Non-destructive biological and chemical traits to track down long term effects of environmentally relevant low concentrations of pharmaceutical mixtures using two freshwater species

Fanny Desbiolles, Laetitia de Jong, Xavier Moreau, Isabelle Laffont-Schwob, Laure Malleret, Christophe Tiliacos, Nicolas Tiliacos, Pascal Wong-Wah-Chung

To cite this version:

Fanny Desbiolles, Laetitia de Jong, Xavier Moreau, Isabelle Laffont-Schwob, Laure Malleret, et al.. Non-destructive biological and chemical traits to track down long term effects of environmentally relevant low concentrations of pharmaceutical mixtures using two freshwater species. Society of Environmental Toxicology and Chemistry, 26th annual meeting, May 2016, Nantes, France. hal-01462322

HAL Id: hal-01462322

https://hal.archives-ouvertes.fr/hal-01462322

Submitted on 8 Feb 2017

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Non-destructive biological and chemical traits to track down long term effects of environmentally relevant low concentrations of pharmaceutical mixtures using two freshwater species

DESBIOLLES Fanny1,2, De JONG Laetitia3, MOREAU Xavier2, LAFFONT-SCHWOB Isabelle2, MALLERET Laure3, TILIACOS Christophe3, TILIACOS Nicolas3, WONG-WAH-CHUNG Pascal1

1 – Aix-Marseille Université, CNRS, Laboratoire de Chimie de l’Environnement, UMR 7376, 13545, Aix-en-Provence, France
2 – Institut Méditerranéen de Biodiversité et d’Écologie marine et continentale, UMR CNRS 7263 /IRD 237, Aix-Marseille Université, Aix-en-Provence. 3 Place Victor Hugo, 13331 Marseille, France
SEAKALIA, Héliopolis – Technopôle de Château Gombert – 3 allée des Mairaîchers, 13013 Marseille, France
fanny.desbiolles@univ-amu.fr

Currently, there are a lot of normalised acute bioassays that evaluate ecotoxicity:
- Of single pollutants
- Under short time exposures (72h or 96h)
- At high concentrations (mg.L⁻¹)

There is a need for new models to evaluate:
- Pollutant mixtures
- Chronic toxicity
- Low environmental concentrations

Context & Objectives

Study of 2 pharmaceuticals not removed in wastewater treatment plants Carbamazepine (CBZ), OxCarbazepine (OxCBZ) and one of their metabolite Acridine-9-carboxylic acid (9-CAA)

Lemna minor L.:
- Cosmopolitan species and fast growth rate
- Normalised bioassay for acute & chronic toxicity

Growth conditions:
- Light : 9h/day, Moisture : 60%, Temperature : 15°C, Hoagland media (10X)
- Optical measurement of early changes in primary and secondary metabolites (anthocyanin, chlorophyll, flavonol, phenol and nitrogen balance indexes)

Pollutants & Freshwater species

Published ecotoxicity values

Only For CBZ1,2

Lemna minor L., EC₂₅ : 25.5 mg.L⁻¹, growth inhibition, 7d, (chronic toxicity)

Hydra attenuata Pall., EC₂₅ : 15.52 mg.L⁻¹, 96h (chronic toxicity)

EC₅₀ : 29.4 mg.L⁻¹, 96h (acute toxicity)

Results

Morphological changes, reflecting progressive intoxication, were observed after only one day of exposure : 21% of polyps exposed to CBZ, OxCBZ or 9-CAA showed first signs of intoxication and 16.6% of polyps exposed to the mixture showed more pronounced signs of intoxication. Interestingly, after 6 days of exposure morphological signs of intoxication tended to disappear and polyps exhibited normal morphological stage until the end of exposure (21 days). These observations suggest that H. attenuata possesses defence mechanisms to face intoxication.

Phenolic index of compounds and control during a 17 day-long exposure

- Phenolic index: The highest concentration of 9-CAA induced an early metabolic stress in Lemna minor L. as shown by the increase of the phenolic index probably due to a defence mechanism. For OxCBZ, a slight metabolic stress was observed but not CBZ nor the mixture at low concentrations impacted this index.
- Nitrogen balance index: OxCBZ and CBZ at the highest concentrations increased the nitrogen balance index after 11 days. It shows a modification of allocation of nitrogen and carbon that may impact photosynthesis in duckweed.
- Chlorophyll index: This primary metabolite was stable for all the compounds and their mixture.
- Anthocyanin and flavonol indexes were below detection limits.

Conclusion

- Both models enable to study non-destructive biological pertinent endpoints.
- The macrophyta, Lemna minor, showed deleterious effects only at high concentrations. This species does not seem highly sensitive to these compounds under the tested conditions.
- Bioassays using Hydro attenuata showed that the selected compounds at environmental concentrations induced deleterious effects at early (morphological changes) and later stages (budding rates). Such negative effects raise the question of the impact on natural populations that are chronically exposed to pollutants.
- These preliminary results could help to develop new tools for water quality monitoring and for chronic toxicity assessment at realistic environmental concentrations.

References

1 Chavan, M. N.; Sahoo, S. Aquatic Ecotoxicity of Pharmaceuticals Including the Assessment of Combination Effects. Toxicon Letters 243 (3) : 168-164.