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Environmental risk assessment of sulfluramid-based ant killer baits at forest areas

COMPANIES PRODUCING THE ANT KILLER BAIT:

DINAGRO AGROPECUÁRIA LTDA.

M.L. INDÚSTRIAS QUÍMICAS LTDA.

PRODUTOS QUÍMICOS SÃO VICENTE

UNIBRAS AGRO QUÍMICA LTDA.

April/1998

[2]

The information contained in this report represent the results achieved during the performance of the "Environmental risk assessment of sulfluramid-based ant killer baits at forest areas" project.
Raw data from the analyses carried out, as well as samples collected during the project performance, are stored at BIOAGRI Laboratórios Ltda.

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PROJECT

Environmental risk assessment of sulfluramid-based ant killer baits at forest areas

Responsible for the project: BIOAGRI LABORATÓRIOS LTDA.

Companies supplying the ant killer bait:

DINAGRO AGROPECUÁRIA LTDA.

M.L. INDÚSTRIAS QUÍMICAS

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Summary

The environmental monitoring project for SULFLURAMID was carried out on 30 ha of forest area with eucalyptus, where the ant killer bait containing SULFLURAMID was applied. 500 m^2 of native forest were maintained without the ant killer bait in order to serve as control treatment. During 1 year, samples of soil, water, fish and wild rats were collected to determine the concentration of SULFLURAMID residues and its most important metabolite, perfluorooctane sulfonamide (PFOSA). Daily observations were conducted at the project site for an eventual identification of any dead animal. The residue analyses for all the matrices - water, soils, fishes and wild rats (blood and lipids) – did not present any level of residues, both for SULFLURAMID and its metabolite PFOSA. The results achieved, in addition to the absence of any death of fishes and animals on site, indicate that, for the ant killer bait used at commercial dosage, there was no negative effect on local fauna.

1. Introduction

The utilization of granulated baits for combating leaf-cutting ants, of the most common genuses, **Atta** and **Acromyrmex**, also known as *Saúvas* and *Quenquéns*, at agricultural & cattle raising and forest areas, has been becoming a regular practice. In this system, baits are placed in bait-holders, with the benefit of preserving the forest sub-woods, thus enabling the treatment of anthills at places hard to be accessed, providing greater safety for the operator.

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2.Purpose:

This project has the purpose of assessing the eventual environmental impact of sulfluramid (N-ethyl perfluorooctane sulfonamide) and its more stable metabolite Perfluorooctane Sulfonamide (PFOSA) on fishes and wild animals at forest area, by characterizing these observations with physical and chemical analyses of soil and water samples, collected at the site where this project was conducted.

This study will be an integral part of the hazardousness/risk assessment in the registration of pesticides at IBAMA, for the SULFLURAMID-based granulated ant killer product of DINAGRO, M.L. IND. QUÍMICAS, PROD. QUÍMICOS SÃO VICENTE and UNIBRAS.

3. Technical, toxicological and ecotoxicological information on sulfluramid

Solubility = 5.0 mg/L at 30 °C

Vapor pressure = 0.054 MPa at 25 °C

log Kow = 3.3

DL50 oral (rats) = 3,250.0 mg/Kg

DL50 dermal (rats) = 2,500.0 mg/Kg

DL50 acute-oral (birds) = 187.5 mg/Kg live weight

DL50 diet-oral (birds) = 263.9 mg/Kg of food

CL50 acute (algae) = 1,000 mg/L

CL50 acute (Daphnia) = 77.63 mg/L

CL50 acute (fishes) = 24.69

CL50 (earthworms) = 1,897 mg/Kg of silica

Biodegradability in aqueous solution = 5.65% in 28 days

Biodegradability in soils = 1.04-1.16% (low degradability in soils in terms of CO_2 evolution)

Mobility: Rf = 0 in three soil types (virtually immobile)

Adsorption/desorption: K adsorption = 106.27-115.55

K desorption = 120.8-138.21 (high adsorption)

4. Materials and Methods:

4.1 Experimental area:

An area of approximately 30 ha was used, in a forest reserve of the company CHAMPION PAPEL E CELULOSE LTDA., at Aguaí, state of São Paulo (location sketch attached0. The treatment was carried out according to the manufacturer's recommendations, by applying 30 bait-holders/ha, containing quantities agronomically recommended of the ant killer product. Six rural workers were employed for this application.

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Application period (10/01/1996)

Field	Area (ha)	Bait consumption (kg)
3 A	12.63	6.0
3 B	8.88	2.0
3 C	2.83	5.0
3 D	4.17	1.5

An area with 5,000 m^2 was reserved as treatment control, without applying sulfluramid. At the areas adjacent to the parcels, all the anthills were previously eliminated to prevent interference on the parcels. The agricultural practices usually employed at forest areas were kept throughout the project area.
The experimental area was allocated close to a lake, which served as water and fish collection point.

4.2 Chemical analysis of the water;

Chemical analyses were carried out on water samples collected during the experimental period:

-pH, NO3, P, K, Ca, Mg, Fe, Cu, Mo, Zn, Cd, Mn, hardness, oxygen dissolved, biochemical oxygen demand (BOD), and chemical oxygen demand (COD).

-Water sample collection dates for chemical analysis:

-1 day before installing the experiment – witness (09/30/96)

-1 day after starting the experiment (10/02/96)

-30 days after starting the experiment (10/31/96)

-60 days after starting the experiment (11/31/96)

-120 days after starting the experiment (01/30/97)

-180 days after starting the experiment (04/01/97)

-365 days after starting the experiment (09/30/97)

4.3 Chemical analysis of the soil:

Soil samples collected in the field were taken to the laboratory, dried in the air, passed by sieve with 2-mm mesh and analyzed in terms of physical-chemical characteristics,

according to IAC (Instituto Agronômico de Campinas) method. The parameters analyzed were:

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-pH, organic matter, Al^{+3}; Ca; Mg; K; Fe; Cu; Mn; Zn; clay, silt and sand contents

-Soil sample collection dates for chemical and physical-chemical analysis:

-1 day before starting the experiment – witness (09/30/96)

-1 year after starting the experiment (09/30/97)

4.4 Soil and lake water sampling:

For the analysis of sulfluramid and PFOSA residues, soil sample collections were performed at 0-10cm profile. Each soil sample was comprised by 10 sub-samples collected randomly.
Water samples were collected from three places in the lake (sub-samples), which were homogenized to comprise a single composed sample.

-Soil and water sample collection dates for sulfluramid and PFOSA residue analysis:

-1 day before starting the experiment (soil) (09/30/96)

-1 day before starting the experiment (water) (09/30/96)

-1 day after starting the experiment (soil) (10/02/96)

-1 day after starting the experiment (water) (10/02/96)

-30 days after starting the experiment (soil) (10/31/96)

-30 days after starting the experiment (water) (10/31/96)

-60 days after starting the experiment (soil) (11/30/96)

-90 days after starting the experiment (soil) (12/30/96)

-120 days after starting the experiment (water) (01/30/97)

-120 days after starting the experiment (soil) (01/30/97)

-180 days after starting the experiment (soil) (04/01/97)

-180 days after starting the experiment (water) (04/01/97)

-365 days after starting the experiment (soil) (09/30/97)

-365 days after starting the experiment (water) (09/30/97)

4.5 Fish sampling:

-Fish sample collection dates for residue analysis:

-Before applying the ant killer product in the area (09/14/96)

-30 days after applying the ant killer product (10/31/96)

-60 days after applying the ant killer product (11/30/96)

-90 days after applying the ant killer product (12/30/96)

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4.6 Wild animal sampling:

The species selected was the wild rat, because it is more abundant and easy to capture. During the project conduction, 20 rattraps were installed at several places in the experimental area. The rats captured were sacrificed for the analysis of residues in blood and fat (lipid) samples.

-Blood and lipid sampling dates for wild animals

-Before applying the ant killer product – blood (08/18/96)

-Before applying the ant killer product – lipids (08/18/96)

-30 days after applying the ant killer product – blood (10/31/96)

-30 days after applying the ant killer product – lipids (10/31/96)

-60 days after applying the ant killer product – blood (11/30/96)

-60 days after applying the ant killer product – lipids (11/30/96)

-90 days after applying the ant killer product – blood (12/30/96)

-90 days after applying the ant killer product – lipids (12/30/96)

-120 days after applying the ant killer product – blood (01/30/97)

-120 days after applying the ant killer product – lipids (01/30/97)

-1 year after applying the ant killer product – blood (09/30/97)

-1 year after applying the ant killer product – lipids (09/30/97)

4.7 Bio-accumulation in fishes:

To determine the sulfluramid, the fishes were collected from a lake close to the project area. Before applying the ant killer bait, the fishes of the lake were captured and maintained in $2m^2$ nylon cages in order to assure that the same fishes were present during the experiment, thus facilitating the collection.

4.8 Evaluation of wild animal death:

At the experimental area, a technician remained lodged in the farm's house in order to run the experimental area each day and log any eventual death of wild animals. A freezer was maintained at the site for freezing the animal until its identification and the analysis of sulfluramid and its main metabolite.

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5. Analysis of Sulfluramid and PFOSA residues in samples of soil, water, fish, blood and lipid by gas chromatography/mass spectrometry (CGMS).

5.1 Equipment

Capillary gas chromatography was used for the analysis of sulfluramid and its main metabolite PFOSA, because it presents good resolution and sensitivity. The equipment used was a HEWLETT-PACKARD 6890 equipped with mass spectrometer model 5973, connected to a HP workstation.

The capillary column used in the study was the HP-5MS (30m length, 0.25mm diameter, 0.25mm film thickness).

The chromatographic parameters were:

Injector temperature: 200 °C
Initial oven temperature: 60 °C
Interface temperature: 260 °C
Carrier gas: Helium
Total flow: 40.2 mL/min
Tr sulfluramid: 7.8 min
Tr PFOSA: 8.2 min

5.2 Reagents

Acetone – pesticide residue degree, J.T.Baker
Ethyl acetate – pesticide residue degree, J.T.Baker
Dichloromethane– pesticide residue degree, J.T.Baker
Nitrogen gas (N_2) – ultra pure
Primary pattern sulfluramid 99.8%
Primary pattern PFOSA 90%
Non-hydrated sodium sulfate – reagent ACS, Merck

5.3 Standard solution

A primary standard solution of sulfluramid was prepared, by weighing 13.6 mg of 99.8% standard in a 10-mL flask, and the volume was completed with acetone. A primary standard solution of PFOSA was prepared, by dissolving 20.8 mg of 90% standard in 10 mL of acetone. Diluted solutions for obtaining the calibration curve, detection limit and linearity of the detector were prepared from these solutions.

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5.4 Bait sample

5.4.1 Procedure: A bait sample used for the field experiment was prepared by weighing, in triplicate, 10g of triturated sample, and adding 20 mL of ethyl acetate.
The flasks were hermetically closed and left during 30 minutes in double boiler at 40 °C. After cooling down to the ambient temperature, the mixture was filtered in paper filter and 1 μL of the filtered solution was injected in the gas chromatographer for sulfluramid and PFOSA analysis.

5.5 Water Sample

5.5.1 Procedure: 500 mL of water sample was extracted with 3 x 100 mL of dichloromethane in separation funnel. The organic phase was dried and transferred to round bottom flask through a funnel containing non-hydrated sodium sulfate. The funnel was flushed with additional 20 mL of dichloromethane, by combining the extracts. The solvent was evaporated under vacuum in Rotavapor (40 °C), and the extract was dissolved in 5 mL of dichloromethane and concentrated to 2 mL in nitrogen flow. 1 μL of this solution was injected in the chromatographer. The sulfluramid and PFOSA concentrations in water were calculated by equation 1:

$$ppb = \frac{\text{Concentration detected x Solvent volume}}{\text{sample mass}} \quad \text{Equation 1}$$

5.5.2 Method validation (Fortification)

From the primary standard solutions (item 3), work solutions were prepared and added to 500 mL of water to obtain the following concentrations of analytes in water: sulfluramid 0.027 ppb, 0.054 ppb and 0.27 ppb – PFOSA: 0.37 ppb, 0.74 ppb and 3.70 ppb.
The analyses were carried out as previously mentioned and the recovery results are presented in the tables below:

Sulfluramid (ppb)	Recovery (%)
0.027	118
0.054	101
0.270	94

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PFOSA (ppb)	Recovery (%)
0.37	99
0.74	99
3.70	102

Detection limit (sulfluramid): 1.3 pg

Detection limit (PFOSA): 9,4 pg

Method quantification limit (sulfluramid): 0.027 ppb

Method quantification limit (PFOSA): 0.37 ppb

Average recovery percentage (sulfluramid): 104.3±12.3

Average recovery percentage (PFOSA): 100.0±11.7

The recovery percentage was calculated by equation 2:

$$\text{Recovery (\%)} = \frac{\text{Concentration analyzed}}{\text{Fortified concentration}} \qquad \text{Equation 2}$$

5.6 Soil sample

5.6.1 Procedure: 100 g of soil sample (air-dried) was extracted with 200 mL of dichloromethane by stirring, in a stirring table, during 2 hours. Dichloromethane was transferred to a flat bottom flask, passing through a column of non-hydrated sodium sulfate. The solvent was evaporated under vacuum in Rotavapor at 40 °C and the extract was dissolved in 5 mL of dichloromethane, which was concentrated to 2 mL with nitrogen flow. 1 μL of this solution was injected in the chromatographer. The sulfluramid and PFOSA concentrations in soil were calculated by equation 1:

5.6.2 Method validation (Fortification):

From the primary standard sulfluramid and PFOSA solutions (item 3), certain volumes were added in 100 g of witness soil to obtain the following concentrations: Sulfluramid 0.136 ppb, 0.271 ppb and 1.357 ppb – PFOSA: 1.87 ppb, 3.74 ppb and 18.72 ppb. The analyses were carried out as previously mentioned and the recovery percentages were calculated by equation 2. The recovery results are shown in the tables below:

Sulfluramid (ppb)	Recovery (%)
0.136	82.5
0.271	87.0
1.357	80.0

PFOSA (ppb)	Recovery (%)
1.87	107.4
3.74	116.0
18.72	88.0

Detection limit (sulfluramid): 1.3 pg

Detection limit (PFOSA): 9,4 pg

Method quantification limit (sulfluramid): 0.136 ppb

Method quantification limit (PFOSA): 1.87 ppb

Average recovery percentage (sulfluramid): 83.2±3.5

Average recovery percentage (PFOSA): 103.8±14.3

5.7 Fish Sample

5.7.1 Procedure: The fish was prepared by discarding the head, tail and fins. 100 g of macerated fish sample was transferred to a mixer with 200 mL of dichloromethane. After homogenization (4 minutes), the mixture remained in rest for decantation and was filtered in non-hydrated sodium sulfate. The procedure was repeated with an additional portion of 200 mL of dichloromethane. The solvent was evaporated under vacuum (40 °C) and the extract dissolved in 2 mL of acetone. 1 μL of this solution was injected in the chromatographer. The fish concentrations were calculated by equation 1:

5.7.2 Method validation (Fortification):

From the primary standard sulfluramid and PFOSA solutions (item 3), certain volumes were added in 100 g of witness fish sample to obtain the following concentrations: Sulfluramid 1,36 ppb, 2,71 ppb and 13,57 ppb – PFOSA: 1.87 ppb, 3.74 ppb and 18.72 ppb.

The analyses were carried out as previously mentioned and the recovery percentages were calculated by equation 2. The recovery results are shown in the tables below:

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Sulfluramid (ppb)	Recovery (%)
1.36	84.0
2.71	87.0
13.57	87.5

PFOSA (ppb)	Recovery (%)
1.87	115.0
3.74	103.6
18.72	80.0

Detection limit (sulfluramid): 1.3 pg

Detection limit (PFOSA): 9,4 pg

Method quantification limit (sulfluramid): 1.36 ppb

Method quantification limit (PFOSA): 1.87 ppb

Average recovery percentage (sulfluramid): 86.2±1.9

Average recovery percentage (PFOSA): 99.5±17.8

5.8 Blood sample

5.8.1 Procedure: 1 mL of blood samples, collected from animals at the experimental field, was transferred to tube containing 10 mL of ethyl acetate. After intense stirring during 20 seconds, the mixture was submitted to ultrasound water bath application during 20 minutes. The tube was centrifuged at 500g during 20 minutes and the floating material transferred to a clean tube. The process was repeated with an addition portion of 10 mL of ethyl acetate and the floating material combined with the previous one. The solvent was then evaporate to be dried with nitrogen in double boiler at 40 °C. The extract was dissolved in 2 mL of acetone. 1 μL of this solution was injected in the chromatographer. The sulfluramid and PFOSA concentrations in the blood were calculated by equation 1:

5.8.2 Method validation (Fortification):

From the primary standard sulfluramid and PFOSA solutions (item 3), certain volumes were added in 1 mL of blood collected from laboratory animals (witness) to obtain the

following concentrations: Sulfluramid 13.57 ppb, 27.14 ppb and 135.7 ppb – PFOSA: 187.2 ppb, 374.4 ppb and 1872.0 ppb.
The analyses were carried out as previously mentioned and the recovery percentages were calculated by equation 2. The recovery results are shown in the tables below:

Sulfluramid (ppb)	Recovery (%)
13.57	95.8
27.14	81.0
135.7	87.1

PFOSA (ppb)	Recovery (%)
187.2	114.1
374.4	82.5
1872.0	95.4

Detection limit (sulfluramid): 1.3 pg

Detection limit (PFOSA): 9,4 pg

Method quantification limit (sulfluramid): 13.6 ppb

Method quantification limit (PFOSA): 187 ppb

Average recovery percentage (sulfluramid): 88.0±7.4

Average recovery percentage (PFOSA): 97.3±15.9

5.9 Lipid sample

5.9.1 Procedure: The extraction process was the same mentioned in the previous item, by using 1 g of lipid sample, extracted from animals (rats) at the experimental field. The sulfluramid and PFOSA concentrations in the blood were calculated by equation 1:

5.8.2 Method validation (Fortification):

From the primary standard sulfluramid and PFOSA solutions (item 3), certain volumes were added in 1 g of lipid collected from laboratory animals (witness) to obtain the following concentrations: Sulfluramid 13.57 ppb, 27.14 ppb and 135.7 ppb – PFOSA: 187.2 ppb, 374.4 ppb and 1872.0 ppb.
The analyses were carried out as previously mentioned and the recovery percentages were calculated by equation 2. The recovery results are shown in the tables below:

Sulfluramid (ppb)	Recovery (%)
13.57	94.3
27.14	87.7
135.7	82.1

[15]

PFOSA (ppb)	Recovery (%)
187.2	109.2
374.4	112.3
1872.0	82.8

Detection limit (sulfluramid): 1.3 pg

Detection limit (PFOSA): 9,4 pg

Method quantification limit (sulfluramid): 13.6 ppb

Method quantification limit (PFOSA): 187 ppb

Average recovery percentage (sulfluramid): 88.0±6.1

Average recovery percentage (PFOSA): 101.4±16.2

6. Results

Table 1 shows the results from the chemical analysis of the water collected during the experimental period, at the lake located within the experimental field, where the sulfluramid- based ant killer bait was applied. By the results shown on this table, we observe that there were no significant variations in the chemical characteristics of the lake water after applying the sulfluramid.

Table 2 shows the physical-chemical results for the soil proceeding from the experimental field, in samples collected before and after (1 year) applying sulfluramid. The results did not present significant differences among the samples in the parameters analyzed, which lead us to conclude that the ant killer bait did not influence physical and/or chemical parameters of the soil. The difference in the organic matter contents was due to the layer of organic material deposited on the soil surface.

Table 3 shows the results from the analysis of the bait used in the experiment. The average sulfluramid concentration in the bait was 0.29%, while PFOSA was not detected in any bait sample.
The standard curves for sulfluramid and PFOSA are shown in graphical format (appendix), with the respective equations that represent them.
The results from the analyses of sulfluramid and PFOSA residue analysis in the different matrices are shown on Tables 4 (water), 5 (soil), 6 (fish), 7 (blood) and 8 (lipid), where it is possible to observe that the concentrations of sulfluramid and its main metabolite PFOSA were always below the method detection limit in all the samples analyzed (water, soil, fish, blood and lipid) regardless the sampling period.
The results indicated that, in addition to the absence of any death of fishes and animals at

the site, the ant killer bait, used in the commercial dosage, did not cause any negative effect on the local fauna.

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Table 1. Analytical results for samples of water collected during the experimental period. The results are expressed in mg/L (ppm):

Parameters	Test.*	1 DAA*	30 DAA	60 DAA	120 DAA	180 DAA	365 DAA
PH	6.34	7.03	7.36	6.92	6.96	7.45	7.63
Nitrate	0.9	1.9	3.8	0.7	1.3	1.40	1.70
Phosphorus	<0.01	<0.01	<0.01	0.03	0.02	0.07	0.08
Potassium	3.3.1	3.90	23.6	64.3	64.6	2.08	2.58
Calcium	1.67	1.68	1.96	0.9	6.5	4.6	4.28
Magnesium	1.01	2.84	3.36	0.3	18.8	1.08	1.06
Iron	0.33	0.23	0.91	0.75	1.5	0.09	0.03
Copper	0.10	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Molybdenum	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	0.04	0.01	0.05	0.06	0.02	0.12	0.02
Cadmium	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	0.01	0.01	0.20	0.08	0.14	0.22	0.03
Hardness	<2	3.8	4.60	<2	64.0	31.0	38.0
OD	6.4	7.8	6.4	4.6	-	-	3.0
BOD	<1	10	<1	3	<1	<1	6
COD	<5	41	<5	12	<5	5	30

*Test. = sample collected before applying the ant killer bait at experimental field

**DAA = days after applying the ant killer bait at experimental field

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Table 2. Physical-chemical results for soil samples collected at experimental field

Parameters	Sample 1*	Sample 2*	Measuring unit
PH	5.0	6.6	-
Organic matter	12.4	5.17	%
Potassium	1.14	0.32	mg/10cm^3
Calcium	21.1	6.92	mg/10cm^3
Magnesium	2.53	0.85	mg/10cm^3
Aluminum	0.34	1.58	mg/10cm^3
Copper	0.47	0.52	mg/10cm^3
Iron	24.3	28.6	mg/10cm^3
Manganese	1.42	1.88	mg/10cm^3
Zinc	0.71	2.33	mg/10cm^3
Silt	4	3	%
Clay	7	5	%
Coarse sand	12	6	%
Medium sand	7	9	%
Fine sand	70	77	%

*Soil sample collected before applying the ant killer bait
**Soil sample collected 1 year after applying the ant killer bait

[18]

Table 3. Sulfluramid and PFOSA (%) concentration in the ant killer bait applied at the experimental area

Commercial product Bait	**Sulfluramid (%)**	**PFOSA (%)**
Sample 1	0.29	n.d.
Sample 2	0.30	n.d.
Sample 3	0.28	n.d.
Average	0.29	

n.d. = not detected at 0.01% level

Table 4. Sulfluramid and PFOSA (ppb) concentration in water samples collected during the experimental period

Sampling period (DAA)*	**Sulfluramid (ppb)**	**PFOSA (ppb)**
Before application	<0.027	<0.37
1	<0.027	<0.37
30	<0.027	<0.37
120	<0.027	<0.37
180	<0.027	<0.37
365	<0.027	<0.37

*DAA = days after applying the ant killer bait

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Table 5. Sulfluramid and PFOSA (ppb) concentration in soil samples collected during the experimental period

Sampling period (DAA)*	**Sulfluramid (ppb)**	**PFOSA (ppb)**
Before application	<0.136	<1.87
1	<0.136	<1.87
30	<0.136	<1.87
60	<0.136	<1.87
90	<0.136	<1.87
120	<0.136	<1.87
180	<0.136	<1.87
365	<0.136	<1.87

*DAA = days after applying the ant killer bait

Table 6. Sulfluramid and PFOSA (ppb) concentration in fish samples collected during the experimental period

Sampling period (DAA)*	**Sulfluramid (ppb)**	**PFOSA (ppb)**
Before application	<1.36	<1.87
30	<1.36	<1.87
60	<1.36	<1.87
90	<1.36	<1.87

*DAA = days after applying the ant killer bait

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Table 7. Sulfluramid and PFOSA (ppb) concentration in blood samples collected during the experimental period

Sampling period (DAA)*	Sulfluramid (ppb)	PFOSA (ppb)
Before application	<13.6	<187
30	<13.6	<187
60	<13.6	<187
90	<13.6	<187
120	<13.6	<187
365	<13.6	<187

*DAA = days after applying the ant killer bait

Table 8. Sulfluramid and PFOSA (ppb) concentration in lipid samples collected during the experimental period

Sampling period (DAA)*	Sulfluramid (ppb)	PFOSA (ppb)
Before application	<13.6	<187
30	<13.6	<187
60	<13.6	<187
90	<13.6	<187
120	<13.6	<187
365	<13.6	<187

*DAA = days after applying the ant killer bait

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7. Technical team

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Márcio Gava

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