Presence of Sprout Inhibitor Residues in Potatoes in Relation to Application Techniques

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The residues on potatoes of the sprout inhibitors propham (IPC) and chloropropham (CIPC) applied as a powder or by aerosol were studied. Sprout inhibitor residues were determined after 15 and 30 days of storage in peeled and unpeeled potatoes. In the powder treatment containing IPC plus CIPC, only residues of IPC were found. In the aerosol treatment containing only CIPC, both CIPC and IPC were determined. Peeling potatoes resulted in large decreases in sprout inhibitor levels in the aerosol treatment. Both aerosol and powder applied CIPC and IPC prevented sprouting for more than 3 months.

Keywords: *Sprout inhibitors; distribution; potatoes; residues*

INTRODUCTION

After harvest, potatoes may be treated with sprout inhibitors such as propham (IPC) and chloropropham (CIPC) (Marth and Schultz, 1952). These inhibitors are applied either by aerosol, or, less frequently, in the powder form.

In Italy, the Ministry of Health (Decreto Presidente della Repubblica 1255, 1968) determines the products that may be used, as well as their methods of application. During the authorization phase, the Ministry sets maximum levels for the quantity of active substance that may remain in the treated potatoes (Ordinanza Ministeriale 57, 1990 and Ord. Suppl. Gazzetta Ufficiale 202, 1990). Both the amount deposited as well as the loss of the sprout inhibitor depend on various factors. Residues vary according to application methods (powder or aerosol), storage conditions, location in the storage room from which the sample was taken and, in samples from the same location, depth of the sample taken (Bertolini et al., 1990; Corsini et al., 1979; Bolroni and Baldini, 1989).

Tests were conducted under conditions representing effective use with the following objectives: (1) to quantify the residues present after powder or aerosol application; (2) to study the distribution of the inhibitors in aerosol-treated potatoes that were stored in piles or in pallet boxes. These treatments of stored potatoes are used with very good results (Rastovski and Van Es, 1981) in Italy and Holland.

MATERIALS AND METHODS

Treatment. The potatoes used were the cultivar Primura, which have smooth skin and are very popular in the fresh market. Before the sprout inhibitor treatment, the tubers were cured at 15–18 °C and 90–95% relative humidity for 15 days. Potatoes passing through a 55–65-mm opening were used.

Aerosol treatment of potatoes with sprout inhibitors (Table 1) was performed directly in storage rooms of 2600 m^3, which under normal conditions were completely filled with potatoes in bins or piles (containing ~9500 metric tons). The dimensions of the piles were 20 × 23 m, and the height was 3.5 m. Wooden pallet boxes (1.2 × 1.1 × 1.0 m), with a distance between slats of 4 cm and containing approximately 600 kg of potates, were used for the bins. The height of the bins was 6 m. With storage in both piles or bins, the aerosol was injected into the air distribution system of the room, which had ducts underneath the open grating of the floor. From these ducts, the refrigerated air was forced through the pile or bins.

Table 1. Procedures Used for Treatment of Potatoes by Sprout Inhibitors

case	type of application	product applied	amount (%)	dose calcd (mg/kg)	type of storage
1	powder	IPC	3.0	20	crates
		CIPC	0.5		
2	aerosol	CIPC	13	9	piles
3	aerosol	CIPC	13	9	bins

Under normal operating conditions, the amount of active ingredient used in the aerosol treatment was less than that in the powdered form treatment (Table 1). Indeed, it may be necessary to repeat aerosol applications during the storage period if the potatoes begin to sprout.

Powder treatment was performed by dusting the potato tubers (Table 1) when the crates were filled. The crates were the normal kind used in fruit markets, with dimensions of 0.50 × 0.30 × 0.28 m.

The storage temperature for all trials was 10 °C with 88–95% relative humidity.

Sampling. Samples of the potatoes treated by aerosol were taken in the cells from four different sites in the bins or piles (Figure 1). The potatoes to be analyzed were collected immediately after treatment at a depth of ~50 cm from the highest point in the pile or bin and then stored in a refrigerator at 10 °C with a relative humidity of 88–95%. Samples for analysis from the aerosol and powder treatments were taken at the time of treatment and after 15 and 30 days of storage.

Analysis. Samples were prepared and determinations made of IPC and CIPC residues as previously described

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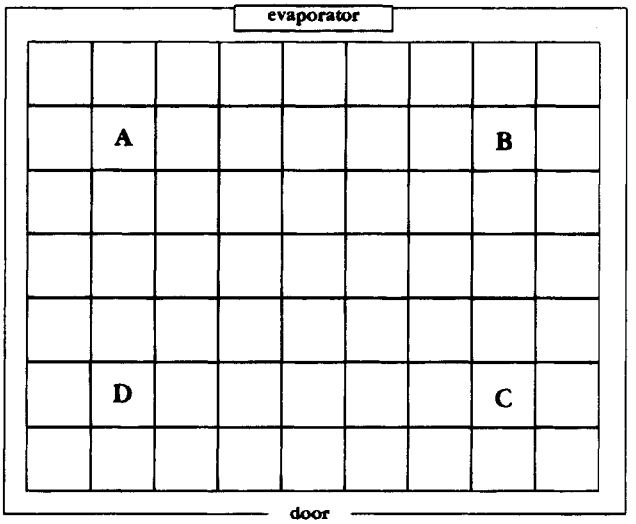

Figure 1. Sampling points in the storage cell.

Table 2. Effects of Storage Time on the Content of CIPC and IPC (Milligrams per Kilogram) in Peeled Potatoes after Application of Powdered Inhibitor to Potatoes Stored in Crates[a]

	0 days		15 days		30 days	
inhibitor	x[b]	$\gamma\%$[c]	x	$\gamma\%$	x	$\gamma\%$
IPC	0.87[a]	19.6	0.83[a]	34.5	0.48[b]	28.0
CIPC	tr[d]	tr	nd[e]	nd	nd	nd

[a] IPC values with the same superscript are not significantly different according to contrast–LSD. [b] x, Average of values obtained in six determinations. [c] $\gamma\%$, Coefficient of variation percentile. [d] tr, trace. [e] nd, Not determinable (at the determination limit of 0.01 mg/kg).

(Bertolini et al., 1990). For each sample, eight potatoes were cut in half and half of each potato was peeled with a knife. The potatoes were ground in a blender, and 50 g was taken for the analysis. The samples were extracted with *n*-hexane and analyzed by gas chromatography utilizing a selective thermoionic detector. With an HP5 chromatographic column, oven temperature of 190 °C and detector temperature of 310 °C, the retention times were 1 min 10 s for IPC and 2 for CIPC. The mean recovery at the 0.05 mg/kg level of fortification was 85%, and the analytical sensitivity was 0.01 mg/kg. All samples were analyzed after the potatoes were peeled, except when they were only washed.

Data Analysis. The data were analyzed by analysis of variance. The coefficient of variation percentile was also calculated as $(S:X)100$, where S is the average standard deviation and X is the average of the values obtained.

RESULTS AND DISCUSSION

Both aerosol and powder application of the sprout inhibitor resulted in excellent sprout control 3 months after treatment. The results of analyses on samples taken at the 0-, 15-, and 30-day intervals are shown in Tables 2, 3, and 4, respectively. In tubers treated with the IPC plus CIPC formulation by the powder technique (Table 2), only residues of IPC, which was present in greater quantities in this formulation, were found. In tubers treated with formulations based only on CIPC by the aerosol technique (Tables 3 and 4), IPC was present at 0.02 mg/kg or less.

Both powder (Table 2) and aerosol treatments (Tables 3 and 4) resulted in residues that were below legal limits in the peeled potatoes. Italian legislation permits the use of IPC and CIPC in stored potatoes and established the limit of 0.5 mg/kg for the sum of residues of both substances in peeled potatoes 30 days after treatment.

If sample site A is excluded, peeled potatoes from storage in piles contained slightly higher CIPC residues than potatoes stored in bins. There were ~10 times more residues present in tubers treated with powder (Table 2) than tubers treated by aerosol (Tables 3 and 4). This result may be attributed to the effect of the greater quantity applied in a single dose.

From a comparison of the results of CIPC residues in peeled as opposed to washed potatoes (Table 3), it is apparent that peeling removes the active ingredients from the edible part of the potato much more than washing.

Potatoes stored in piles and treated by aerosol had a higher concentration of the product (Table 4) in tubers taken from sampling point A than point B, even though point A is symmetrical to point B. Uneven distribution caused by differential airflow in the piles may be the cause of this discrepancy.

The large coefficients of variation resulted in few significant differences in the variance analysis (Tables 2, 3, and 4). Multiple range analysis showed that the powder application of IPC exhibited significant differences between 0–30 days and 15–30 days (Table 2). Also, CIPC aerosol treatment of potatoes stored both in bins (Table 3) and in piles (Table 4) resulted in residues on peeled potatoes that did not decrease significantly during storage but varied significantly as a function of sampling point in the cell.

Table 3. Effects of Storage Time on the Content of CIPC + IPC (Milligrams per Kilogram) after CIPC Application by Aerosol to Potatoes Stored in Bins

		0 days				15 days				30 days			
		IPC		CIPC		IPC		CIPC		IPC		CIPC	
sampling point	parameter	peeled	washed	peeled	washed	peeled	washed	peeled	washed	peeled	washed	peeled	washed
A	x[a]	nd[b]	—[c]	0.08	—	0.01	0.19	0.06	3.91	nd	0.19	0.06	4.01
	$\gamma\%$[d]	—	—	9.7	—	6.37	19.8	14.3	12.1	—	32.9	10.1	12.6
B	x	0.01	—	0.02	—	0.01	—	0.02	—	nd	—	0.03	—
	$\gamma\%$	14.0	—	14.0	—	25.5	—	32.8	—	—	—	28.5	—
C	x	nd	—	0.02	—	0.01	—	0.02	—	nd	—	0.03	—
	$\gamma\%$	—	—	25.7	—	42.4	—	30.8	—	—	—	15.5	—
D	x	nd	—	0.05	—	0.01	0.21	0.06	3.93	nd	0.22	0.03	3.86
	$\gamma\%$	—	—	26.5	—	27.8	18.4	14.2	8.8	—	22.8	30.2	10.6
total	X	nd	—	0.04	—	0.01	0.20	0.04	3.92	nd	0.20	0.04	3.93
	Γ%	—	—	60.1	—	27.4	17.5	49.6	9.44	—	25.5	43.2	10.6

[a] x, average of values obtained in three determinations. [b] nd, Not determinable (at the determination limit of 0.01 mg/kg). [c] —, Analysis not done. [d] $\gamma\%$, Coefficient variation percentile.

Table 4. Effect of Storage Time on the Content of CIPC + IPC (Millograms per Kilogram) in Peeled Potatoes after CIPC Application by Aerosol to Piles of Potatoes[a]

sampling point	parameter	0 days		15 days		30 days	
		IPC	CIPC	IPC	CIPC	IPC	CIPC
A	x[b]	nd[c]	0.24[a]	0.02[d]	0.27[a,a]	0.01	0.24[a]
	γ%[e]	—[f]	16.3	52.0[d]	13.6[d]	39.4	56.4
B	x	nd	0.05[c]	0.01	0.06[c]	0.01	0.07[c]
	γ%	—	34.3	40.2	26.2	31.0	15.6
C	x	nd	0.04[c]	0.01	0.03[c]	0.02	0.05[c]
	γ%	—	7.1	25.7	21.1	24.0	6.01
D	x	nd	0.07[b]	0.01	0.10[b]	0.02	0.15[b]
	γ%	—	5.7	12.2	25.9	56.2	29.4
total	X	nd	0.10	0.01	0.11	0.02	0.13
	Γ%	—	85.6	38.6	84.7	41.1	76.7

[a] CIPC values with the same superscript are not significantly different according to contrast-LSD. [b] x, Average of values obtained in three determinations. [c] nd, Not determinable (at the determination limit of 0.01 mg/kg). [d] Values also obtained from washed samples: IPC: $x = 0.22$; $\gamma\% = 31.3$; CIPC: $x = 12.67$; $\gamma\% = 19.0$. [e] γ%, Coefficient variation percentile. [f] —, Analysis not done.

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