COMMON OCTOPUS (*OCTOPUS VULGARIS*), AS A NEW BIOINDICATOR SPECIES FOR COASTAL POLLUTION MONITORING

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Introduction

Octopus vulgaris is an ecological relevant species and was tested as bioindicator species due to its territorial and predator nature. Biomarkers that measure sub cellular effects have been used as early warning tools in ecological risk assessment in various potential bioindicator species (1). Metals and polycyclic aromatic hydrocarbons (PAH) are ubiquitous compounds detected at high levels in marine environments near urban and industrialized areas. PAH metabolites and metals have the ability to enhance the production of reactive oxygen species causing damage to important biomolecules. Having this in mind, oxidative stress biomarkers were validated and tested for their usefulness as biomarkers of environmental pollution (towards metals and PAHs) in O. vulgaris.

Objectives

Evaluate the oxidative stress biomarkers potential, in Octopus vulgaris, to monitor metal and PAH pollution in coastal areas.

Materials and Methods

Octopuses were captured in the NW Portuguese coast in January, June, November of 2011 and September of 2012. Animals were divided in two groups, one sampled immediately after arrival to the laboratory (day 0) and the other remained for 14 days in clean aerated seawater tanks. Digestive gland and arms were dissected after anesthesia with ice-cold water (2) and tissues stored for biomarker studies and chemical quantification. Oxidative stress biomarkers were assessed by measuring antioxidant enzyme activity - through spectrophotometric measurements of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GP), glutathione reductase (GR) and glutathione s-transferase (GST) in the digestive gland - and by measuring oxidative damage to lipids (lipid peroxidation - LPO) and proteins (protein carbonyl content - PCO) in both tissues (3). Metals (Cu, Zn, Pb, Cd and As) were quantified by high-resolution continuum source atomic absorption spectrometry (4); 18 PAHs (the 16 PAHs considered by USEPA as priority pollutants, dibenzo(a,l)pyrene and benzo(k)fluoranthene) were determined by liquid chromatography with photodiode array and fluorescence detection (5). Differences between groups were tested using Two-Way ANOVA with a Tukey HSD test at 5% significance level. Correlations between biomarkers and pollutants were tested by Pearson analysis.

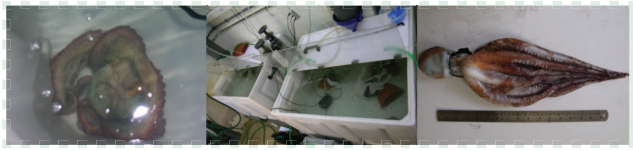

Figure 1 - Octopuses were kept in captivity for 14 days in 500L tanks to evaluate detoxification ability

Results

Results presented are a summary of data obtained for biomarkers, PAHs and metal accumulation in tissues. Only non-essential metal concentrations are shown to focus on the ones regulated by the EU for food consumption. Cadmium and lead concentrations in the edible parts were below the maximum levels established. This data has been previously published [6,7]

Metal Levels

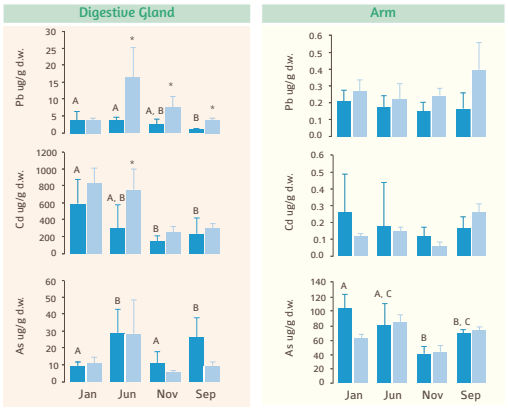

Figure 2 - Metal concentrations in the digestive gland and arm of octopus at day 0 (■) and day 14 (■) in the different seasons.

Oxidative Damage

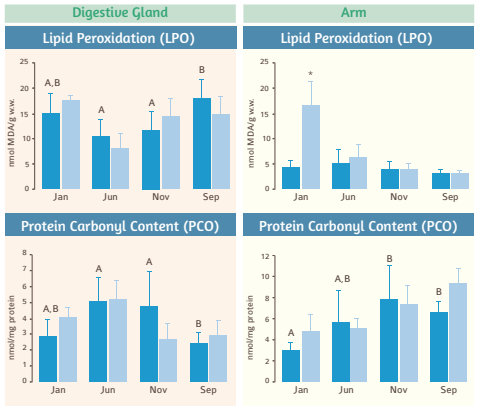

Figure 3 - LPO and PCO in the digestive gland and arm, at day 0 (■) and day 14 (■) in the different seasons.

Significant Correlations

	Positive Correlations	Negative Correlations
GST	SOD (0.38) PCO D.G. (0.45) Pb D.G. (0.30)	LPO D.G. (-0.68)
CAT	Naphtalene (0.31)	SOD (-0.33) Pb D.G. (-0.32) Cu D.G. (-0.32)
SOD	GST (0.38) PCO D.G. (0.31) Pb D.G. (0.78) Cu D.G. (0.76) Cd D.G. (0.29) As D.G. (0.46) Zn D.G. (0.53)	CAT (-0.33) LPO D.G. (-0.39)
LPO D.G.		GST (-0.68) SOD (-0.39) PCO D.G. (-0.35) Pb D.G. (-0.36)
PCO D.G.	GST (0.45) SOD (0.31)	LPO D.G. (-0.35)
LPO arm		Zn Arm (-0.33)
PCO arm		

Table 1 - Significant ($p < 0.05$) correlations between biomarkers studied and pollutants quantified (metals, PAHs). Between parenthesis are the correlation coefficient (=r).

Antioxidant Defense (Digestive Gland)

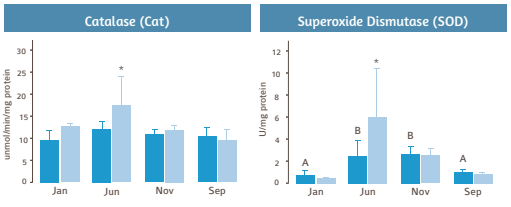

Figure 4 - CAT and SOD activities in the digestive gland at day 0 (■) and day 14 (■) in the different seasons.

PAH Levels

PAHs were detected in the digestive gland (mean concentration of 36.7 µg/Kg ΣPAHs) and in the arm (mean concentration of 6.13 µg/Kg ΣPAHs), however, oxidative stress biomarkers were not correlated with PAH levels. Benzo(a)pyrene, the carcinogenic PAH, was detected in the arm of only one individual at levels below the regulatory limits.

Conclusions

- **Antioxidant enzymes were highly responsive to metal levels in tissues while PAH contents did not reveal significant correlation with oxidative stress biomarkers.**
- **Octopus tissues reflected the environmental contamination patterns.**
- **Octopus vulgaris seems to be a useful bioindicator species in metal environmental monitoring while it does not appear as a good sentinel species for PAH monitoring.**

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Acknowledgments

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