WATER QUALITY GUARANTEE ISSUES IN BRAZIL: FOCUS TO PESTICIDES AND MICROPLASTIC CONTAMINATION

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OUR STUDIES ABOUT PESTICIDES / MICROPLASTICS

SURFACE WATER CONTAMINATION

APPLICATION

FATE & TRANSPORT

RISK ASSESSMENT

WATER TREATMENT

DRINKING WATER QUALITY

Fate and transport in the environment after application

Surface water and soil contamination
  • Risk assessment to the biota

Drinking water quality
  • Human exposition levels

APPLICATION

FATE & TRANSPORT

RISK ASSESSMENT

WATER TREATMENT

DRINKING WATER QUALITY
Occurrence of pesticides in waters from the largest sugar cane plantation region in the world

- Raphael D. Acayaba
- Master project

☑ 175 surface water samples from 28 samplings points
☑ 21 groundwater samples from 10 sampling points
☑ Sampling between 2015/2016
☑ Analysis by SPE – LC-MS/MS

☑ In surface water, all 14 compounds studied were detected in at least one sample.

☑ Diuron, hexazinone, tebuthiuron, 2-OH-ATZ and carbendazim - detection frequencies >90%

Acayaba RD, Albuquerque AF, Ribessi RL, Umbuzeiro GA, Montagner CC; Environmental Science and Pollution Research (2021) 28(8) 9824, DOI: 10.1007/s11356-020-11428-1
Occurrence of pesticides in waters from the largest sugar cane plantation region in the world

Acayaba RD, Albuquerque AF, Ribessi RL, Umbuzeiro GA, Montagner CC; Environmental Science and Pollution Research (2021) 28(8) 9824, DOI: 10.1007/s11356-020-11428-1
Occurrence of pesticides in surface and groundwaters

✓ No correlation of pesticide occurrence in the dry and rainy season or between pesticides and land use (urban or non-urban) was found in the dataset provided in this study.

✓ In groundwater, atrazine, 2OH-ATZ, diuron, tebuthiuron, carbofuran, imidacloprid and carbendazim were detected in at least one sample, but only tebuthiuron was detected at concentrations above LOQ.

✓ This study highlights the need for actions to reduce the amount of pesticides used in crops aiming at the protection of aquatic life and the implementation of a broad monitoring program to protect surface and underground water resources for human consumption.
The mobility of the compounds was evaluated based on the OECD Guide No. 312, using atrazine as a reference substance.

Atrazine is considered to be of moderate mobility and this compound allows obtaining the relative mobility factor (RMF) for the chemicals in each soil.

Transport of emerging contaminants: a column experimental study in granitic and alluvial soils
Paulo HP Stefano, Ari Roisenberg, Elias B Gomes, Bianca V Goulart, Cassiana C Montagner
Environmental Monitoring and Assessment (2021) 193:262; DOI: 10.1007/s10661-021-09026-w
PESTICIDES’ MOBILITY IN SOILS

Concentration of each compound in the soil by depth, from 5 to 25 cm.

Relative mobility factor (RMF) of the studied contaminants in different soils

<table>
<thead>
<tr>
<th>Contaminants</th>
<th>Viamão</th>
<th>Gneiss</th>
<th>P.Grossa</th>
<th>Quarternary</th>
<th>Santana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simazine</td>
<td>0.8</td>
<td>0.6</td>
<td>0.8</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>Ametrine</td>
<td>0.8</td>
<td>0.4</td>
<td>0.6</td>
<td>0.5</td>
<td>0.15</td>
</tr>
<tr>
<td>Tebuthiuron</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.8</td>
<td>1</td>
</tr>
<tr>
<td>2,4-D</td>
<td>0.15</td>
<td>0.4</td>
<td>0.6</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>Diclofenac</td>
<td>0.15</td>
<td>0.15</td>
<td>0.4</td>
<td>1.3</td>
<td>0.15</td>
</tr>
<tr>
<td>Fipronil</td>
<td>0.4</td>
<td>0.4</td>
<td>0.6</td>
<td>0.8</td>
<td>0.15</td>
</tr>
</tbody>
</table>

✓ **GUS Index (Groundwater Ubiquity Score)** indicates the leaching potential of a substance using physical and chemical data such as adsorption coefficient (Koc) and half-life.

✓ **GUS > 2.8, leaching may occur.**

✓ **Simazine and tebuthiuron are the substances with the greatest leaching potential.**

✓ **Fipronil, 2,4-D and Diclofenac tend not to leach.**

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**Requirements**

- Self-sustainable systems
- Organisms from different trophic levels of local fauna and flora
- Sampling must not disturb the mesocosm system

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✓ Applied nominal concentration was based on the Predicted Environmental Concentration (PEC):

- 2,4D – 447 μg L\(^{-1}\)
- Fipronil – 63 μg L\(^{-1}\)

✓ Vinasse was applied composing 1.3% of the total of mesocosms

✓ Total volume of each mesocosms was 1,500 L
Fipronil concentration in mesocosm systems (2 h–150 days after pesticide application) associated with ecotoxicological effects on organisms of different trophic levels for treatments only Fipronil (red), Fipronil+ 2,4-D (blue), and Fipronil+2,4-D+vinasse (green).

100% mortality
2 Effects on tadpoles physiology
3 Decreased rates of amplexus and total reproduction
4 Mortality rates of 90%

Fate and toxicity of 2,4-D and fipronil in mesocosm systems
NOTES:

✓ Applied nominal concentration was based on the Brazilian recommended management:

- 2,4D – 1200 g ha⁻¹
- Fipronil – 500 g ha⁻¹

✓ Total volume of each mesocosms was 9,000 L

SANDY SOIL

Brotas, SP
FAPESP 2015/18790-3
Fate and transport of fipronil at mesocosms and soil during the management of sugarcane

Fipronil ($\mu$g kg$^{-1}$) in sugarcane crop soil

Effects of pasture intensification and sugarcane cultivation on non-target species: A realistic evaluation in pesticide-contaminated mesocosms


STOTEN 922 (2024) 171425; 10.1016/j.scitotenv.2024.171425

*PNEC value for Fipronil = 12 ng L$^{-1}$
Effects of pasture intensification and sugarcane cultivation on non-target species: A realistic evaluation in pesticide-contaminated mesocosms


STOTEN 922 (2024) 171425; 10.1016/j.scitotenv.2024.171425
Interdisciplinary Research

Analytical methods and technologies
- Characterization
- Quantification
- Fate and behavior (sorption/degradation)
- NIAS / IAS Leaching

Occurrence
- Improve the knowledge about the critical scenarios

Risk Assessment

Ecotoxicology
- Lab and mesocosms
SORPTION AND MOLECULAR TRANSPORT OF ATRAZINE, TESTOSTERONE, AND PROGESTERONE ONTO POLYAMIDE MICROPLASTICS IN DIFFERENT AQUATIC MATRICES

Molecular dynamics configurations showing the main sorption mechanism interactions of ATZ onto PA microplastic surface: (a) electrostatic interactions between –CH groups, (b) ATZ both as N⋯H⋯N hydrogen bond donor and acceptor, (c, d) ATZ as N⋯H⋯O hydrogen bond donor. The values in the figures are the hydrogen bond lengths in Å. Oxygen, nitrogen, carbon, hydrogen, and chlorine atoms are represented by red, blue, gray, white, and green colors, respectively.

Sorption efficiency in polyamide microplastics on ultrapure water (UW), surface water (SFW), groundwater (GW), and seawater (SW) at equilibrium time (48 h). Sorption and desorption efficiency on/from PA microplastics in UW at equilibrium (48 h). Experimental conditions: temperature = 20 °C; PA = 10 g L⁻¹; CE = 1 mg L⁻¹.
EFFECTS OF POLYETHYLENE MICROPLASTICS IN DAPHNIA MAGNA
Matheus Rezende’ Project – in progress
Atrazine and its degradation products in drinking water source and supply: Risk assessment for environmental and human health in Campinas, Brazil
Beatriz DC Vizioli, Giulia Silva da Silva, Jéssyca F. de Medeiros, Cassiana C. Montagner; Chemosphere (2023) DOI: 10.1016/j.chemosphere.2023.139289
Atrazine and its degradation products in drinking water source and supply: Risk assessment for environmental and human health in Campinas, Brazil
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**Fig. 1.** Monthly concentrations (ng L⁻¹) of ATZ (blue), HYA (green), DIA (yellow), and DEA (red) for:
- a) DWTP1 in surface water (SW) (Capivari River);
- b) DWTP1 in drinking water (DW) (Capivari River);
- c) DWTP2 in surface water (SW) (Atibaia River);
- d) DWTP2 in drinking water (DW) (Atibaia River).

**Fig. 2.** Human health risk assessment by the Risk Quotient (RQ) approach for the sum of ATZ + DIA + DEA and HYA for DWTP1 (dark gray) and DWTP2 (light gray), according to the Brazilian drinking water standards. RQ values > 1 indicate risk (red line).

**Fig. 3.** Human health risk assessment by the Risk Quotient (RQ) approach for ATZ, HYA, DIA, DEA, and Sum for DWTP1 (dark gray) and DWTP2 (light gray), according to the European Directive. RQ values > 1 indicate risk (red line).
**Removal of Pesticides from Source Waters: Direct Potable Reuse vs. Reuse “de facto”**

Multiple barriers as an efficient treatment for removing pesticides aiming Direct Potable Reuse: a pilot scale study

Jéssyca F. de Medeiros, Cassiana C. Montagner; Environmental Pollution (2024) in press
TI PANARA – Brazil

✓ MT / PA States
✓ ~500,000 hectares
✓ 7 villages
✓ ~750 people
✓ by 2021, ~64,000 hectares had been deforested within the Iriri River basin
The Panara ask for help!

How to propose sustainable agribusiness and guarantee the water security of the Iriri River?

How can science help mitigate the impacts on their culture caused by climate changes?

How to protect our Amazon rainforest?
THANK YOU FOR YOUR ATTENTION!