



Acute effects of benzo[α]pyrene causes on oxidative stress and cell damage in bay scallop *Argopecten irradians*

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Introduction

Polycyclic aromatic hydrocarbons (PAHs)

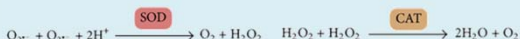
- are compounds widely present in the environment
- are known to accumulate in the body of aquatic organisms
- cause toxic reactions

Benzo[α]pyrene (BaP)

- PAH and a highly studied polymer compound
- Has a long retention period when accumulated
- Induces AhR-mediated CYP1 enzymes which convert it into mutagenic and carcinogenic metabolites

Antioxidant response

- Bivalves activate the antioxidant system to defend against large amounts of reactive oxygen species (ROS)
- Through antioxidant enzymes expressed toxic ROS generated in the body is converted into non-toxic water and oxygen to protect tissues



- Antioxidant enzymes : superoxide dismutase (SOD) and catalase (CAT)

Biomarkers in relation to oxidative stress

- ROS generated excessively can lead to oxidative damage mainly represented by lipid peroxidation (LPO), DNA damage
- DNA damage and apoptosis are recognized as general biomarkers

Purpose of this study

In this study, *A. irradians* was exposed to BaP to evaluate the latter's acute effect on the expression of the antioxidant system and DNA damage

Material & Methods

Experimental environment

- Study animal : Bay scallop *Argopecten irradians* (shell length, 57.1 ± 4.0 mm)
- The water temperature and salinity maintained at 17 °C and 30 psu
- Half of the total volume of seawater was changed daily prior to sampling

Experimental condition

- Photoperiod : 12L:12D
- Sampled at 0, 3, 6, 12, 24, 48, 72 hours

Acute exposure concentration

- Control group (Cont.)
- Low dose group (0.5 [BaP 0.5] and 1.0 µg/L [BaP 1.0])
- High dose group (10 [BaP 10] and 50 µg/L [BaP 50])

Quantitative PCR

- SOD and CAT
- Detection of apoptotic cells
- TUNEL assay
- Plasma parameter analysis ; SOD, CAT, H₂O₂ and LPO
- Statistical analysis
- SPSS version 25.0 / two-way ANOVA / P < 0.05

Experimental design



Results

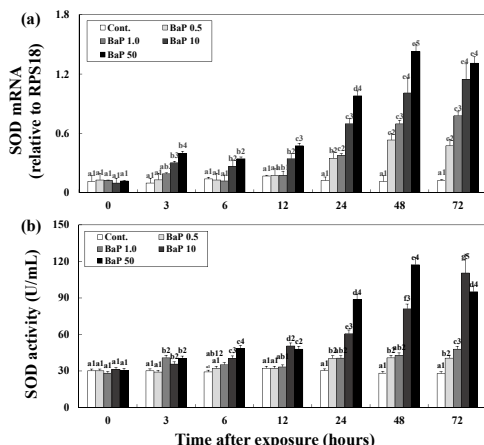


Fig. 1. Changes in the expression of the (a) SOD mRNA in the digestive diverticula and (b) SOD activity in the hemolymph of *A. irradians* exposed to BaP for 72 h. All values are means ± SD (n = 5).

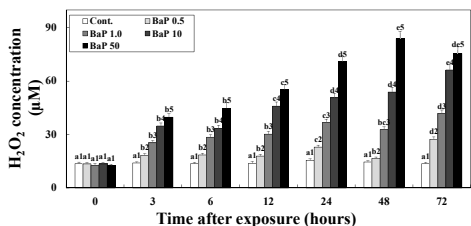


Fig. 3. Concentration of H₂O₂ in the hemolymph of *A. irradians* exposed to BaP for 72 h. All values are means ± SD (n = 5).

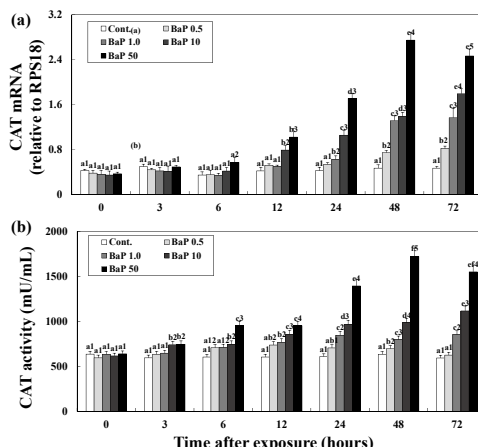


Fig. 2. Changes in the expression of the (a) CAT mRNA in the digestive diverticula and (b) CAT activity in the hemolymph of *A. irradians* exposed to BaP for 72 h. All values are means ± SD (n = 5).

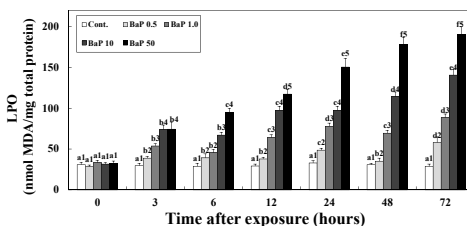


Fig. 4. Concentration of LPO in the hemolymph of *A. irradians* exposed to BaP for 72 h. All values are means ± SD (n = 5).

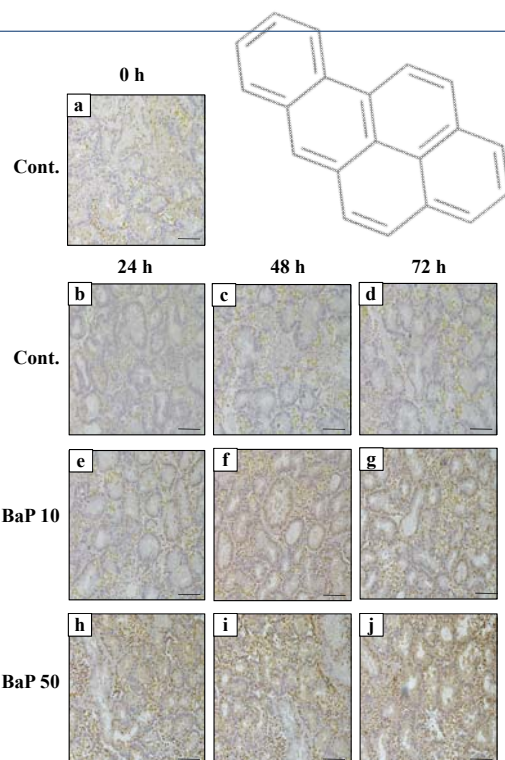


Fig. 5. Terminal deoxynucleotidyl transferase (TdT)-mediated dUTP nick end labeling (TUNEL) assay using digestive diverticula sections from *A. irradians* in control and high dose groups [10 and 50 µg/L] exposed to BaP for 24, 48, and 72 h. Dark-colored cells indicated by white arrows are apoptotic. Scale bars = 100 µm.

Conclusion

- ❖ Bay scallops were subjected to high levels of oxidative stress when exposed to high concentrations of BaP.
- ❖ High concentrations of BaP exposure could have potential adverse effects in bivalves.
- ❖ The oxidative stress biomarkers (antioxidant enzymes, ROS, LPO, etc.) in scallops has an important relationship with the detoxification of BaP.

This study suggests

Antioxidant enzyme activity and LPO level may reflect the overall detoxification capacity and damage level of scallops.



Some new light on the study of the ecotoxicological effects of BaP (a kind of PAHs) on marine bivalves.