (1)lethality, (2) growth, (3)reproduction and (4) locomotion. The effect of high-glucose in the *in-vivo* models particularly for *Caenorhabditis elegans* (*C. elegans*) still unclear.

Method



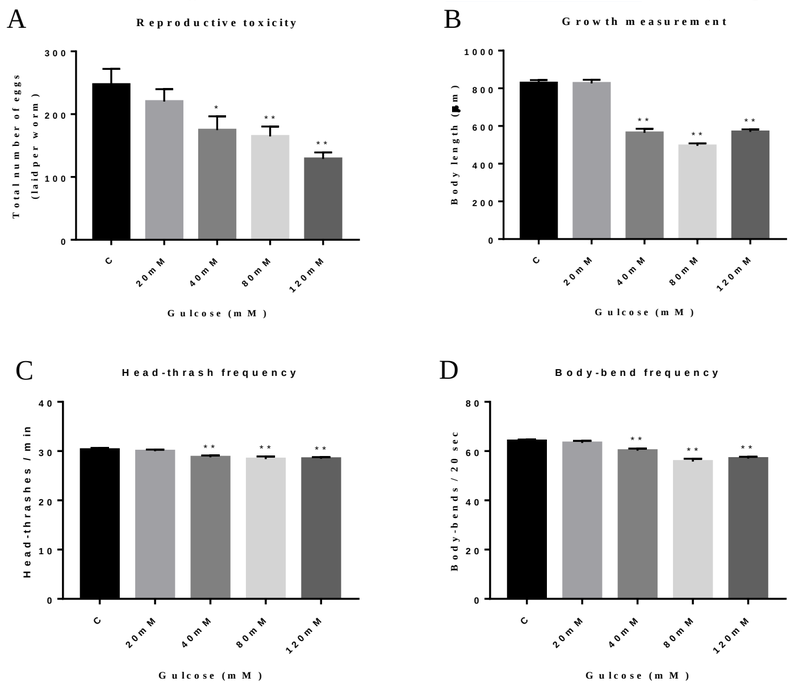


Fig. 1. Effects of Glucose on biological parameters in *C. elegans*. A. Reproduction. B. Growth. C. Head thrash. D. Body bend. *Significant differences with control ($p < 0.05$).

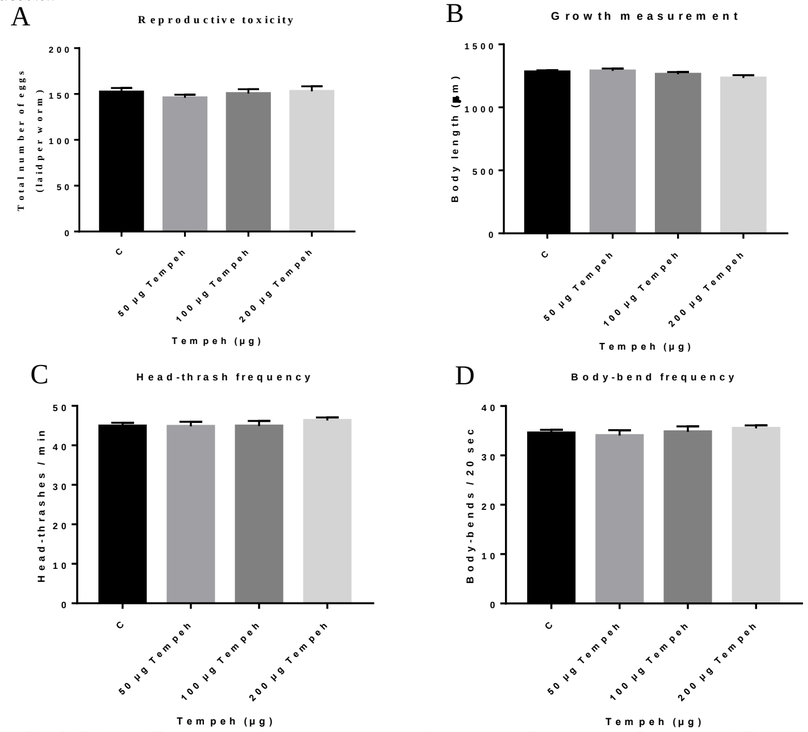


Fig. 2. Effects of Tempeh on biological parameters in *C. elegans*. A. Reproduction. B. Growth. C. Head thrash. D. Body bend. *Significant differences with control ($p < 0.05$).

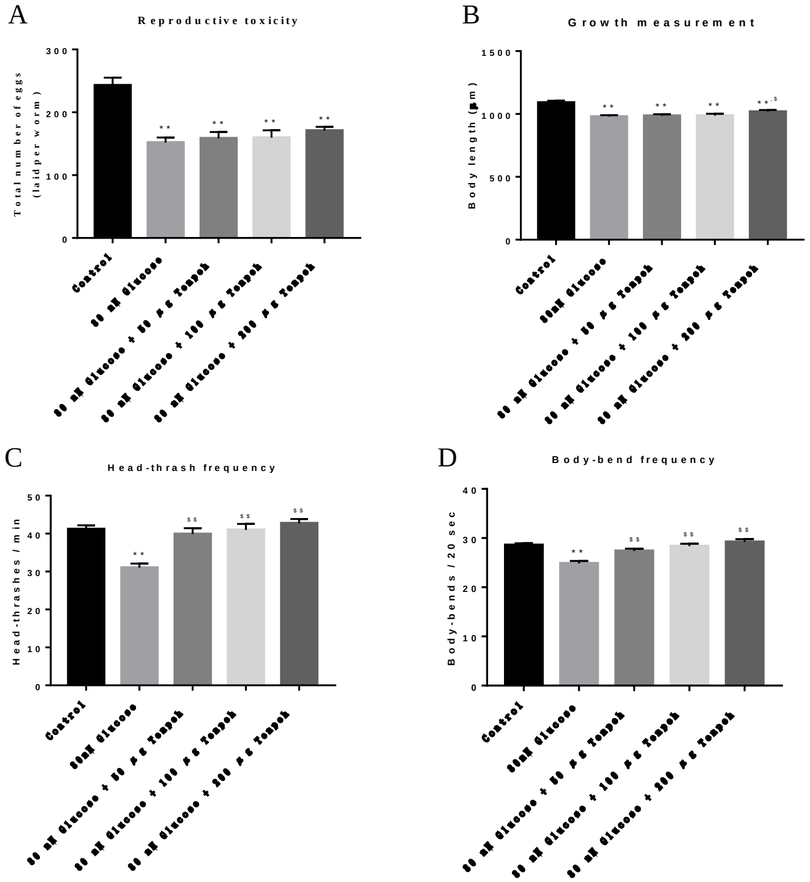


Fig. 3. Effects of Glucose and with Tempeh on biological parameters in *C. elegans*. A. Reproduction. B. Growth. C. Head thrash. D. Body bend. *Significant differences with control ($p < 0.05$).

Results

To investigate the toxicity of Glucose, the *C. elegans* were exposed to 20, 40, 80, 120 mM of Glucose for 72hr. The result showed that exposure to 20-120mM of glucose significantly reduced the brood size of *C. elegans* compared with the control group **(Fig. 1A)**. Like the result of reproductive toxicity, body length in the control group was 828 μm, which was significantly decreased to 495 μm at 80mM compared with the control groups **(Fig. 1B)**. In comparison with the control group, head-trash frequency and body-bend frequency slightly decreased in any of the glucose concentrations (40-120mM) **(Fig. 1C, D)**.

To test effect of Tempeh on *C. elegans*, we exposed *C. elegans* at 50, 100, 200 μg of Tempeh. The result showed that exposure to 50, 100, 200 μg of Tempeh had no any effect on the brood size, reproduction, head-trash frequency and Body-bend frequency of *C. elegans* compared with the control group **(Fig. 2A, B, C, D)**

To examine the possible effect the of Tempeh, the *C. elegans* were exposed to various concentrations of Tempeh overnight before exposure to 80 mM of glucose. The result showed that exposure to Tempeh could reduce the toxicity of glucose. The reproductive toxicity of *C. elegans* was slightly increase compared with the 80 mM of glucose group **(Fig. 3A)**. In addition, the body length in 50, 100 μg of Tempeh had no significant effects, but 200 μg of Tempeh can reduce the toxicity of glucose **(Fig. 3B)**. In contrast, there was no significant effects on locomotion after exposure to glucose with any concentrations of Tempeh **(Fig. 3C, D)**.

Conclusion

The present study revealed that high-glucose significantly disrupted the lifespan, growth, reproduction, and locomotion behavior of *C. elegans*. Tempeh can reduce the toxicity effect of glucose. These findings showed that high-glucose disrupted the physiological behaviors of *C. elegans*, and Tempeh maybe be a good source to provide Type II diabetes (T2D).