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Risk of Intoxication with Sulfluramid in a Packing Plant of Mirex-S

J. G. Machado-Neto,[1] M. E. C. Queiroz,[2] D. Carvalho,[2] A. J. Bassini[3]

[1] Department of Crop Protection, School of Agricultural and Veterinary Sciences, São Paulo State University, Rodovia Carlos Tonanni, km 5, 14870-000, Jaboticabal, São Paulo, Brazil
[2] Department of Pharmaceutical Sciences, University of Ribeirão Preto, 14096-380, Ribeirão Preto, São Paulo, Brazil
[3] Aracruz Celulose S.A., Aracruz, Espírito Santo, Brazil

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The majority of occupational hazards caused by pesticides are due to high skin exposure and to inhalation of material during spray operations. Many types of exposure appear to be entirely dermal in character (Klaassen 1996).

Workers who handle pesticides are exposed to the risk of intoxication depending on the toxicity of the compound and the degree of exposure under specific working conditions. Toxicity is an intrinsic property of a particular compound, but it also depends on the extent of adsorption by various uptake routes. Exposure is largely dependent on the job being done and how it is done, the physical form of the pesticide, and the environmental conditions (Van Hemmen 1992).

Occupational exposure has been quantified for various mixer/loader/spray and field worker situations: chlorothalonil in greenhouse carnation culture (Jongen et al 1991) alachlor among commercial pesticide applicators (Sanderson et al 1995) benomyl among nursery workers (Hoekstra et al 1996) and granulated insecticides in coffee crops (Machado-Neto et al 1996). A wide variety of direct and indirect dermal sampling methods used to estimate this type of exposure have been reviewed (McArthur 1992).

However, few studies are available about occupational exposure in the pesticide industry or in closed environments, and more specifically no information is available for packing Mirex-S into bait bags in Brazilian factories.

Thus, the objective of the present study was to determine the risk of intoxication with sulfluramid for workers involved in the packing of Mirex-S in a factory that produces bait bags by estimating the safety margin under these working conditions.

MATERIALS AND METHODS

Worker skin exposure to sulfluramid during packing of Mirex-S bait (0.3% sulfluramid) into small bait bags, was quantified in the factory of Aracruz Celulose S.A. Company. The factory is located in a brick building and the

Correspondence to: J. G. Machado-Neto

packing machine is placed in a room measuring 12 m in length by 4 m in width and 6 m in height. A connected adjacent room of the same size is used to store the original containers of Mirex-S (cardboard boxes with transparent plastic bags with 25 kg of bait each) and the plastic boxes for transporting bait bags to the eucalyptus forests, each box containing 150 bait bags. The filling machine (EMBRAPAC Equipamentos S.A.) was adapted for packing Mirex-S bait into fully sealed plastic bags containing 30 g of granules each.

The factory was operated by three persons, and their activities consisted in the following steps: every operational batch was based in processing ten original Mirex-S boxes, one worker opened and removed the plastic bags from the ten boxes, and stacked them close to the browser of the packing machine. At the same time, the other two workers took care of the maintenance and operation of the packing machine. Alternative turns in operations as feeding the packing machine, receiving the bait bags and manually controlling their quality on the receiving table located at the opposite end of the browser of the machine, were made among workers during the remainder of the day. Bait bags that were not completely sealed were discarded and cut with scissors on the top of the receiving table, consisting of a perforated iron sheet, with 1" holes, through which the bait fell down into a container under the table. The bait bags selected on the receiving table were placed in plastic boxes located by the side of the table which were used to transport the bags to the field. At 11:00 a.m., two workers took one hour for lunch while the third one continued to work, and then was relieved. The air temperature inside the packing room ranged from 29.7°C to 35.8°C during the study. Besides this task, in the first 15 minutes of every day, workers have to load a truck with the plastic boxes containing bait bags

Skin exposure in the three workers was assessed for three days for a total period of 9,7 to 10,4 hours/day, resulting in nine replicates. The sampled clothes were a cap of flannel-like fabric covering the workers head and neck, cotton gloves and white duck overalls. At the end of the period of exposure, the overalls were cut with scissors into sleeves, right leg, left leg and trunk. These parts together with the cap and gloves were individually identified and placed in plastic bags and stored in a freezer until the time for sulfluramid measurement. Foot exposure was not evaluated since workers always wore impermeable boots that were covered by the trouser cuffs.

For determination of sulfluramid in the 54 samples, the exposed clothes were extracted separately with ethyl acetate in flasks, which were closed with duraseal-lined polypropylene caps and mechanically shaken for 40 minutes on a water bath at 40°C. Extracts were poured through filter paper (Sartorius 0.47 µm) and concentrated in a rotary evaporator under a nitrogen stream, reconstituted to 5 mL with ethyl acetate and stored at -20 °C until the time for chemical analysis.

Sulfluramid was analyzed by gas chromatography (Varian model Star 3400 Cx) equipped with an electron capture detector (EDC). The GC column used was a fused-silica capillary column (30 m x 0.25 mm x i. d. x 0.1 m) coated with chemically bonded phenyl-methyl polysiloxone DB-5 film (J & W Scientific). Nitrogen was the carrier and make-up gas. Temperatures of the injector and detector were maintained at 250°C and 300°C, respectively. Columns were programmed from 100°C to 108°C at 1°C/min and 20°C/min until a final temperature of 280°C was reached. Quantification was based on the average of peak areas from three consecutive injections obtained from a pure external standard and by regression analysis.

The margin of safety (MOS) for the studied working conditions, with the three workers performing daily activities in a rotating system, was estimated by the formula of Severn (1984) modified by Machado-Neto (1997): MOS = (NOEL x 70) / (QAE x 10), where NOEL = 10 mg sulfluramid/kg rat/day (Tomlin 1997); 70 = mean workers body weight (kg); QAE = 0.6 evaluated skin exposure, with 0.1 being due to dermal absorption of sulfluramid (Jensen 1984) and 0.5 being used to replace the respiratory exposure which was not quantified, although it has been reported that the respiratory exposure of granule applicators in closed environments represented at most 12% of the total exposure (Crome 1985), and 10 is a safety factor used to compensate for the extrapolation of toxicologic data obtained for laboratory animals to man (Brouwer et al. 1990).

The criterion used to classify MOS of the evaluated working conditions was that proposed by Machado-Neto (1997) i.e.: if MOS ≥ 1, the condition is safe, the exposure is acceptable and the risk is tolerable, and if MOS < 1, the condition is unsafe, the exposure unacceptable and the risk intolerable. MOS was estimated for days of 8 and 10 hours of effective exposure, since these workers put in two extra hours of work per day.

RESULTS AND DISCUSSION

Recovery rates from fortified clothes, caps and gloves at three different levels (25, 50 and 100 μm/sample) were 84, 91 and 88% for clothes, 84, 89 and 90% for caps, and 89, 86 87 % for gloves, respectively. The linearity of the responses of the detector was studied within the range of 1 to 50 μm/mL. Responses were linear in the range studied, with an r value of 0.9806 - 0.9987. The minimal detectable amount was 0.1 μg/mL. Coefficients of variations were 6 and 4% at concentrations of 5 μg/mL and 50 μg/mL. In general, no interferences were observed in the analysis of the matrices.

The results of skin exposure on the various parts of the workers' body and the MOS estimated for the activities performed when packing Mirex-S in bait bags in the factory are presented in Table 1.

Table 1. Mean values concerning skin exposure to sulfluramid (μg/day) in various body parts of workers, and mean margin of safety (MOS) during Mirex-S packing activities in a factory producing bait bags during 8 and 10 hour working days.

Body parts	8 hour day		10 hour day		% / total exposure
	μg/day	S.D.	μg/day	S.D.	
Head + Neck	13.4	5.5	16.8	6.9	3.7
Arms	72.1	28.7	90.1	35.8	20.1
Hands	89.7	52.3	112.1	65.3	25.1
Trunk	57.0	17.6	71.0	22.9	15.8
Right leg	53.9	24.7	67.4	30.9	15.0
Left leg	73.0	31.0	91.2	38.7	20.3
Total	359.1	112.5	448.6	140.7	-
MOS	324.9	-	260.1	-	-

S.D. = standard deviation

Data presented in Table 1 show that working conditions can be considered as extremely safe (Machado-Neto, 1997), since estimated MOS values were 324.9 and 260.1 for 8 hour and 10 hour work days, respectively. It should be pointed out that these working conditions were extremely safe even with respiratory exposure being overestimated as 50% of skin exposure, when for similar conditions they account at most for 12% (Crome, 1985). We believe that the major factors determining the reduced skin exposure of the workers to sulfluramid were: the type of Mirex-S formulation (granules), the low concentration of sulfluramid in the product handled (0.3%) and the closed circuit of the filling machine.

Hands were the most exposed body parts, receiving 25% of the total dermal exposure, followed by left leg and arms, because they were in direct contact or very close to the handled product.

On the basis of estimated MOS values, the risk of intoxication for workers employed in packing Mirex-S into bait bags is classified as acceptable, the occupational exposure during a day of work of 8 or 10 hours is tolerable, and the working conditions extremely safe.

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