

High concentration of Taurine and DMSO prove an uninhabitable environment for regeneration in planarians

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ABSTRACT

Introduction: Planarians are widely used as a model for learning about regeneration in the scientific field due to their unique regenerative abilities using stem cells and similar neurological aspects to humans. Neoblasts direct nearby cells to grow into a specific state so that the planarian may regenerate with full functionality. Dimethyl sulfoxide (DMSO), a cryoprotectant, is used in various research studies to study the effects of cell damage and ice crystal formation, as well as allowing a hydrophobic drug to be dissolved more easily in water. In previous experiments, it was found that soaking planarians in any solution of DMSO over 5% for a period of over 5 minutes caused significant harm and led to the death of the planarians. Taurine acts as a mild stimulant and neurotransmitter and a neuroprotective agent to prevent injury to neurons. There is a numerous amount of Taurine amino acids in the brain for neuron development and is often used to protect stem cells that are used for regeneration.

Objective: Both the effect of Taurine on a planarian's regenerative ability and understanding of how much longer a planarian from various solutions of Taurine should live in comparison to planarians coming from artificial pond water (APW) was hoped to be found.

Methods: 2 planarians are cut laterally and placed in each of the solutions of Taurine to be left to regenerate over the course of 7 days, after which the regenerated planarians will be observed in a solution of 10% DMSO on 5-minute intervals until 30 minutes.

Results: Planarians lacked regenerative ability and had heavily damaged stem cells that were not able to aid in regeneration, thus making them more vulnerable to the DMSO solution.

Discussion: Prolonged exposure to Taurine inhibits most regenerative cell reproduction, causing harm to the organism when placed again in a dangerous environment. Additionally, prolonged exposure to Taurine leads to an expression of abnormal behavior.

METHODS O.01mM O.03mM O.1mM O.3mM O

Figure 1. Experimental setup. Taurine is placed in 5 separate containers filled with differing concentrations of the solute (Taurine + APW). Planarians are left in the solution to regenerate for 7 days, then the same planarians are placed in a premeasured 10% solution of DMSO (DMSO + APW). Regeneration baseline is 2 distinctly separated ocelli on a given planarian.



Figure 3. Planarians throughout the experiment. (Left image) Scarred planarian that regenerated partially, but with a scar. Suggests Taurine interference with regenerative cells. (Middle Image) Planarian that climbed to top of container, eventually drying out. Suggests Taurine interference with behavior. (Right image) Stationary, curled up planarians immediately after being transferred to the 10% solution of DMSO.

REGENRATION AND TOXICOLOGY RESULTS

The planarians that regenerated in Taurine regenerated in an abnormal way. Contrary to the hypothesis, only 6.7% of the planarians regenerated close to their original size, whereas the remaining 93.3% failed to regenerate past a few millimeters in length. Placing the planarians into their respective concentrations of DMSO led to all planarians shrinking rapidly and failing to respond to any external stimuli within the minute, leading to an immediate halt in the experiment. After the experiment was halted, it was not

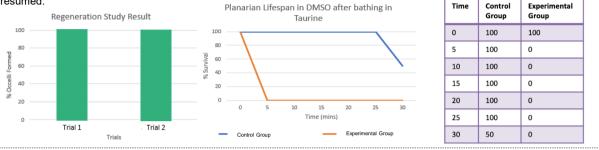


Figure 2. Results of Regeneration and Lifespan Experiment. (Left graph) Results of first part of the experiment;100% planarian regeneration in both trials. (Middle graph) Results of the second part of the experiment; all planarians die before the 5-minute mark, compared to the control group. P-value of 0.004**. (Right Table) Written results of graph in the middle.

PREVIOUS STUDY RESULTS

Regeneration Study Result Planarian Survival Rate in Varying DMSO Concentrations

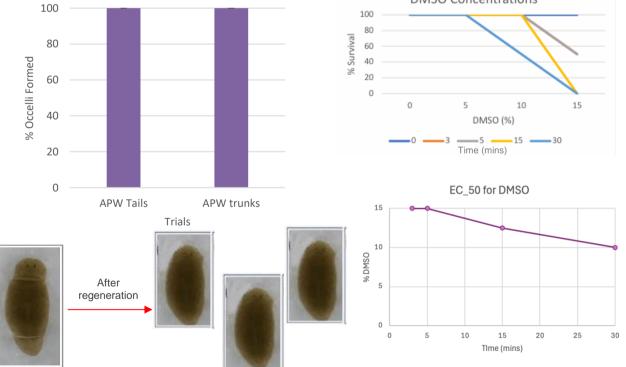
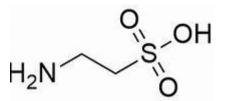


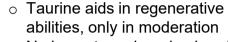
Figure 4. Previous results that determined variables for current experiment. (Large left graph) Graph depicts 100% regeneration in control experiment with only APW (Regeneration benchmark being both ocelli are formed and able to be distinguished as two separate organs using the given microscope in the classroom.) (Top right) Graph depicts a previous experiment where planarians from APW were placed in different solutions of DMSO, being 5%, 10%, and 15%, for the purpose of studying lifespan over the course of 30 minutes. (Bottom right) Graph depicts EC₅₀ for various concentrations of DMSO, allowing for the best concentration for this experiment to be properly determined. (Bottom left diagram) What the regeneration of a planarian looks like in only APW.

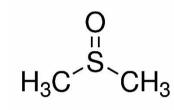
TAURINE REACTION AND DIMETHYL SULFOXIDE



Large amounts of Taurine vs. small amounts (relative to the particular organism)

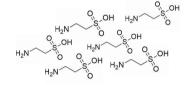
Taurine (2-aminoethansulfonic acid)





DMSO (Dimethyl sulfoxide)

- Remains toxic to small organisms (planarians) past 10 minutes
- Has no significant reaction with Taurine that would cause harm to small organisms



A large concentration of Taurine

CONCLUSIONS AND DISCUSSION

This experiment aimed to assess the effects of Taurine on planarian regeneration and their resilience to DMSO exposure. Contrary to expectations, extended exposure to Taurine appeared to inhibit the regenerative capabilities of planarians rather than enhance them. Most organisms failed to regenerate properly, with only a small fraction (6.7% approaching standard size. Also, all regenerated planarians displayed increased vulnerability when exposed to 10% DMSO, rapidly shrinking and becoming unresponsive within the first 5-minute time interval.

These results suggest that while Taurine has known neuroprotective properties, its extended exposure in this context may negatively impact stem cell activity and regeneration, as well as behavioral aspects. Future studies should further investigate the duration and concentration of Taurine expose to better understand its role in regenerative processes.

ACKNOWLEDGEMENTS AND LITERATURE CITED

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