Research article[1]

Effect of Exposure to the Gum-Resin Extract of Ferula assa-foetida on Oxidative Stress in Paramecium sp.

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Abstract:

Oxidative stress is a key mechanism involved in the toxicity of many natural and chemical substances. *Ferula assa-foetida*, a medicinal plant widely used in traditional pharmacopoeia, contains various bioactive compounds that may induce toxic effects at certain concentrations. The present study aims to evaluate the effect of exposure to the gum-resin extract of *Ferula assa-foetida* on selected oxidative stress biomarkers in *Paramecium* sp. Cultures of *Paramecium* sp. were exposed to different concentrations of the extract for a defined period. Levels of malondialdehyde (MDA), a marker of lipid peroxidation, as well as catalase (CAT) activity, a key antioxidant enzyme, were measured to assess the oxidative status of the cells. The results showed a significant increase in MDA levels accompanied by variations in CAT activity depending on the tested concentrations, indicating a disruption of oxidative balance in *Paramecium* sp. These findings suggest that the gum-resin extract of *Ferula assa-foetida* can induce cellular oxidative stress, reflecting a dose-dependent toxic potential. This study highlights the relevance of *Paramecium* sp. as a suitable biological model for evaluating the oxidative toxicity of plant extracts.

Keywords: Oxidative stress; *Ferula assa-foetida*; *Paramecium* sp.; Malondialdehyde (MDA); Catalase (CAT)

Introduction

Medicinal plants are widely used for their therapeutic properties; however, some may induce toxic effects depending on the dose and exposure conditions. *Ferula assa-foetida*, rich in bioactive compounds, has attracted particular interest in pharmacology and toxicology. Oxidative stress is one of the main mechanisms involved in cellular toxicity. The objective of this study is to evaluate the impact of *F. assa-foetida* extract on selected oxidative stress biomarkers in *Paramecium* sp

MDA Assay

Lipid peroxidation was evaluated by measuring MDA using the TBARS method. Absorbance was measured with a spectrophotometer, and results were expressed as nmol/mg of protein.

Catalase Activity Assay

CAT activity was determined by measuring the decomposition of hydrogen peroxide (H_2O_2), monitored spectrophotometrically, and expressed as U/mg of protein.

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Figure 1: *Ferula assa-foetida*

Materials and Methods

Biological Material

The study was conducted on *Paramecium* sp. cultured in an appropriate medium under controlled temperature (28°C) and pH conditions, ensuring optimal viability of the cultures prior to exposure.

Preparation of the Extract

The gum-resin of *Ferula assa-foetida* was dried at room temperature, finely ground, and subjected to extraction using an appropriate solvent (aqueous or hydroalcoholic). The obtained extract was filtered, concentrated, and stored at low temperature until use.

Exposure Protocol

Paramecium sp. cultures were divided into a control group and several treated groups exposed to different concentrations of the extract for 3 hours.

Statistical Analysis

Results were expressed as mean ± standard deviation. Statistical comparisons were performed using ANOVA followed by a post hoc test. A p-value < 0.05 was considered statistically significant. Exposure of *Paramecium* sp. to the gum-resin extract of *Ferula assa-foetida* resulted in a significant and dose-dependent increase in MDA levels compared with the control group, indicating an intensification of lipid peroxidation.

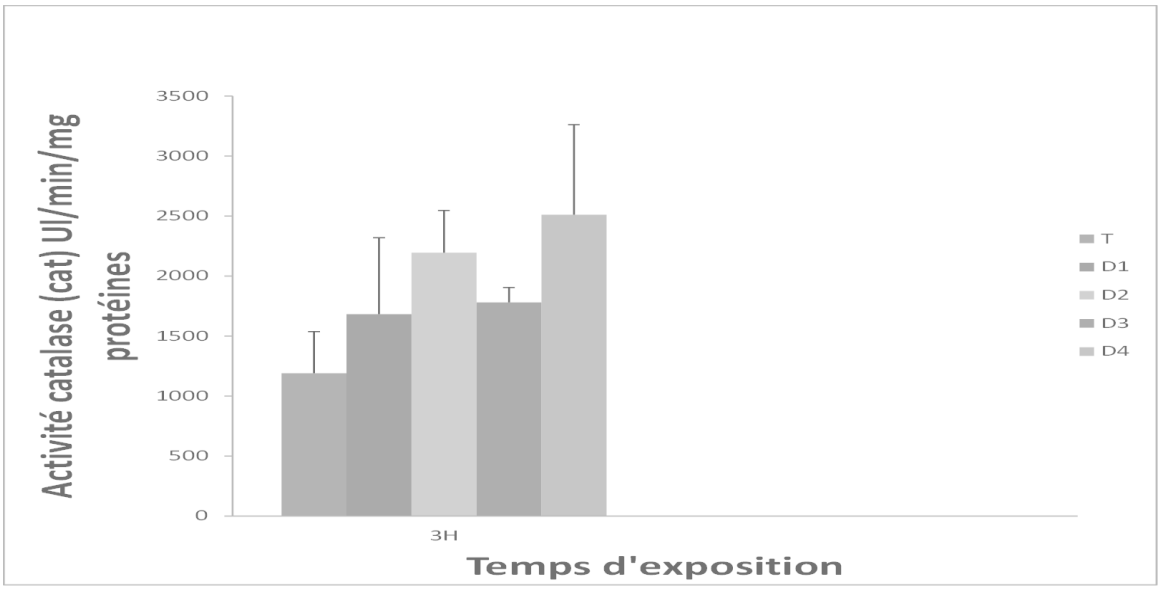

Figure 2: MDA

Furthermore, catalase activity showed a significant variation depending on the tested concentrations. An increase in enzymatic activity was observed at low concentrations, followed by a decrease at higher concentrations.

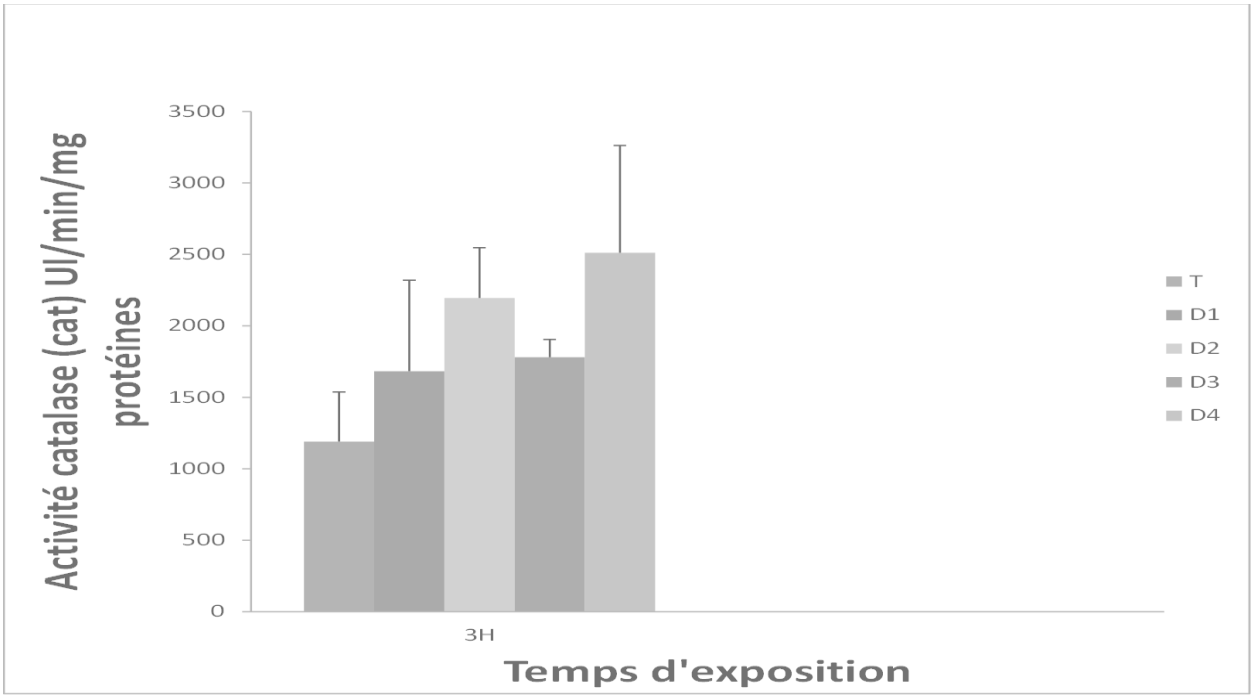

Figure 3: CAT

Results and Discussion

The significant increase in MDA levels observed in this study reflects cellular membrane damage induced by excessive production of reactive oxygen species. These results confirm the involvement of oxidative stress in the toxicity of the gum-resin extract of *Ferula assa-foetida*.

The variation in catalase activity suggests an adaptive response of the antioxidant system at low concentrations, aimed at neutralizing excess hydrogen peroxide. Conversely, the decrease in enzymatic activity at higher concentrations may be related to enzyme inhibition or depletion of cellular antioxidant defenses.

These observations are consistent with several toxicological studies reporting pro-oxidant effects of plant extracts rich in bioactive compounds when administered at high doses. The use of *Paramecium* sp. as a biological model proved to be relevant for the evaluation of oxidative toxicity.

Conclusion

Exposure to the gum-resin extract of *Ferula assa-foetida* induces oxidative stress in *Paramecium* sp., characterized by increased lipid peroxidation and disruption of catalase activity. These results demonstrate a dose-dependent toxic potential of this plant extract and highlight the need for thorough toxicological evaluation prior to its use at high concentrations. *Paramecium* sp. appears to be a relevant alternative model for the toxicological assessment of plant extracts.

Ethical Considerations

This study was conducted in accordance with internationally accepted ethical standards for laboratory research. The experimental procedures involved the use of *Paramecium sp.*, a unicellular protozoan organism that does not fall under animal or human research ethics regulations. No vertebrate animals, human participants, or human biological materials

were involved in this research. All laboratory procedures were performed following institutional biosafety guidelines to ensure responsible handling of biological materials and plant extracts.

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Author Contributions

Trilli Aicha: Conceptualization, experimental design, laboratory experimentation, data collection, and initial manuscript drafting.
Trilli Hanine: Data analysis, interpretation of results, manuscript revision, and critical review for scientific content. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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Conflict of Interest

The authors declare that there are no known financial or personal relationships that could have appeared to influence the work reported in this paper.

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