CARBOSULFAN (145)/CARBOFURAN (096)

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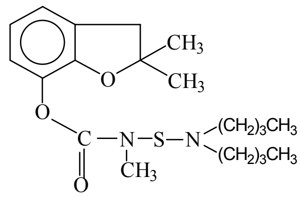
EXPLANATION

Carbosulfan, an insecticide, was evaluated by the JMPR in 1984, 1986, 1991, 1992, 1993, 1997 and 1999. It was identified for re-evaluation at the 1997 CCPR and scheduled for consideration by the 2003 JMPR. In 1984, substantial residue data were available but, because sufficient information on nationally approved uses was not provided, the JMPR was unable to estimate maximum residue levels. In 1997, the JMPR received data from residues trials and processing for oranges. The present Meeting received information on: identity; animal and plant metabolism; residues analysis; residues data on potatoes, sugar beet, rice and maize; fate of residues in storage and processing; and residues in food and commerce.

IDENTITY

ISO common name:	carbosulfan (E-ISO, (m)F-ISO
Synonyms or code numbers:	FMC 35001
IUPAC name:	2,3-dihydro-2,2-dimethylbenzofuran-7-yl (dibutylaminothio)methylcarbamate
Chemical Abstracts name:	2,3-dihydro-2,2-dimthyl-7-benzofuranyl[(dibutylamino)thio]methylcarbamate
CAS number:	*[55285-14-8]*
Molecular formula:	$C_{20}H_{32}N_2O_3S$
Molecular mass:	380.5
Structural formula:	

PHYSICAL AND CHEMICAL PROPERTIES

Pure active ingredient

		Reference
Appearance:	liquid	Alvarez, 1995
Odour:	none	Alvarez, 1995
Melting point:	not clearly defined	Alvarez, 1995
Boiling point:	thermally unstable	Alvarez, 1995
Vapour pressure at 25°C:	$2.69\ 10^{-7}$mm Hg	Alvarez, 1995
Henry's law constant	$4.66\ 10^{-3}$ Pam^{3} mol^{-1}	Alvarez, 1995
Solubility in water	3 mg/l	Alvarez, 1995
Solubility in organic solvents at 25°C:	miscible with acetone, hexane, acetonitrile and toluene	Alvarez, 1995
Dissociation constant in water	none	
Octanol/water partition coefficient:	log Kow = 5.4 at pH 9	Alvarez, 1995
Hydrolysis (sterile solution):	half-life at pH 5 = 0.2 h half-life pH 7 = 11.4 h	El Naggar, 1982
Photolysis in water:	mainly to carbofuran and butylamine in aqueous solution, half-life 1.4 days at pH 7.	Muller, 1994

Technical material

		Reference
Appearance:	liquid	Alvarez, 1995
Colour:	brown	Alvarez, 1995
Odour:	none	Alvarez, 1995
Minimum purity:	86%	Alvarez,1995
Melting point:	not clearly defined	Alvarez, 1995

Formulations

Carbosulfan is available in the following formulations: emulsifiable concentrates (EC), suspension concentrates (SC), emulsions, oil in water (EW), wettable powders (WP), capsule suspensions (CS), dry seed treatment (DS) and dustable powders (DP).

METABOLISM AND ENVIRONMENTAL FATE

The meeting received animal metabolism data from studies on hens. The metabolism was shown to start with hydrolysis of carbosulfan to form carbofuran and butylamine which are further oxidized to hydroxy carbofuran and phenolic and butylaminol compounds.

Metabolism

Laying hens

Wilkes (1981) fed uniformly ring-labelled carbosulfan ([^{14}C-phenyl]carbosulfan) and dibutylamine-labelled carbosulfan ([^{14}C 1-DBA]carbosulfan) to laying hens, with treatment levels corresponding to 0.5, 1.5 and 5.0 ppm in the feed, which were equivalent to approximately 0.05, 0.15 and 0.5 mg/kg body weight. Each hen was dosed orally by capsule, once per day for 14 days.

Samples of muscle, fat, liver, skin, gizzard and heart were collected at the end of the study. Eggs were collected each day. The samples were homogenized and the TRRs were determined by oxidative combustion. Tissues and eggs were also extracted with ethanol/ether/hexane (1:2:1). The extract was partitioned with 0 01 N HCl (polar products). The aqueous phase was buffered and treated with dichloromethane. The post-extraction solids were extracted with methanol and phosphate buffer and filtered. The filtrate was partitioned with dichloromethane. The organic solvent extracts were cleaned-up by gel permeation chromatography and analyzed by HPLC.

The [^{14}C-phenyl]carbosulfan and its degradation products were absorbed and rapidly eliminated from tissues of chickens. From dosing with [^{14}C-phenyl]carbosulfan, the ^{14}C levels in eggs reached a plateau of 0.026 mg/kg (carbosulfan equivalents) in the yolk and 0.009 mg/kg (carbosulfan equivalents) in the white, by the 5th day of dosing at the 5.0 ppm level. At all dose rates, the yolks contained higher levels of ^{14}C than the whites. Residue levels in the whites and yolks of eggs collected after the final oral dose, declined rapidly.

Residues of ^{14}C from [^{14}C-DBA]carbosulfan also reached a plateau at 5 days, in both yolks and whites. The maximum level (carbosulfan equivalents) observed in egg yolk was 1.87 mg/kg and in egg white was 0.119 mg/kg. Residue levels in the whites and yolks of eggs collected after the final oral dose, declined rapidly. By day 24 (11 days depuration), residue levels in egg whites were at or below the limit of detection (0.002 mg/kg). On day 27 (14 days of depuration), there were still measurable levels of ^{14}C residues in the egg yolks (0.055 mg/kg).

Table 1. Material balance and carbosulfan metabolite distribution in eggs laid by hens during dosing with [^{14}C-DBA]carbosulfan at the equivalent of 5 ppm in the feed (Markle, 1982b).

Residue fraction or component	Egg whites (9-12 days)		Egg yolks (9-12 days)	
	% of TRR	^{14}C, mg/kg carbosulfan equivalents	% of TRR	^{14}C, mg/kg carbosulfan equivalents
Extractable identified components				
carbosulfan	-	<0.002	-	<0.002
dibutylamine	3.8	0.001	4.3	0.023
minor metabolite A	-	<0.002		<0.002

Residue fraction or component	Egg whites (9-12 days)		Egg yolks (9-12 days)	
	% of TRR	^{14}C, mg/kg carbosulfan equivalents	% of TRR	^{14}C, mg/kg carbosulfan equivalents
Extractable unknowns				
MW >500	-	-	66.3	-
others	9.9		19.5	-
Total % extractable	13.7	-	90.1	-
Aqueous extractable	6.5	-	1.9	-
Post-extraction solids (PES)	66.0		5.6	-
Total % recovered	86.2	-	97.6	-

Maximum ^{14}C residues (carbosulfan equivalents) in tissues were observed in the liver (0.28 mg/kg) and gizzard (0.17 mg/kg). In the case of [^{14}C-phenyl]carbosulfan, the radioactivity was depleted rapidly in all tissues and at all treatment levels.

Table 2. Distribution of total radio-labelled residue (TRR) in poultry tissues from hens previously dosed at 5.0 ppm with [^{14}C-phenyl]carbosulfan (Markle, 1982a). Day 0 was within 6 hours of the last dose.

Tissue	TRR, carbosulfan equivalents, mg/kg		
	0 days depuration	7 days depuration	14 days depuration
Breast muscle	0.110	<0.002	<0.002
Thigh muscle	0.115	<0.002	<0.002
Blood	0.191	<0.002	<0.002
Fat	0.081	<0.002	<0.002
Gizzard	0.171	<0.002	<0.002
Heart	0.159	<0.002	<0.002
Liver	0.281	0.002	<0.002
Skin	0.145	<0.002	<0.002

Samples of liver and thigh muscle tissues from the first day after withdrawal of treatment (day 0) at the high dose (5 ppm) were selected for characterization and assay of the metabolites (Table 3).

Table 3. Nature and quantities of metabolites of [^{14}C-phenyl]carbosulfan in thigh muscle and liver of hens, on day 0 of depuration at 5 ppm (Markle, 1982a).

Residue fraction or component	Thigh muscle		Liver	
	% TRR	mg/kg	% TRR	mg/kg
Extractable identified components				
carbosulfan	-	<0.002	-	<0.002
carbofuran	-	<0.002	-	<0.002
3-OH, *N*-OH carbofuran	9.3	0.007	2.1	0.004
3-OH, 7-phenol	7.1	0.004	16.0	0.021
3-OH carbofuran	36.9	0.026	1.1	<0.002
3-keto, 7-phenol	6.4	0.003	2.5	0.003
3-keto-carbofuran	1.7	<0.002	1.7	0.003
7-phenol	-	<0.002	3.3	0.004
minor metabolites	2.1	<0.002	0.5	<0.002
Extractable unknowns				
MW >500	3.0	-	8.3	-
other	3.6	-	2.4	-
Total % extractable	70.1	-	37.9	-
Aqueous extractable	14.6	-	44.9	-
Post-extraction solids (PES)	1.6	-	18.6	-
Total % recovered	86.3	-	101.4	-

The post-extraction solids from the liver and the polar, aqueous fractions from the liver and thigh muscle were hydrolyzed with 0.25N HC1, to check for additional release of conjugated metabolites. Only 3-keto carbofuran was released. There were no detectable residues (<0.002 ppm) of carbosulfan or carbofuran in any tissue analyzed. The ^{14}C residues resulting from treatment with the ^{14}C-DBA-carbosulfan appeared to be fat-soluble and had been incorporated into macromolecules and other natural products.

In the case of hens dosed with [^{14}C-DBA]carbosulfan and then allowed a period of depuration, ^{14}C residues declined in the liver but not in the fat or skin. At 14 days after cessation of treatment withdrawal, no significant reduction in ^{14}C residue levels in the fat and skin had occurred at any treatment level. In this study, organo-soluble metabolites containing the dibutylamine moiety were determined by derivatization with phenyl*iso*cyanate. Results of analysis of the high dose (5.0 ppm) tissues are summarized in Table 4 and show that, in general, the tissue levels seen at 0 days of depuration (within 6 hours after the final dose) were similar to those observed with the [^{14}C-phenyl]carbosulfan.

Table 4. Distribution of total radio-labelled residue (TRR) in poultry tissues from hens previously dosed at 5.0 ppm with [^{14}C-DBA]carbosulfan (Markle, 1982b). Day 0 was within 6 hours of the last dose.

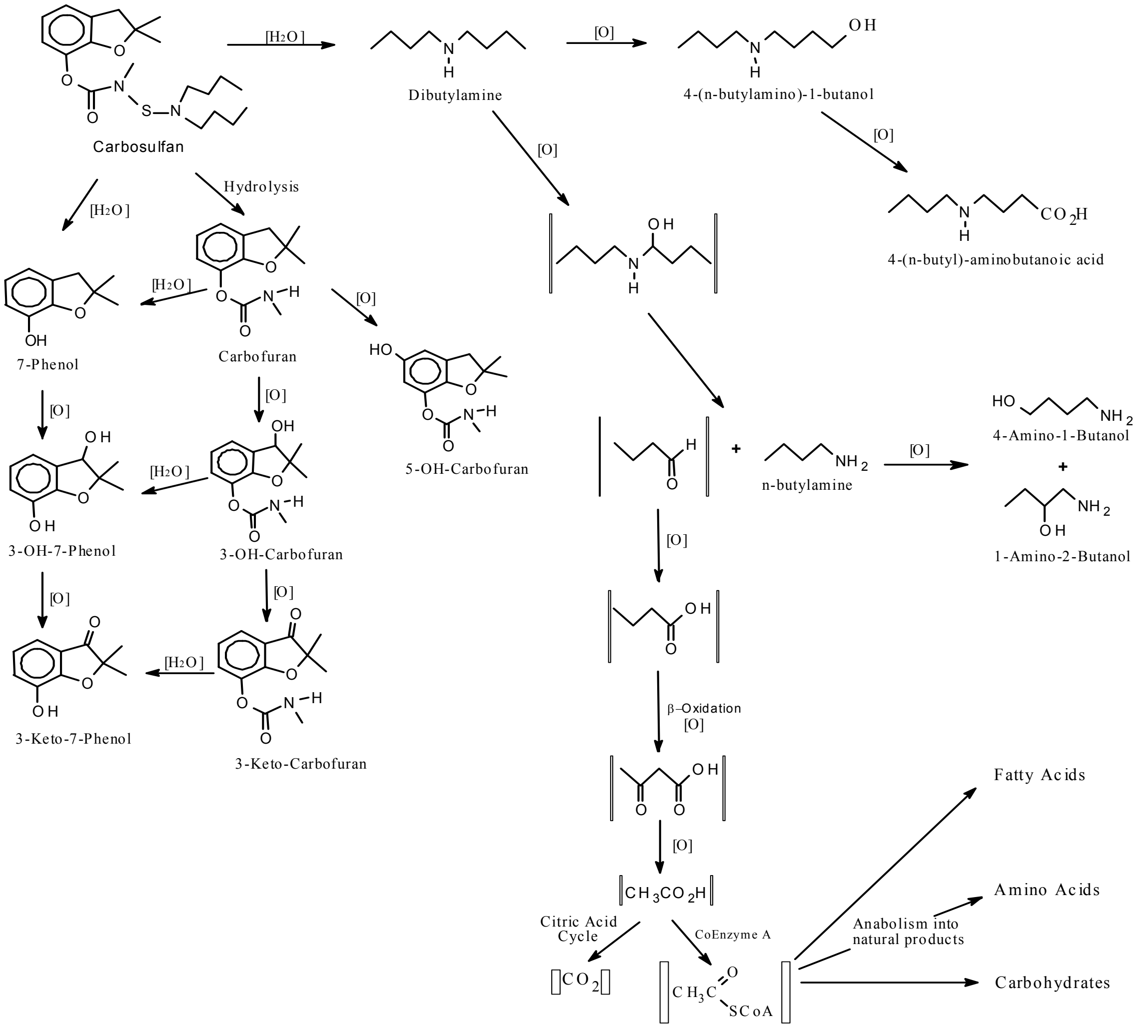
Tissue	TRR, carbosulfan equivalents, mg/kg		
	0 days depuration	7 days depuration	14 days depuration
Breast muscle	0.127	0.045	0.036
Thigh muscle	0.162	0.068	0.045
Blood	0.158	0.036	0.028
Fat	0.304	0.410	0.372
Gizzard	0.305	0.076	0.045
Heart	0.239	0.097	0.038
Liver	1.352	0.078	0.019
Skin	0.122	0.161	0.143

Dibutylamine was the major extractable component of residues in thigh muscle and liver (Table 5). There were also low levels of dibutylamine in the fat on the first day of depuration. No detectable residues (<0.002 ppm) of carbosulfan or carbofuran-related metabolites were detected in any of the tissues. Significant low-molecular weight (MW <500) unknowns were found in the thigh muscle, liver, egg yolks and egg whites. Dibutylamine was a major metabolite in extracts of liver (40.0% TRR), thigh muscle (28.7%), egg yolk (4.5%) and egg white (5.2%). The major unknown component represented 15.8% of the total residue in the thigh muscle, 11.5% in the liver, 8.4% in the egg yolk and 5.5% in egg whites. Expressed as dibutylamine equivalents, the unknown residues would be 0.02 mg/kg in thigh muscle and 0.05 mg/kg in liver. The post-extraction solids from thigh muscle and liver were hydrolyzed with 0.25 N HCl, to release conjugated metabolites. The ^{14}C of the dibutylamine side chain was largely incorporated into fatty tissues, possibly in the form of natural constituents.

Table 5. Nature and quantities of metabolites of [^{14}C-DBA]carbosulfan in tissues of hens, during depuration after being fed at 5 ppm (Markle, 1982a). Values in mg/kg are as carbosulfan equivalents.

Fraction	Thigh muscle (0 days)		Liver (0 days)		Fat (0 days)		Fat (14 days)	
	% TRR	mg/kg	% TRR	mg/kg	% TRR	mg/kg	% TRR	mg/kg
Extractable residue								
Carbosulfan	-	<0.002		<0.002	0.2	<0.002	-	<0.002
Dibutylamine	22.5	0.012	36.9	0.182	3.1	0.003	-	<0.002
Minor metabolites	-	<0.002		<0.002	-	<0.002	-	<0.002
Extractable unknowns								
MW >500	9.3	-	12.3	-	81.7	-	99.2	-
Other	27.3	-	13.3	-	5.0	-	1.3	-
Total %								
Extractable	59.1	-	62.5	-	89.8	-	100.5	-
Aqueous	15.5	-	23.4	-	1.2	-	1.9	-
PES	23.4	-	10.9	-	-	-	-	-
Total % recovered	98.0		96.8		91.0		102.4	

Figure 1. Proposed metabolism of carbosulfan in hens.



METHODS OF RESIDUE ANALYSIS

As reviewed by the 1997 JMPR, a number of analytical procedures were available for the determination of carbosulfan and its carbamate metabolites in crop and animal products. Recent methods have been based on the extraction of carbosulfan with dichloromethane (from citrus) or acetone (from animals products), followed by clean-up on solid-phase extraction (SPE) cartridges before analysis. Carbosulfan residues were determined by high performance liquid chromatography (HPLC) coupled to a post-column reactor, in which methylamine was liberated and coupled with *o*-phthalaldehyde, and the derivative detected by fluorescence. The detection system is more or less specific for detection of *N*-methyl carbamates and the identity of the carbamate detected is established from the HPLC retention time. Metabolites were determined by a procedure which began with acid hydrolysis of the crop or animal tissue, employed SPE techniques for extraction and clean-up and the final determination utilized the same carbamate analyzer system as used for carbosulfan. A limit of determination of 0.05 mg/kg was achieved for all analytes in most commodities.

Table 6. Summary of analytical methods.

Matrix	Method	LOQ (ppm)	Reference
Maize, sugar beet, brassicas, potatoes	GC/NPD	0.05	Anonymous, 1979a and 1979b
Maize, sugar beet, brassicas potatoes	GC/NPD	0.05	Anonymous, 1979c and 1979d

Matrix	Method	LOQ (ppm)	Reference
Brassicas, potatoes	GC/NPD	0.05	Woodhouse and Almond, 1980 MacDonald and Brown, 1986
Oilseed rape, cotton seed, hazelnuts, pineapples	GC/MSD GC-NPD	0.05	Almond and MacDonald, 1981
Tobacco	GC/MSD	0.05	Ginzburg and Enriquez, 1999
Sugar beet, potatoes	GC/NPD	0.05	Weidenauer and Mollard, 1992 Almond *et al*., 1982a Almond *et al*., 1982b
Citrus	GC/NPD	0.05/0.01	Leppert, 1981 Barros, 1985 Gill, 1995 Wood, 1996
Maize, rice, cotton, sugarcane	LC/MS LC/MS/MS	0.05	Dow, 2003
Cotton seed, hazelnuts, dry hops, pineapple	GC/MSD	0.05	Ginzburg and Weidenauer, 1997b
Leafy cabbages, Brussels sprouts, cauliflowers, sugar beet	HPLC-PCD	0.05	Ginzburg, 2001f
Meat, meat by-products, milk	HPLC GC/MSD	0.025 0.050	Chen, 1995 Burton, 1996a, 1996b
Meat, milk and eggs	HPLC-PCD	0.05 (meat, eggs) 0.02 (milk)	Ginzburg, 2001e
Soil	HPLC-PCD	0.005	Baumann, 2001
Water	HPLC-PCD	0.01	Ginzburg, 2000

PCD: post-column derivatization (with fluorescence detection).

Typically, crop residue analytical methods determined the important carbamate components of residues: carbosulfan, carbofuran and 3-hydroxy-carbofuran. Analyses for residues of carbosulfan must be performed on properly stored, frozen samples, in order to prevent the degradation of residues to carbofuran. Typically, carbosulfan, carbofuran and 3-hydroxy-carbofuran residues were extracted from crops with hexane/propan-2-ol, acetonitrile or acetone, cleaned-up by partition into dichloromethane and/or SPE cartridges and quantified by gas or liquid chromatography. Several detection systems were used, including a nitrogen-phosphorus detector (GC-NPD), mass selective detector (GC-MSD), HPLC with post-column derivatization detector (HPLC-PCD) or HPLC-MS.

Cattle meat and milk, poultry meat and eggs

The analytical method for determination of residues of carbosulfan and its metabolites containing the carbamate moiety in cattle meat and milk involved extraction with acetone, followed by centrifugation and liquid-liquid partition clean-up (Chen, 1995). The cleaned-up extract, in acetonitrile (ACN), was analyzed by reversed-phase HPLC and post-column reaction/fluorescence detection. Limits of quantification were 0.025 and 0.05 mg/kg for milk and tissues, respectively.

Carbofuran and 3-hydroxy-carbofuran metabolites were determined by a procedure involving initial acid hydrolysis of the matrix, to liberate conjugated residues (Chen, 1995). Clean-up was by liquid-liquid partition and, after evaporation of the solvent, the residue was redissolved in ACN and determined by reversed phase (C-18) HPLC with post-column derivatization/fluorescence detection.

Phenolic metabolites of carbofuran were determined by a procedure which also initially involved acid hydrolysis of the matrix, followed by SPE and liquid-liquid partition techniques for concentration and clean-up (Chen, 1995). The analytes were derivatized with pentafluorobenzyl bromide (PFBBr) and the 3-hydroxy-7-phenol, PFB derivative was then ethylated (absolute ethanol). The analytes were partitioned in hexane and analyzed by GC-MSD using a DB-5 fused silica capillary column.

The analytical method for dibutylamine (DBA) involved acetone extraction, followed by partition into dichloromethane and derivatization with dansyl chloride (Chen, 1995). The derivative was re-dissolved in hexane for analysis by GC-MSD, using a DB-5 fused silica capillary column.

Ginzburg (2001e) reported another method for the analysis of meat, milk and eggs. Carbosulfan and carbofuran were extracted from a 5 g sample of the matrix, using a hexane/acetone (4:1 v/v) mixture. After filtration, carbosulfan and carbofuran were partitioned into acetonitrile and cleaned-up firstly in an EnviCarb SPE cartridge, followed by an amino-propyl SPE cartridge. Conjugated forms of the metabolite, 3-hydroxy carbofuran, were extracted from the filter cake by refluxing with 0.25 M HCl. After filtration, the free 3-hydroxy carbofuran was cleaned-up on a C-18 SPE cartridge, followed by the same amino-propyl SPE cartridge, eluting with 1% methanol in dichloromethane. After evaporation of the solvent, the residue was dissolved in acetonitrile/water (30:70 v/v) and analyzed by HPLC with post-column derivatization (HPLC-PCD) and fluorescence detection.

Validation data supporting the methods are summarized in Tables 7 and 8.

Table 7. Recovery of carbosulfan and carbofuran added to samples of cattle meat, cow milk and hen eggs at various concentrations (Ginzburg, 2001e).

Level of addition, mg/kg	Carbosulfan recovery, % (n = 5)						Carbofuran recovery, % (n = 5)					
	Meat		Eggs		Milk		Meat		Eggs		Milk	
	Mean	RSD %	Mean	RSD %	Mean	RSD %	Mean	RSD %	Mean	RSD %	Mean	RSD %
0.025					88.7	6.4					103.1	7.4
0.05	74.4	15.5	88.9	17.6			90.8	12.1	106.8	5.2		
0.25					98.9	7.3					94.5	7
0.50	78.3	14.7	77.2	18			100.5	19.1	91	5.2		

Method P-3065M, for determination of carbosulfan residues in cow milk (Chen, 1995), was validated in an independent laboratory (Burton, 1996a).

Table 8. Recovery of carbosulfan and some of its metabolites from milk, by method P-3065M (Burton, 1996a & 1996b).

Level of addition, mg/kg	Average recovery (n = 2)			
	Carbosulfan	Carbofuran	3-hydroxycarbofuran	3-keto carbofuran
0.025	87	93.5	95.5	83
0.050	97.5			
0.100		102	102	105.5

Fruit, vegetables and grain

In a method used by the Korean Society of Environment and Agriculture (KSEA, 1996), to analyze brown rice, potatoes, peanuts, garlic, carrots, corn and green onions for residues of carbofuran, samples were cut finely, homogenized and stored at -20^{o}C until analysis. Samples were then extracted with acetone, followed by addition of saturated NaCl solution and partition into dichloromethane. The dichloromethane extract was concentrated under vacuum and passed through a Florisil column, which was eluted with ethyl acetate/*n*-hexane (3:7 v/v). The solvent was removed under reduced pressure and the residue was redissolved in acetone and analyzed by GC-NPD. Detection limits were 0.05 mg/kg for rice; 0.02 mg/kg for garlic, peanuts and potatoes; and 0.125 mg/kg for green onions, carrots and corn. Recoveries of carbofuran were 79-109% at 0.05-0.2 mg/kg.

Multi-residue methods

Gas chromatographic multi-residue methods (US FDA Pesticide Analytical Manual, PAM Vol 1, multi-residue methods, protocol C) were tested for the determination of residues of carbosulfan.(Mayer, 1995). Carbosulfan was reported to have been detected by electron-capture detector (ECD), flame-photometric detector with a sulfur filter (FPD-S) or a nitrogen/phosphorus detector (NPD). NPD provided the best sensitivity.

USE PATTERN

Carbosulfan is registered in many countries for use against a large number of plant pests on a wide range of crops.

Table 9. Registered uses of carbosulfan.

Crop	Country	Form	Application					PHI, days
			Method	Timing	Rate kg ai/ha	Conc. kg ai/hl	Max No.	
Potatoes	Italy	GR 5%	In furrow	At planting	0.75		1	n/a
Potatoes	Italy	GR 5%	Surface application covered by thin layer of soil	Shortly before planting	2.0-2.25		1	n/a
Potatoes	France	GR 10% (Alize)	Mechanical soil incorporation	At planting	1.25		1	
Potatoes	Czech Republic	EC 25%	Foliar application during increased occurrence of larvae	NS	0.25		1	NS
Potatoes	Brazil	GR 5%	Mix into soil before planting or apply broadcast after planting, with manual applicator	Just before or just after planting	2		1	60
Potatoes	Brazil	SC 40%	Foliar application using manual back pack or tractor-mounted sprayer	NS	0.1-0.2		NS	21
Potatoes	Japan	GR 3%	Soil incorporation	At planting	1.8		1	n/a
Potatoes	Philippines	SC 20%	Foliar spray	Starting at 20 days after planting, 7-day intervals	0.2		7	14
Maize	France	(MG) GR 5%	Applied using a microgranulator / mixer suitable for sowing	At planting	0.6		1	n/a
Maize	France	GR 10% (Alize)	Mechanical soil incorporation	At planting	0.75		1	n/a
Maize	Belgium	GR 10%	Mechanical soil incorporation	At planting	0.6		1	n/a
Maize	Italy	GR 5%	In furrow	At planting	0.5		1	n/a
Maize	Italy	GR 5%	Surface application covered by thin layer of soil	Shortly before sowing	1.75-2.0		1	n/a
Maize	Indonesia and Philippines	FS 25%	Mix with seed	Just before planting	0.025 kg a.i./5 kg seed		1	n/a
Maize	Brazil	FS 25%	Applied directly to seeds, using mixing machines or rotating drums	Just before planting	0.5-0.7 kg a.i./100 kg seed		1	n/a
Maize	Uruguay	FS 35%	Applied directly to seeds, using mixing machines or rotating drums	Just before planting	0.21-0.245 kg a.i./100 kg seed		1	n/a
Maize	Germany	TK 47.5%	Applied directly to seeds	Prior to planting	61 g/unit, 2 units/ha		1	n/a
Rice	Brazil	SC 40%	Foliar application using manual back pack or tractor-mounted sprayer	NS	0.4		NS	97
Rice	Brazil	FS 25%	Applied directly to seeds, using mixing machines or rotating drums	Prior to planting	0.375-0.5 kg a.i./100 kg seed		1	n/a

Crop	Country	Form	Application					PHI, days
			Method	Timing	Rate kg ai/ha	Conc. kg ai/hl	Max No.	
Rice	Brazil	FS 25%	Applied directly to seeds, using mixing machines or rotating drums	Prior to planting	0.35 kg a.i./100 kg seed		1	n/a
Rice	India	GR 6%	Broadcast in-furrow application or place around the root zones of plant by hand or by a suitable granule applicator	NS	1		1	37
Rice	Japan	GR 3% or GR 5%	Broadcast granules onto the seedling box	3 days before transplanting	40–70 g/box (30x60x3cm box, 5l soil) 0.0012-0.0021 kg a.i./box		1	n/a
Rice	Korea	GR 3%	Seed box at peak occurrence	Before transplanting	60 g per seed box		1	n/a
Rice	Korea	GR 3%	Broadcast application, paddy field	From peak infestation, 7-15 days 1st generation, 2-4 days 2nd generation	0.12 kg a.i./0,1 ha		2	n/a
Rice	Korea	SC 20%	Foliar spray	Early stage infestation, monitoring Jul-Aug	0.05		4	21
Rice	China	EC 20%	Foliar spray	NS	0.6-0.75		1	30
Rice	China	ST 35%	Seed treatment		0.0375-0.28 kg a.i./100 kg		1	n/a
Cotton seed	Spain	EC 25%	Foliar application using boom sprayer	14 days interval	0.25-0.375		2	28
Cotton seed	Spain, Italy and Greece	CS 25%	Foliar application using boom sprayer	14 days interval	0.25-0.375		2	28
Cotton seed	Australia	EC 25%	Apply as a spray in-furrow	At planting	0.5-1.0		1	n/a
Cotton seed	Brazil	SC 40%	Foliar application using manual back pack or tractor-mounted sprayer	NS	0.12		NS	60
Cotton seed	Brazil	SC 20%	Foliar application using manual back pack or tractor-mounted sprayer	NS	0.12		NS	60
Cotton seed	Brazil	TS 35%	Applied directly to seeds using machines	Prior to planting	0.7 kg a.i./100 kg seed		1	n/a
Cotton seed	Brazil	SC 40%	Foliar application using manual back pack or tractor-mounted sprayer	NS	0.1-0.2		NS	21
Cotton seed	Japan	GR 3%	Incorporated into the soil	At planting	1.8		1	n/a
Cotton seed	Philippines	SC 20%	Foliar sprays	Starting at 20 days after sowing, 7-day intervals	0.2		7	14

Crop	Country	Form	Application					PHI, days
			Method	Timing	Rate kg ai/ha	Conc. kg ai/hl	Max No.	
Sugar beet	France	GR 5%	Applied by using a microgranulator mixer for sowing seeds	At sowing	0.75-1.0		1	n/a
Sugar beet	France	GR 10%	Mechanical soil incorporation	At planting	0.75		1	n/a
Sugar beet	Belgium	GR10%	Mechanical soil incorporation	At planting	0.75		1	n/a
Sugar beet	Switzerland	EC 25%	Foliar application		0.6			
Sugar beet	Spain	GR 5%	Apply with a micro-granule applicator	At the time of sowing	0.6		1	n/a
Sugar beet	Italy	GR 5%	In-furrow	At the time of planting	0.6		1	n/a
Sugar beet	Italy	GR 5%	Surface application covered by thin layer of soil	Shortly before sowing	1.75-2.0		1	n/a
Sugar beet	Hungary	EC 25%	Foliar application with sprayer and worked into the soil	NS	1.25-1.5		1	0

n/a Not applicable.
NS Not specified.

RESIDUES RESULTING FROM SUPERVISED TRIALS

The Meeting received reports on supervised field trials of the application of carbosulfan to potatoes, sugar beet, maize, rice and cotton seed. Reports were according to GLP requirements and included method validation, dates of analyses of samples, sprayers used and their calibration, plot size, residue sample size and sampling method. Unless otherwise specified, all trials were conducted in the field with foliar application. In each trial, two or three treated samples and one control sample were collected at sampling time and analyzed within 5 months after harvest. The average residues found in treated samples are shown in Tables 10-19. Data were not corrected for recovery of the analytical method. Where residues were not detected the results are shown as below the LOQ (e.g. <0.02 mg/kg). Residues data were rounded to two significant figures, or for residues near the LOQ, to one significant figure. Values double underlined are within maximum GAP (±30%) and were used by the Meeting for estimation of maximum residue levels, STMRs and HRs.

Table 10. Residues resulting from the use of carbosulfan (formulated as GR or SC) in supervised trials on potatoes grown in France, Italy, Brazil, the Philippines and Japan.

POTATOES Location, year, report No.	Application			PHI, days [1/]	Residues, mg/kg [1/]		
	Rate, kg a.i/ha	Form	No.		Carbosulfan	Carbofuran	3-OH carbofuran
France, Le Rheu, 1979 FCC 24/28/42/821050	1.25	5G	1	0	<0.01	0.03	<0.01
				153	<0.01	0.05	<0.01
France, Manosque, 1979 FCC 24/28/42/821050	1.25	5G	1	0	<0.01	0.06	<0.01
				141	<0.05	0.06	<0.01
France, Manosque, 1980 FCC 24/28/42/821050	1.25	5G	1	0	<0.03	<0.01	<0.01
				88	<0.03	<0.01	<0.01
France, Manosque, 1980 FCC 24/28/42/821050	1.875	5G	1	0	<0.03	<0.01	<0.01
				88	<0.03	<0.01	<0.01
France, Manosque, 1980 FCC 24/28/42/821050	1.25	5G	1	0	<0.03	<0.01	<0.01
				123	<0.03	<0.01	<0.01
France, Manosque, 1980 FCC 24/28/42/821050	1.875	5G	1	0	<0.03	<0.01	<0.01
				123	<0.03	<0.01	<0.01
France, Manosque, 1981 FCC 24/28/42/821050	1.25	5G	1	0	<0.01	<0.01	<0.05
				207	<0.01	<0.01	<0.05
France, Manosque, 1981 FCC 24/28/42/821050	1.875	5G	1	0	<0.01	<0.01	<0.05
				207	<0.01	<0.01	<0.05
France, Azat Mourioux, 1981 FCC 24/28/42/821050	1.25	5G	1	0	<0.01	<0.01	<0.05
				156	<0.01	<0.01	<0.05

POTATOES Location, year, report No.	Application Rate, kg a.i/ha	Form	No.	PHI, days [1]	Residues, mg/kg [1] Carbosulfan	Carbofuran	3-OH carbofuran
France,Azat Mourioux, 1981 FCC 24/28/42/821050	1.875	5G	1	0	<0.01	<0.01	<0.05
				156	0.16/0.01	0.01	<0.05
France, Manosque, 1980 FCC 28	1.25	5G	1	0	<0.03	<0.01	<0.01
				88	<0.03	<0.01	<0.01
France,Manosque, 1980 FCC 28	1.875	5G	1	0	<0.03	<0.01	<0.01
				88	<0.03	<0.01	<0.01
France, Manosque, 1980 FCC 28	1.25	5G	1	0	<0.03	<0.01	<0.01
				123	<0.03	<0.01	<0.01
France, Manosque, 1980 FCC 28	1.875	5G	1	0	<0.03	<0.01	<0.01
				123	<0.03	<0.01	<0.01
France, Estillac, 1982 FCC 28	1.25	5G	1	0	<0.01	0.02	<0.01
				92	0.02 [2]	0.01 [2]	<0.01 [2]
France, Estillac, 1982 FCC 28	1.25	5G	1	0	<0.01	0.02	<0.01
				123	0.02 [2]	0.01 [2]	<0.01 [2]
France, Manosque, 1982 FCC 28	0.75	5G	1	0	<0.01	0.02	<0.01
				106	0.02 [2]	0.02 [2]	<0.01 [2]
Italy, Boffa Ordona, 1997 P-3317	1.00	5G	1	0	<0.05	<0.05	<0.05
				107	<0.05	0.06	<0.05
Italy, Orta Novo, 1997 A-17-98-44	1.00	5G	1	0	<0.05	<0.05	<0.05
				100	<0.05	<0.05	<0.05
Italy, Calepio di Settala, 1998 P-3317	0.957	5G	1	0	<0.05	<0.05	<0.05
				105	<0.05	<0.05	<0.05
Italy, Pancarana, 1997 P-3317	0.957	5G	1	0	<0.05	<0.05	<0.05
				139	<0.05	<0.05	<0.05
Brazil, Campo Largo, 1996 BR015	2.00	50G	1	120	<0.05		
Brazil, Campo Largo, 1996 BR015	4.00	50G	1	120	<0.05		
Brazil, Campo Largo, 1996 BR015	2.00	50G	2	60	<0.05		
Brazil, Campo Largo, 1996 BR015	4.00	50G	2	60	<0.05		
Brazil, Ponta Grossa, 1998 BR021	0.24	SC 400	1	21	<0.05		
Brazil, Ponta Grossa, 1998 BR021	0.48	SC 400	1	21	<0.05		
Brazil, Irai, 1998 BR022	0.24	SC 400	1	0 7 15	<0.05 [1] < 0.05 < 0.05		
Brazil, Irai, 1998 BR022	0.48	SC 400	1	0 7 15	<0.05 [1] < 0.05 < 0.05		
Philippines, Baguio, 2001, Anonymous, 2001	0.3	SC200	7	14	<0.05	<0.05	<0.05
Japan, Ushiku, 1991 CS 3IETI	1.8	3G	1	92	<0.005	<0.005	<0.005
Japan, Ushiku, 1991 CS 3IETI	1.8	3G	2	61	<0.005	<0.005	<0.005
Japan, Kouchi, 1992 CS 3IETI	1.8	3G	1	91	<0.005	<0.005	<0.005
Japan, Kouchi, 1992 CS 3IETI	1.8	3G	2	61	<0.005	<0.005	<0.005

[1] Results for day 0 are for the untreated control samples or for samples taken before treatment.

[2] These values represent the highest results obtained.

Table 11. Residues resulting from supervised trials of 1 application of carbosulfan to sugar beet grown in Spain, France, Belgium, Switzerland, Italy (all 5G or 10G formulations) and Hungary (EC25).

SUGAR BEET, ROOTS Location, year, report No.	Application			PHI, days	Residues, mg/kg		
	Rate, kg a.i/ha	Form	No.		Carbosulfan	Carbofuran	3-OH carbofuran
France, Hanguest 80, 1979 CS5G/8.2/SB4	0.6	5G	1	160	<0.05	<0.05	<0.05
France, Hanguest 80, 1979 CS5G/8.2/SB4	1.8	5G	1	160	<0.05	<0.05	0.07
France, Hanguest 80, 1979 CS5G/8.2/SB4	0.6	5G	1	130	<0.05	<0.05	<0.05
France, Hanguest 80, 1979 CS5G/8.2/SB4	1.8	5G	1	130	<0.05	<0.05	<0.05
France, Marchelpot, 1979 CS5G/8.2/SB4	0.6	5G	1	130	<0.05	<0.05	<0.05
France, Marchelpot , 1979 CS5G/8.2/SB4	1.8	5G	1	130	<0.05	<0.05	<0.05
France, Dorengt, 1979 CS5G/8.2/SB4	0.6	5G	1	131	0.18	<0.05	0.06
France, Dorengt, 1979 CS5G/8.2/SB4	1.8	5G	1	131	0.18	<0.05	0.06
France, Dorengt, 1979 CS5G/8.2/SB4	0.6	5G	1	161	0.06	<0.05	<0.05
France, Dorengt, 1979 CS5G/8.2/SB4	1.8	5G	1	161	<0.05	<0.05	<0.05
France, Marchelpot 80, 1979 CS5G/8.2/SB4	0.6	5G	1	160	<0.05	<0.05	<0.05
France, Marchelpot 89, 1979 CS5G/8.2/SB4	1.8	5G	1	160	<0.05	<0.05	<0.05
France, Varennes, 1979 CS5G/8.2/SB4	0.6	5G	1	132	<0.05	<0.05	<0.05
France, Varennes, 1979 CS5G/8.2/SB4	1.8	5G	1	132	0.09	<0.05	0.07
France, Varennes, 1979 CS5G/8.2/SB4	0.6	5G	1	162	<0.05	<0.05	<0.05
France, Varennes, 1979 CS5G/8.2/SB4	1.8	5G	1	162	<0.05	<0.05	<0.05
France, Remancourt 02, 1979 CS5G/8.2/SB4	0.6	5G	1	131	<0.05	<0.05	<0.05
France, Remancourt 02, 1979 CS5G/8.2/ SB4	1.8	5G	1	131	<0.05	<0.05	<0.05
France, Remancourt, 1979 CS5G/8.2/SB4	0.6	5G	1	161	<0.05	<0.05	<0.05
France, Remancourt, 1979 CS5G/8.2/SB4	1.8	5G	1	161	<0.05	<0.05	<0.05
France, Chamery, 1979 CS5G/8.2/SB4	0.6	5G	1	129	0.15	<0.05	<0.05
France, Chamery, 1979 CS5G/8.2/SB4	1.8	5G	1	129	0.20	<0.05	<0.05
France, Chamery, 1979 CS5G/8.2/SB4	0.6	5G	1	159	0.06	<0.05	<0.05
France, Chamery, 1979 CS5G/8.2/ SB4	1.8	5G	1	159	0.06	<0.05	<0.05
France, Morchies, 1978 CS5G/8.2/SB4	0.6	5G	1	172	<0.05	<0.05	<0.05
France, Morchies, 1978 CS5G/8.2/SB4	1.8	5G	1	172	<0.05	<0.05	<0.05
Belgium, Gembloux, 1981 CS10G/8.2/SB1	1.0	10G	1	149	<0.02	<0.02	<0.05
Belgium, Gembloux, 1981 CS10G/8.2/SB1	1.0	10G	1	79	<0.02	<0.02	<0.05
Switzerland, Domdidier, 1980 CS5G/8.2/SB7	2.84	5G	1	164	<0.05	<0.05	<0.05

SUGAR BEET, ROOTS Location, year, report No.	Application			PHI, days	Residues, mg/kg		
	Rate, kg a.i/ha	Form	No.		Carbosulfan	Carbofuran	3-OH carbofuran
Switzerland, Payerne, 1980 CS5G/8.2/SB7	1.25	5G	1	170	<0.05	<0.05	<0.05
Spain, Corrales del Vino, 2000 FA-17-00-37, method 17 00 15	0.642	10G	1	97-145	<0.05	<0.05	<0.05
Spain, Requeras de Abajo, 2001 FA-17-01-21	0.642	10G	1		<0.05	<0.05	<0.05
Italy, Pantigliate, 2000 FA-17-00-36	0.628	10G	1	132	<0.05	<0.05	<0.05
Italy, Liscate, 2001 FA-17-01-20	0.674	10G	1	102-130	<0.05	<0.05	<0.05
Hungary, Szolnok, 1988 13.1.3/4	0.5	EC 25	1	155	<0.02	<0.02	<0.02

Table 12. Residues resulting from supervised trials of 1 application of carbosulfan to maize grown in Belgium, France and Italy (5G or 10G formulations); Brazil and the Philippines (seed treatment).

MAIZE, GRAIN Location, year, report No.	Application			PHI, days	Residues (mg/kg)		
	Rate, kg a.i/ha	Form	No.		Carbosulfan	Carbofuran	3-OH carbofuran
Belgium, Ligny, 2001 FA-17-01-19	0.62	10G	1	166	<0.05	<0.05	<0.05
Belgium, Saint Amand, 2000 FA-17-00-35	0.65	10G	1	171	<0.05	<0.05	<0.05
France, Rocourt St Martin, 1979 CS5G/8.2/MA2	1.5	5G	1	193	<0.05	<0.05	<0.05
France, Rocourt St Martin, 1979 CS5G/8.2/MA2	0.5	5G	1	193	<0.05	<0.05	<0.05
France, Saint Augène, 1979 CS5G/8.2/MA2	1.5	5G	1	193	<0.05	<0.05	<0.05
France, Saint Augène, 1979 CS5G/8.2/MA2	0.5	5G	1	193	<0.05	<0.05	<0.05
France, St Tulle, 1979 CS5G/8.2/MA2	1.5	5G	1	161	<0.05	<0.05	<0.05
France, St Tulle, 1979 CS5G/8.2/MA2	0.5	5G	1	161	<0.05	<0.05	<0.05
France, Val de Vesle, 2000 FA 17-00-34	0.68	10G	1	166	<0.05	<0.05	<0.05
France, Provart, 2001 FA-17-01-18	0.57	10G	1	173	<0.05	<0.05	<0.05
France, St Tulle, 1979 CS5G/8.2/MA2	1.5	5G	1	161	<0.05	<0.05	<0.05
Italy, Saluggia, 1981 CS5G/8.2/MA3	0.6	5G	1	140	<0.05	<0.05	<0.05
Seed treatments, a.i. rate in g/kg seed							
Brazil, Jaguaruina, 2002, P 3588	7	25ST	1	132	<0.01	<0.01	<0.01
Brazil, Mococa, 2002, P 3588	7	25ST	1	139	<0.01	<0.01	<0.01
Brazil, Trindade, 1994, BR002	5	250ST	1	159	<0.05		
Brazil, Trindade, 1994, BR002	10	250ST	1	159	<0.05		
Brazil, Trindade, 1994, BR005	7	TS	1	159	<0.05		
Brazil, Trindade, 1994, BR005	14	TS	1	159	<0.05		
Brazil, Léopoldo Bulhöes, 1994, BR006	7	TS	1	159	<0.05		
Brazil, Léopoldo Bulhöes, 1994, BR006	14	TS	1	159	<0.05		
Brazil, Goianapolis, 1994, BR031	7	TS	1	159	<0.05		
Brazil, Goianapolis, 1994, BR031	14	TS	1	159	<0.05		
Brazil, Miguelopolis, 2000, BR057	6	TS	1	105	<0.05		
Brazil, Miguelopolis, 2000, BR057	12	TS	1	105	<0.05		
Brazil, Iyuverava, 2000, BR058	6	TS	1	128	<0.05		
Brazil, Iyuverava, 2000, BR058	12	TS	1	128	<0.05		

MAIZE, GRAIN Location, year, report No.	Application			PHI, days	Residues (mg/kg)		
	Rate, kg a.i/ha	Form	No.		Carbosulfan	Carbofuran	3-OH carbofuran
Philippines, Pangasinan, Baguio, 2002. Anonymous 2002d	7.05	25ST	1	NS	≤0.05	≤0.05	≤0.05

NS Not stated.

Table 13. Residues in rice grain resulting from supervised trials of foliar and seed treatment applications of carbosulfan to rice grown in India, Japan, China, Korea and Brazil.

RICE, GRAIN Location, year, report No.	Application			PHI, days	Portion analyzed	Residues (mg/kg)		
	Rate kg/ha	Form	N°			Carbosulfan	Carbofuran	3-OH carbofuran
Foliar treatments								
India, Palakkad, 1998 RIL/RES/marshal-27	1	6G	1	31	Grain	0.02		
India, Palakkad, 1998 RIL/RES/marshal-27	2	6G	1	31	Grain	0.03		
India, Palakkad, 1998 RIL/RES/marshal-27	1	6G	1	36	Grain	≤0.01		
India, Palakkad, 1998 RIL/RES/marshal-27	2	6G	1	36	Grain	<0.01		
India, Palakkad, 1999 RIL/RES/marshal-27	1	6G	1	31	Grain	≤0.01		
India, Palakkad, 1999 RIL/RES/marshal-27	2	6G	1	31	Grain	0.02		
Japan, Saitama, 1988, CS2IET	0.42	3G	2	111	Unpolished rice	<0.005	<0.005	<0.005
Japan, Saitama, 1988, CS2IET	0.60	3G	2	111	Unpolished rice	<0.005	<0.005	<0.005
Japan, Chiba, 1988, CS2IET	0.60	3G	2	132	Unpolished rice	<0.005	<0.005	<0.005
Japan, Kagawa, 1988, CS2IET	0.42	3G	2	123	Unpolished rice	<0.005	<0.005	<0.005
Japan, Aichi, 1980, CS1NCI	1	5G	2	125	Unpolished rice	<0.005	<0.005	<0.005
Japan. Aichi, 1980, CS1NCI	2	5G	2	125	Unpolished rice	<0.005	<0.005	<0.005
Japan, Miyagi, 1980, CS1NCI	1	5G	2	147	Unpolished rice	<0.005	<0.005	<0.005
Japan, Miyagi, 1980 CS1NCI	2	5G	2	147	Unpolished rice	<0.005	<0.005	<0.005
Korea, Kyungbuk, 1998, C-R4	1.2	3G	2	45	Husked rice	≤0.02	≤0.03	≤0.02
Korea Kyungbuk, 1998, C-R4	1.2	3G	3	45	Husked rice	≤0.02	≤0.03	≤0.02
Korea, Kyungbuk, 1998, C-R4	1.2	3G	3	30	Husked rice	≤0.02	≤0.03	≤0.02
Korea Kyungbuk, 1998, C-R4	1.2	3G	4	30	Husked rice	≤0.02	≤0.03	≤0.02
Korea, Daejeon, 2000, C-R5	0.5	SC 20%	3	30	Husked rice	<0.01	<0.02	<0.02
Korea, Daejeon, 2000, C-R5	0.5	SC 20%	3	21	Husked rice	<0.01	<0.02	<0.02
Korea, Daejeon, 2000, C-R5	0.5	SC 20%	4	30	Husked rice	<0.01	<0.02	<0.02
Korea, Daejeon, 2000, C-R5	0.5	SC 20%	4	21	Husked rice	<0.01	<0.02	<002
China, Tianjin, 1991, C-R1	0.75	EC 20%	1	99	Husk Unpolished rice	<0.002 <0.002	<0.002 <0.002	<0.002 <0.002
China, Tianjin, 1991, C-R1	0.75	EC 20%	1	69	Husk Unpolished rice	<0.002 <0.002	<0.002 <0.002	<0.002 <0.002
China, Tianjin, 1991, C-R1	0.75	EC 20%	2	69	Husk Unpolished rice	<0.002 <0.002	<0.002 <0.002	<0.002 <0.002
China, Tianjin, 1991, C-R1	0.75	EC 20%	3	69	Husk Unpolished rice	<0.002 <0.002	<0.002 <0.002	<0.002 <0.002
China, Tianjin, 1992, C-R1	0.75	EC 20%	1	100	Husk Unpolished rice	<0.002 <0.002	<0.002 <0.002	<0.002 <0.002
China, Tianjin, 1992, C-R1	0.75	EC 20%	1	70	Husk Unpolished rice	<0.002 <0.002	<0.01 <0.002	<0.01 <0.002
China, Tianjin, 1992, C-R1	0.75	EC 20%	2	70	Husk Unpolished rice	<0.002 <0.002	<0.01 <0.002	<0.01 <0.002
China, Tianjin, 1992, C-R1	0.75	EC 20%	3	70	Husk Unpolished rice	<0.002 <0.002	0.016 <0.002	0.016 <0.002
Seed treatments, a.i. rate in g/kg seed								
Brazil, Mococa, 2002, P 3588	5	TS	1	135	Grain	≤0.01	≤0.01	≤0.01
Brazil, Pindamon Hangaba 2002, P 3588	5	TS	1	130	Grain	≤0.01	≤0.01	≤0.01
Brazil, Trindade, 1994, BR009	5	TS	1	159	Grain	≤0.05		
Brazil, Trindade, 1994, BR009	10	TS	1	159	Grain	<0.05		
Brazil, Trindade, 1994, BR030	7	350TS	1	159	Grain	<0.05		

RICE, GRAIN Location, year, report No.	Application			PHI, days	Portion analyzed	Residues (mg/kg)		
	Rate kg/ha	Form	N°			Carbosulfan	Carbofuran	3-OH carbofuran
Brazil, Trindade, 1994, BR030	14	350TS	1	159	Grain	<0.05		
Brazil, Cachoeirinha, 2001, BR045	3.5	350 TS	1	125	Grain	<0.05		
Brazil, Cachoeirinha, 2001 BR045	7	350TS	1	125	Grain	<0.05		
Brazil, Arroio Grande, 2001 BR046	3.5	350 TS	1	138	Grain	<0.05		
Brazil, Arroio Grande, 2001 BR046	7	350TS	1	138	Grain	<0.05		
Brazil, Santa Maria, 2001, BR047	3.5	350 TS	1	139	Grain	<0.05		
Brazil, Santa Maria, 2001, BR047	7	350TS	1	139	Grain	<0.05		
Brazil, Santa Maria, 1994, BR013	7.5	50 G	1	30 50 70	Grain	<0.05 <0.05 <0.05		
Brazil, Santa Maria, 1994, BR013	15	50 G	1	30 50 70	Grain	<0.05 <0.05 <0.05		
Brazil, Santa Maria, 1994, BR014	7.5	50 G	1	30 50 70	Grain	<0.05 <0.05 <0.05		
Brazil, Santa Maria, 1994, BR014	15	50 G	1	30 50 70	Grain	<0.05 <0.05 <0.05		
Brazil, Massaranduba, 1998 BR019	4	400 SC	1	97	Grain	<0.05		
Brazil, Massaranduba, 1998 BR019	8	400 SC	1	97	Grain	<0.05		
China, Shanghai, 1995, C-R2	8.05	35ST	1	159	Husks Unpolished rice	<0.02 <0.01	<0.02 <0.01	<0.05 <0.02
China, Shanghai, 1995, C-R2	16.1	35ST	1	159	Husks Unpolished rice	<0.02 <0.01	<0.02 <0.01	<0.05 <0.02
China, Shanghai, 1996, C-R2	8.05	35ST	1	138	Husks Unpolished rice	<0.02 <0.01	<0.02 <0.01	<0.05 <0.02
China, Shanghai, 1996, C-R2	16.1	35ST	1	138	Husks Unpolished rice	<0.02 <0.01	<0.02 <0.01	<0.05 <0.02
China, Shanghai, 1996, C-R2	16.1	35ST	1	138	Husks Unpolished rice	<0.02 <0.01	<0.02 <0.01	<0.05 <0.02
China, Daxing, 1995, C-R3	8	35ST	1	167	Seedlings Husks Unpolished rice	<0.005 <0.005 <0.005	<0.05 <0.05 <0.05	<0.01 <0.01 <0.01
China, Daxing, 1995, C-R3	8	35ST	1	167	Seedlings Husks Unpolished rice	<0.005 <0.005 <0.005	<0.05 <0.05 <0.05	<0.01 <0.01 <0.01
China, Daxing, 1995, C-R3	16.1	35ST	1	167	Seedlings Husks Unpolished rice	0.19 <0.005 <0.005	<0.05 <0.05 <0.05	0.017 0.06 <0.01
China, Daxing, 1995, C-R3	16.1	35ST	1	167	Seedlings Husks Unpolished rice	<0.005 <0.005 <0.005	<0.05 <0.05 <0.05	<0.01 <0.01 <0.01
China, Daxing, 1996, C-R3	8	35ST	1	158	Seedlings Husks Unpolished rice	<0.005 <0.005 <0.005	<0.05 <0.05 <0.05	<0.01 <0.01 <0.01
China, Daxing, 1996, C-R3	16.1	35ST	1	158	Seedlings Husks Unpolished rice	<0.005 <0.005 <0.005	<0.05 <0.05 <0.05	0.017 <0.01 <0.01

Table 14. Residues in cotton seed resulting from supervised trials of foliar and seed treatment applications of carbosulfan to cotton grown in Australia, Brazil and Greece.

COTTON SEED Location, year, report No.	Application			PHI, days	Residues (mg/kg)		
	Rate, kg a.i./ha	Form	No.		Carbosulfan	Carbofuran	3-hydroxy carbofuran
Australia, Harparary, 1991, 2011/91	0.72	EC 250	2	60	<0.05		
Australia, Harpararry, 1991, 2011/91	0.96	EC 250	2	60	<0.05		
Australia, Weewaa, 1991, 92/1569	1.00	EC 250	2	181	<0.05		
Australia, Weewaa, 1991, 92/1569	1.50	EC 250	2	181	<0.05		
Australia, Bowenville, 1992, 93/4465	1.00	EC 250	1	174	0.03		
Australia, Bowenville, 1992, 93/4465	2.00	EC 250	1	174	0.05		
Australia, Boggabri, 1995, 95/3027	1.00	EC 250	1	187	<0.05		
Australia, Boggabri, 1995, 95/3027	2.00	EC 250	1	187	<0.05		
Australia, Brookstead, 1995, 95/3027	2.00	EC 250	1	162	<0.05		
Australia, Brookstead, 1995, 95/3027	2.00	EC 250	1	162	<0.05		
Brazil, Campinas, 2002, P-3588	0.12	SC 40	1	55	<0.01	<0.01	< 0.01
Brazil, Santo Antonio, 2002, P-3588	0.12	SC 40	1	87	<0.01	<0.01	< 0.01
Brazil, Cambara, 1995, BR017	0.2	SC 200	1	0 20 30	<0.05 < 0.05 < 0.05		
Brazil, Cambara, 1995, BR017	0.4	SC 200	1	0 20 30	<0.05 < 0.05 < 0.05		
Brazil, Londrina, 1995, BR018	0.2	SC 200	1	0 20 30	<0.05 < 0.05 < 0.05		
Brazil, Londrina, 1995, BR018	0.4	SC 200	1	0 20 30	<0.05 < 0.05 < 0.05		
Brazil, Rio das Pedras, 1998, BR020	0.12	SC 400	1	0 30 60	<0.05 < 0.05 < 0.05		
Brazil, Rio das Pedras, 1998, BR020	0.24	SC 400	1	0 30 60	<0.05 < 0.05 < 0.05		
Greece, Nissi Imathiaz Alexandrie, 1995, FA-17-96-06	0.35	EC 25	2	27	<0.05	<0.05	<0.05
Greece, Nissi Imathiaz Alexandrie, 1995, FA-17-96-06	0.33+0.36	EC 25	2	27	<0.05	<0.05	<0.05
Greece, Nissi Imathiaz Alexandrie, 1995, FA-17-96-06	0.35	EC 25	2	27	<0.05	<0.05	<0.05
Greece, Nissi Imathiaz Alexandrie, 1995, FA-17-96-06	0.35+0.33	EC 25	2	28	<0.05	<0.05	<0.05
Greece, Metohi, 1996, FA-17-96-13	0.372+0.389	EC25	2	28	<0.05	<0.05	<0.05
Greece, Metohi, 1996, FA-17-96-13	0.363+0.366	EC 25	2	28	<0.05	<0.05	<0.05
Greece, Trigono Giannitsa, 1996, FA-17-96-13	0.388+0.384	EC 25	2	28	<0.05	<0.05	<0.05
Greece, Trigono Giannitsa, 1996, FA-17-96-13	0.362+0.368	EC 25	2	28	<0.05	<0.05	<0.05
Greece, Gefyra, 2000, FA-17-00-39	0.38+0.38	EC 25	2	48	<0.05	<0.05	<0.05
Spain, Maribanez, 2000, FA-17-00-40	0.37	CS 25	2	64	<0.05	<0.05	<0.05
Greece, Nea Malgara, 2001, FA-17-01-23	0.38+0.37	CS 25	2	65	<0.05	<0.05	<0.05
Spain, Maribanez, 2001, FA-17-01-24	0.36+ 0.37	CS 25	2	56	<0.05	<0.05	<0.05
Seed treatment, a.i. rate g/kg seed							
Brazil, Leme, 2001, BR042	7	350TS	1	199	< 0.05		
Brazil, Leme, 2001, BR042	14	350TS	1	199	< 0.05		
Brazil, Leme, 1994, BR029	7	350TS	1	154	< 0.05		
Brazil, Leme, 1994, BR029	14	350TS	1	154	< 0.05		

Table 15. Residues resulting from supervised trials of 1 application of carbosulfan to sugar beet grown in Spain, France, Belgium, Switzerland and Italy (5G or 10G formulations); Hungary (EC25).

SUGAR BEET FOLIAGE (TOPS) Location, year, report No.	Application			PHI, days	Residues (mg/kg)		
	Rate, kg a.i./ha	Form	No.		Carbosulfan	Carbofuran	3-hydroxy carbofuran
Belgium, Gembloux, 1981, CS10G/8.2/SB1	1.0	10G	1	149	<0.02	<0.02	<0.05
Belgium, Gembloux, 1981, CS10G/8.2/SB1	1.0	10G	1	79	<0.02	<0.02	0.08
France, Hangest 80, 1979, CS5G/8.2/SB4	0.6	5G	1	160	<0.05	<0.05	<0.05
France, Hangest 80, 1979, CS5G/8.2/SB4	1.8	5G	1	160	<0.05	< 0.05	< 0.05
France, Hangest 80, 1979, CS5G/8.2/SB4	0.6	5G	1	130	<0.05	<0.05	<0.05
France, Hangest 80, 1979, CS5G/8.2.SB4	1.8	5G	1	130	<0.05	< 0.05	< 0.05
France, Marchelpot, 1979, CS5G/8.2/SB4	0.6	5G	1	130	<0.05	<0.05	<0.05
France, Marchelpot, 1979, CS5G/8.2/SB4	1.8	5G	1	130	<0.05	< 0.05	< 0.05
France, Dorengt, 1979, CS5G/8.2/SB4	0.6	5G	1	131	<0.05	<0.05	<0.05
France, Dorengt, 1979, CS5G/8.2/SB4	1.8	5G	1	131	<0.05	< 0.05	< 0.05
France, Dorengt, 1979, CS5G/8.2/SB4	0.6	5G	1	161	<0.05	<0.05	<0.05
France, Dorengt, 1979, CS5G/8.2/SB4	1.8	5G	1	161	<0.05	< 0.05	< 0.05
France, Marchelpot, 1979, CS5G/8.2/SB4	0.6	5G	1	160	<0.05	<0.05	<0.05
France, Marchelpot, 1979, CS5G/8.2/SB4	1.8	5G	1	160	<0.05	< 0.05	0.09
France, Varennes, 1979, CS5G/8.2/SB4	0.6	5G	1	132	<0.05	<0.05	0.08
France, Varennes, 1979, CS5G/8.2/SB4	1.8	5G	1	132	<0.05	< 0.05	0.08
France, Varennest, 1979, CS5G/8.2/SB4	0.6	5G	1	162	<0.05	<0.05	<0.05
France, Varennes, 1979, CS5G/8.2/SB4	1.8	5G	1	162	<0.05	< 0.05	< 0.05
France, Remancourt, 1979, CS5G/8.2/SB4	0.6	5G	1	131	<0.05	<0.05	<0.05
France, Remancourt, 1979, CS5G/8.2/SB4	1.8	5G	1	131	<0.05	< 0.05	0.07
France, Remancourt, 1979, CS5G/8.2/SB4	0.6	5G	1	161	<0.05	<0.05	<0.05
France, Remancourt, 1979, CS5G/8.2/SB4	1.8	5G	1	161	<0.05	0.06	0.09
France, Chamery, 1979, CS5G/8.2/SB4	0.6	5G	1	129	<0.05	<0.05	<0.05
France, Chamery, 1979, CS5G/8.2/SB4	1.8	5G	1	129	<0.05	<0.05	0.05
France, Chamery, 1979, CS5G/8.2/SB4	0.6	5G	1	159	<0.05	<0.05	<0.05
France, Chamery, 1979, CS5G/8.2/SB4	1.8	5G	1	159	<0.05	<0.05	0.05
France, Morchies, 1978, CS5G/8.2/SB4	0.6	5G	1	172	<0.05	<0.05	<0.05
France, Morchies, 1978, CS5G/8.2/SB4	1.8	5G	1	172	<0.05	<0.05	0.05
Hungary, Szolnok, 1988, 13.1.3/4	0.5	EC25	1	155	<0.02	<0.02	<0.02
Italy, Pantigliate, 2000, FA-17-00-36	0.628	10G	1	132	<0.05	<0.05	<0.05
Italy, Liscate, 2001, FA-17-01-20	0.674	10G	1	102-130	<0.05	<0.05	<0.05
Switzerland, Payerrne, 1980, CS5G/8.2/SB7	2.84	5G	1	164	<0.05	<0.05	<0.05
Switzerland, Domdidier, 1980, CS5G/8.2/SB7	1.25	5G	1	170	<0.05	<0.05	<0.05
Spain, Corrales del Vino, 2000, FA-17-00-37	0.642	10G	1	97-145	<0.05	<0.05	<0.05
Spain, Requeras de Abajo, 2001, FA-17-01-21	0.642	10G	1	156	<0.05	<0.05	<0.05

Table 16. Residues resulting from supervised trials of 1 application of carbosulfan to maize grown in Belgium, France, Germany and Italy (5G or 10G formulations); Brazil (seed treatment).

MAIZE FODDER & FORAGE Location, year, report No.	Application			PHI, days	Portion analyzed	Residues (mg/kg)		
	kg a.i./ha	Form	No.			Carbosulfan	Carbofuran	3-hydroxy carbofuran
Belgium, St Amand, 2000, FA-17-00-35	0.65	10G	1	116	Plant + cob	<0.05	<0.05	<0.05
Belgium, Ligny, 2001, FA-17-00-35	0.62	10G	1	124	Plant + cob	<0.05	<0.05	<0.05
France Rocourt St Martin, 1979, CS5G/8.2/MA2	1.5	5G	1	97	Whole plant	<0.05	<0.05	<0.05
France, Rocourt St Martin, 1979, CS5G/8.2/MA2	0.5	5G	1	97	Whole plant	<0.05	<0.05	<0.05
France, Rocourt St Martin, 1979, CS5G/8.2/MA2	1.5	5G	1	130	Whole plant	<0.05	<0.05	<0.05
France, Rocourt St Martin, 1979 CS5G/8.2/MA2	0.5	5G	1	130	Whole plant	<0.05	<0.05	<0.05
France, St Tulle, 1979, CS5G/8.2/MA2	1.5	5G	1	89	Whole plant	<0.05	<0.05	<0.05
France, St Tulle, 1979, CS5G/8.2/MA2	0.5	5G	1	89	Whole plant	<0.05	<0.05	<0.05

MAIZE FODDER & FORAGE Location, year, report No.	Application			PHI, days	Portion analyzed	Residues (mg/kg)		
	kg a.i./ha	Form	No.			Carbosulfan	Carbofuran	3-hydroxy carbofuran
France, Val de Vesles, 2000, FA-17-00-34	0.68	10G	1	118	Whole plant	<0.05	<0.05	<0.05
France, Provart, 2001, FA-17-01-18	0.57	10G	1	139	Plant + cob	<0.05	<0.05	<0.05
France, St Tulle, 1979, CS5G/11.2/MA2	1.5	5G	1	89	Whole plant	<0.05	<0.05	<0.05
Germany, 1982, CS6.3/SBL Taylor, 1982	0.665	5G	1	87	Whole plant	<0.05	<0.05	<0.05
Germany, 1982, CS6.3/SBL Taylor, 1982	0.665	5G	1	91	Whole plant	<0.05	<0.05	<0.05
Germany, 1982, CS6.3/SBL Taylor, 1982	0.665	5G	1	91	Whole plant	<0.05	<0.05	<0.05
Italy, Fresolona, 1981, CS5G/ 8.2/MA3	0.6	5G	1	90	Whole plant	<0.05	<0.05	<0.05
				124	Whole plant	<0.05	<0.05	0.09
Italy, Saluggia, 1981, CS5G/8.2/MA3	0.6	5G	1	91	Whole plant	<0.05	<0.05	0.06
Seed treatments, a.i. rate in g/kg seed								
Brazil, Jaguaruina, 2002, P-3588	7	25ST	1	92	Forage	<0.01	<0.01	<0.01
Brazil, Mococa, 2002, P-3538	7	25ST	1	89	Forage	<0.01	<0.01	<0.01

Table 17. Residues in rice straw resulting from supervised trials of foliar and seed treatment applications of carbosulfan to rice grown in India, Japan, China, Korea and Brazil.

RICE, STRAW Location, year, report No.	Application			PHI, days	Portion analyzed	Residues (mg/kg)		
	kg a.i./ha	Form	No.			Carbosulfan	Carbofuran	3-hydroxy carbofuran
China, Tiangin, 1991, C-R1	0.75	EC 20%	1	99	Straw	<0.002	<0.01	<0.002
China, Tiangin, 1991, C-R1	0.75	EC 20%	1	69	Straw	<0.002	0.095	0.019
China, Tiangin, 1991, C-R1	0.75	EC 20%	2	69	Straw	<0.002	0.118	0.019
China, Tiangin, 1991, C-R1	0.75	EC 20%	3	69	Straw	<0.002	0.186	0.021
China, Tiangin, 1992, C-R1	0.75	EC 20%	1	100	Straw	<0.002	<0.01	<0.002
China, Tiangin, 1992, C-R1	0.75	EC 20%	2	70	Straw	<0.002	0.152	0.026
China, Tiangin, 1992, C-R1	0.75	EC 20%	3	70	Straw	<0.002	0.154	0.027
China, Tiangin, 1991, C-R1	0.75	EC 20%	3	70	Straw	<0.002	0.170	0.035
India, Palakkad, 1998, RIL/RES/Marshal-27	1	6G	1	31	Straw	<0.01		
India, Palakkad, 1998 RIL/RES/Marshal-27	2	6G	1	31	Straw	0.02		
India, Palakkad, 1998 RIL/RES/Marshal-27	1	6G	1	36	Straw	0.02		
India, Palakkad, 1998 RIL/RES/Marshal-27	2	6G	1	36	Straw	0.02		
India, Palakkad, 1999 RIL/RES/Marshal-27	1	6G	1	31	Straw	0.01		
India, Palakkad, 1999 RIL/RES/Marshal-27	2	6G	1	31	Straw	0.03		
Japan, Saitama, 1988, CS2IET	0.42	3G	2	111	Straw	<0.005	0.005	0.015
Japan, Saitama, 1988, CS2IET	0.60	3G	2	111	Straw	<0.005	0.005	0.022
Japan, Chiba, 1988, CS2IET	0.60	3G	2	132	Straw	<0.005	<0.005	0.012
Japan, Kagawa, 1988, CS2IET	0.42	3G	2	123	Straw	<0.005	0.005	0.014
Japan, Aichi, 1980, CS1NCI	1	5G	2	125	Straw	<0.01	0.01	0.02
Japan. Aichi, 1980, CS1NCI	2	5G	2	125	Straw	<0.01	0.01	0.09
Japan, Miyagi, 1980, CS1NCI	1	5G	2	147	Straw	<0.01	0.02	0.27
Japan, Miyagi, 1980, CS1NCI	2	5G	2	147	Straw	<0.01	<0.01	<0.01
Korea, Kyunghu, 1998, C-R4	1.2	3G	2	45	Straw	<0.03	<0.05	0.04
Korea, Kyunghu, 1998, C-R4	1.2	3G	3	45	Straw	<0.03	0.07	0.08
Korea, Kyunghu, 1998, C-R4	1.2	3G	3	30	Straw	<0.03	0.05	0.05
Korea, Kyunghu, 1998, C-R4	1.2	3G	4	30	Straw	<0.03	0.08	0.08
Korea, Kyunghu, 2000, C-R5	0.5	SC 20%	3	30	Straw	<0.01	<0.02	<0.02
Korea, Kyunghu, 2000, C-R5	0.5	SC 20%	3	21	Straw	<0.01	<0.02	<0.02
Korea, Kyunghu, 2000, C-R5	0.5	SC 20%	4	30	Straw	<0.01	<0.02	<0.02
Korea, Kyunghu, 2000, C-R5	0.5	SC 20%	4	21	Straw	<0.01	<0.02	<0.02
Seed treatment, a.i. rate g/kg seed								
Brazil, Mococa, 2002, P-3588	5	TS	1	135	Straw	<0.01	<0.01	<0.01

RICE, STRAW Location, year, report No.	Application			PHI, days	Portion analyzed	Residues (mg/kg)		
	kg a.i./ha	Form	No.			Carbosulfan	Carbofuran	3-hydroxy carbofuran
Brazil, Pindamon Hangoba, 2002, P-3588	5	TS	1	130	Straw	<0.01	<0.01	<0.01
China, Shanghaï, 1995, C-R2	8.05	35ST	1	159	Rice plant	<0.02	<0.02	<0.05
China, Shanghaï, 1995, C-R2	16.1	35ST	1	159	Rice plant	<0.02	<0.02	<0.05
China, Shanghaï, 1996, C-R2	8.05	35ST	1	138	Rice plant	<0.02	<0.02	<0.05
China, Shanghaï, 1996, C-R2	16.1	35ST	1	138	Rice plant	<0.02	<0.02	<0.05
China, Shanghaï, 1996, C-R2	16.1	35ST	1	138	Rice plant	<0.02	<0.02	<0.05

Table 18. Residues of carbosulfan in cotton baled fodder and cotton gin trash, resulting from supervised trials of foliar and seed treatment applications of carbosulfan to cotton grown in Australia.

COTTON FODDER & GIN TRASH Location, year, report No.	Application			PHI, days	Carbosulfan residues (mg/kg)	
	Rate kg a.i/ha	Form	No.		Baled fodder	Cotton gin trash
Australia, Boggahi, 1995, 95/3027	1.00	EC	1 at planting	187	<0.05	<0.05
Australia, Boggahi, 1995, 95/3027	2.00	EC	1 at planting	187	<0.05	<0.05
Australia, Brookstead, 1995, 95/3027	2.00	EC	1 at planting	162		<0.05
Australia, Brookstead, 1995, 95/3027	2.00	EC	1 at planting	162		<0.05

FATE OF RESIDUES IN PROCESSING

The meeting received no new information relating to the new uses and field trials data.

RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

The Meeting received residues data on food in commerce or at consumption.

Market basket surveys

Market basket surveys have shown that residues of carbosulfan are not found in crops in commerce or in food ready for consumption. Residues of carbosulfan in food are not generally expected, based upon the rapid degradation of the compound and the use pattern. Residues would be expected to occur only if the product is misused (excessive rate or number of applications and/or an inadequate pre-harvest interval). The degradation products, carbofuran and 3-hydroxy carbofuran, are also rarely detectable in crops and foods.

In a survey conducted in 1999 by the US Food and Drug Administration (USFDA, 1999), 9,438 samples (3,426 domestic and 6,012 imported products, approximately 72% being fruit or vegetables) were analyzed by multi-residue methods with limits of detection generally down to 0.01 mg/kg. No carbosulfan, carbofuran, or 3-hydroxy carbofuran was detected in any of the crop food samples. In 2000, the Pesticide Data Program (PDP) of the US Department of Agriculture (USDA, 2000) analyzed 9,242 samples of fruit, vegetables or grain for residues of carbofuran and 3-hydroxy carbofuran. Only 4 samples, 1 of cantaloupe melons and 3 of sweet peppers, contained detectable residues of carbofuran, with a maximum level of 0.025 mg/kg (USA tolerance, 0.2 mg/kg). Only 2 samples, 1 of grapes and 1 of sweet peppers, contained detectable residues of 3-hydroxy carbofuran, with a maximum of 0.017 mg/kg (USA tolerance, 0.2 mg/kg).

A survey conducted by the Korean Society of Environment and Agriculture (KSEA, 1996) was specifically intended to screen domestic agricultural products for residues of carbofuran, as part of the evaluation of the safety of carbofuran. Samples (210 in total) of 7 domestic crops (brown rice, potatoes, peanuts, garlic, carrots, corn and green onions) produced in 1995 were collected nationwide, directly from markets or farms near the sites of production. Of the 210 samples analyzed, only five contained detectable residues of carbofuran, which occurred in 1 rice, 2 garlic and 2 carrot samples (Table 19). A sample of garlic contained the highest level found, 0.13 mg/kg, but this was below the Korean MRL for carbofuran of 0.5 mg/kg. Carbofuran was not detected in peanuts, potatoes, green onions or corn. The current FAO/WHO ADI for carbofuran is 0-0.002 mg/kg bw/day and the average weight of a Korean adult is about 55 kg and therefore the maximum ADI corresponds to 0.11 mg/day. Table 20 shows the assessment of the consumer intake of carbofuran, based on the findings of the survey, and indicates that the worst-case (maximum residue levels) accounts for about 16% of the maximum ADI.

Table 19. Carbofuran residues in 210 samples of Korean domestic agricultural products obtained in 1995.

Crop	No. samples	No. samples containing detectable residues	Frequency of residues (%)	Residues, mg/kg	Average residue level, mg/kg
Rice	60	1	1.7	0.06	0.001 [1/]
Garlic	40	2	5	0.07, 0.13	0.005 [1/]
Peanuts	20	0	0	ND	ND
Potatoes	10	0	0	ND	ND
Green onions	40	0	0	ND	ND
Carrots	20	2	10	0.015, 0.015	0.0015 [1/]
Corn	20	0	0	ND	ND

ND:<0.05 mg/kg for rice; <0.02 mg/kg for garlic, peanuts and potatoes; and <0.125 mg/kg for green onions, carrots and corn.

[1/] Average calculated assuming ND = 0.

Table 20. An assessment average adult Korean consumer intake of carbofuran, based on the highest and average residue levels found in the 1995 survey of residues in Korean domestic agricultural products.

Crop	Amount of food ingested, g/day	Amount of carbofuran ingested, according to residue level assumed			
		Maximum residue level, mg/kg	Residue ingested, mg/day	Average residue level, mg/kg	Residue ingested, mg/day
Rice (brown)	276.2	0.06	0.016572	0.001	0.000276
Garlic	6.6	0.13	0.000858	0.005	0.000033
Peanuts	0.4	ND	0.00	ND	0.00
Potatoes	12.1	ND	0.00	ND	0.00
Green onions	10.8	ND	0.00	ND	0.00
Carrots	3.7	0.015	0.000055	0.0015	0.000005
Corn	0.2	ND	0.00	ND	0.00
Total			0.017485		0.000314

NATIONAL MAXIMUM RESIDUE LIMITS

The Meeting was aware of the national or regional MRLs presented in Table 21. In the UK, Hungary, and India, the MRL for all commodities is set at 0.1 mg/kg.

Table 21. MRLs for carbosulfan in some countries.

Country or region	Crop	MRL	Definition
Argentina	Beans, dry	0.1	Carbofuran
	Citrus fruit	0.1	Carbosulfan + carbamates
	Maize	0.1	Carbofuran
	Peaches	4.3	Carbosulfan + carbamates
	Potatoes	0.5	Carbofuran
	Sorghum	0.1	Carbofuran
	Tomatoes	0.1	Carbofuran
Australia	Bananas	0.1	Carbofuran + hydroxycarbofuran
	Cotton	0.05	Carbosulfan
	Rice	0.2	Carbofuran + hydroxycarbofuran
	Sugarcane	0.1	Carbofuran + hydroxycarbofuran
Austria	Coffee	0.1	Carbofuran + hydroxycarbofuran
	Grapes	0.2	Carbofuran + hydroxycarbofuran
	Maize	0.2	Carbofuran + hydroxycarbofuran
Austria (continued)	Potatoes	0.5	Carbofuran + hydroxycarbofuran
	Sugar beet	0.2	Carbofuran + hydroxycarbofuran
	Sunflower seed	0.1	Carbofuran + hydroxycarbofuran
	Turnips	1	Carbofuran + hydroxycarbofuran
Brazil	Peanuts	0.1	Carbofuran + hydroxycarbofuran
	Beans, dry	0.05	Carbosulfan
	Citrus fruit	0.05*	Carbosulfan
	Coconut	0.01	Carbosulfan

Country or region	Crop	MRL	Definition
Brazil	Coffee	0.1	Carbofuran + hydroxycarbofuran
	Cotton	0.05	Carbosulfan
	Cotton	0.1	Carbofuran + hydroxycarbofuran
	Maize	0.05	Carbosulfan
	Potatoes	0.05	Carbosulfan
	Rice	0.2	Carbofuran + hydroxycarbofuran
	Rice, irrigated and upland	0.05	Carbosulfan
	Tomatoes	0.05	Carbosulfan
Canada	Bananas	0.1	Carbofuran
	Coffee	0.1	Carbofuran
	Maize	0.1	Carbofuran
	Peanuts	0.1	Carbofuran
	Peppers	0.5	Carbofuran + hydroxycarbofuran
	Potatoes	0.5	Carbofuran + hydroxycarbofuran
	Rice	0.1	Carbofuran
	Strawberries	0.4	Carbofuran + hydroxycarbofuran
	Sugar beet	0.1	Carbofuran
Chile	Potatoes	0.5	Carbofuran + hydroxycarbofuran
	Rice	0.2	Carbofuran + hydroxycarbofuran
	Sugar beet	0.1	Carbofuran + hydroxycarbofuran
	Tomatoes	0.1	Carbofuran + hydroxycarbofuran
China	Cabbages	0.1	Carbosulfan
	Citrus fruit	0.5	Carbosulfan
	Hairy gourds (pumpkins)	0.1	Carbosulfan
	Pome fruits	0.1	Carbosulfan
	Rice	0.5	Carbosulfan
Cyprus	Bananas	0.1	
	Potatoes	0.05	
	Rice	0.02	
	Strawberries	0.1	
	Sugar beet	0.1	
	Tomatoes	0.1	
Denmark	Bananas	0.1	Carbofuran + hydroxycarbofuran
	Potatoes	0.5	Carbofuran + hydroxycarbofuran
	Turnips	0.1	Carbofuran + hydroxycarbofuran
Ecuador	Cotton	0.1	Carbosulfan
EU	Berries	0.05*	Carbosulfan
	Carrots, parsnips	0.1	Carbosulfan
	Citrus fruit	0.05*	Carbosulfan
	Hops	1	Carbosulfan
	Miscellaneous fruits	0.05*	Carbosulfan
	Oilseeds	0.05*	Carbosulfan
	Pome fruits	0.05*	Carbosulfan
	Potatoes	0.05	Carbosulfan
	Stone fruits	0.05*	Carbosulfan
	Tea	0.1*	Carbosulfan
	Tree nuts	0.05*	Carbosulfan
Finland	Potatoes	0.5	Carbofuran + hydroxycarbofuran
France	Maize	0.1	Carbofuran + hydroxycarbofuran
	Rape seed	0.5	Carbofuran + hydroxycarbofuran
	Strawberries	0.5	Carbofuran + hydroxycarbofuran
	Sunflower seed	0.5	Carbofuran + hydroxycarbofuran
	Sunflower seed	0.5	Carbofuran + hydroxycarbofuran
Germany	Potatoes	0.5	Carbofuran + hydroxycarbofuran
Germany (continued)	Sugar beet	0.2	Carbofuran + hydroxycarbofuran
Italy	Maize	0.1	
	Potatoes	0.1	
Japan	Cabbages	1	Carbosulfan
	Radishes, Japanese	1	Carbosulfan
	Strawberries	5	Carbosulfan
	Sugarcane	0.2	Carbosulfan
Korea	Rice	0.2	Carbosulfan

Country or region	Crop	MRL	Definition
Malaysia	Bananas	0.1	
	Grapes	0.4	
	Strawberries	0.5	
Mexico	Maize	0.02	Carbosulfan
Netherlands	Potatoes	0.5	Carbofuran + hydroxycarbofuran
	Rice	0.2	Carbofuran + hydroxycarbofuran
	Soya beans	0.2	Carbofuran + hydroxycarbofuran
Paraguay	Rice	0.2	
	Tomatoes	0.1	
Peru	Beans, dry	0.1	Carbosulfan
	Garlic, onion	0.1	Carbosulfan
	Rice	0.1	Carbosulfan
	Potatoes	0.1	Carbosulfan
	Pumpkins	0.1	Carbosulfan
	Tomatoes	0.1	Carbosulfan
Portugal	Potatoes	0.5	Carbofuran + hydroxycarbofuran
South Africa	Maize	0.1	Carbofuran + hydroxycarbofuran
	Potatoes	0.05	Carbofuran + hydroxycarbofuran
	Rape seed	0.5	Carbofuran + hydroxycarbofuran
	Sugarcane	0.1	Carbofuran + hydroxycarbofuran
Spain	Citrus fruit	2	Sum of metabolites
	Cotton	0.1	Sum of metabolites
	Melons, watermelons	1	Sum of metabolites
	Sorghum	2	Sum of metabolites
	Sugar beet	0.1	Sum of metabolites
Taiwan	Grapes	2	Carbosulfan
Uruguay	Potatoes	0.5	
	Rice	0.2	
USA	Alfalfa forage	5	Carbofuran + hydroxycarbofuran
	Bananas	0.1	Carbofuran + hydroxycarbofuran
	Cattle fat, cattle meat	0.02	Carbofuran + hydroxycarbofuran
	Coffee	0.1	Carbofuran + hydroxycarbofuran
	Cotton	0.2	Carbofuran + hydroxycarbofuran
	Grapes	0.2	Carbofuran + hydroxycarbofuran
	Maize	0.1	Carbofuran + hydroxycarbofuran
	Peanuts	1.5	Carbofuran + hydroxycarbofuran
	Potatoes	1	Carbofuran + hydroxycarbofuran
	Rice	0.2	Carbofuran + hydroxycarbofuran
	Sorghum	0.1	Carbofuran + hydroxycarbofuran
	Soya beans	0.2	Carbofuran + hydroxycarbofuran
	Strawberries	0.2	Carbofuran + hydroxycarbofuran
	Sugar beet	0.1	Carbofuran + hydroxycarbofuran
	Sugarcane	0.1	Carbofuran + hydroxycarbofuran

* MRL set at or about the LOQ.

APPRAISAL

Carbosulfan is a broad-spectrum carbamate pesticide used to control insects, mites and nematodes by soil, foliar and seed treatment applications, mainly on potatoes, sugar beet, rice, maize and citrus. Carbofuran is the main metabolite of carbosulfan in plants and is itself a pesticide.

Carbosulfan was evaluated for residues under the Periodic Review Programme by the JMPR in 1997. The present evaluation of carbosulfan includes estimates for carbofuran resulting from the use of carbosulfan. The current definition of the carbosulfan residue for compliance with MRLs and for dietary risk assessment is “carbosulfan”.

The carbofuran residue is defined as carbofuran + 3-hydroxycarbofuran, for compliance with MRLs, and carbofuran + 3-hydroxycarbofuran + conjugated 3-hydroxycarbofuran, for dietary risk assessment.

The Meeting received information on metabolism in hens, methods of analysis, supervised trials conducted on potatoes, sugar beet, cotton, maize and rice, residues in food in commerce, and national MRLs.

Animal metabolism

One metabolism study in hens was reported. The hens were dosed with either phenyl- or dibutylamine-labelled carbosulfan for 14 days at levels corresponding to approximately 0.5, 1.5 or 5 ppm in the diet. At each treatment level, a plateau of ^{14}C residues in eggs was reached at day 5. From both labelled compounds, the yolks contained higher ^{14}C residues than the whites.

The maximum ^{14}C residues observed in egg yolks and whites were 1.87 mg/kg and 0.119 mg/kg, respectively, at the dose of 5 ppm, and 0.18 mg/kg and 0.014 mg/kg, respectively, at the 0.5 ppm dose. Only dibutylamine was detected in yolk, at 0.023 mg/kg, after 9-12 days (4.3% of the TRR). Carbosulfan was less than 0.02 mg/kg.

The highest radioactive tissue residues from both labels were observed in liver. After seven days of depuration, all radioactive tissue residues were below 0.002 mg/kg.

With the phenyl-labelled compound, the major extractable residue found in the thigh muscle at day 0 was 3-hydroxycarbofuran. The 3-hydroxy-7-phenol was the major metabolite in liver. There were no detectable residues (<0.002 mg/kg equivalents) of carbosulfan or carbofuran in any tissue analyzed.

A significant amount of radioactivity was found in the fat from the dibutylamine label. High ^{14}C residues were observed in the liver (1.35 mg/kg equivalents) and fat (0.30 mg/kg equivalents). After 14 days of depuration all residues had decreased to less than 0.05 mg/kg, except in fat (0.37 mg/kg) and skin.

Dibutylamine was the main metabolite in the extractable fraction of the thigh muscle (22.5% of the TRR) and liver (39.6% of the TRR) at day 0. Essentially all of the radioactive residue (>95% of the TRR) in the 14-day fat sample was isolated as fatty acids. Derivatization of this fraction with bromoacetophenone and isolation of the derivatized fatty acids indicated that the radiocarbon had been mainly incorporated into palmitic (33.3% of the TRR), oleic (37.0%), stearic (7.7%) and linoleic (6.2%) acids.

The metabolism of carbosulfan in hens begins with hydrolysis to the 7-phenol, carbofuran and dibutylamine. Further hydrolysis and oxidation gives 3-hydroxycarbofuran, the 3-hydroxy-7-phenol, 3-keto-7-phenol, 3-ketocarbofuran, butylamine, substituted butanols and 5-hydroxycarbofuran. Metabolism studies in rats and goats, evaluated by the 1997 JMPR, showed a common metabolic pathway.

Methods for residue analysis

Analytical methods were described for the determination of carbosulfan, carbofuran, 3-hydroxycarbofuran, dibutylamine and phenolic metabolites in plant and animal products. Carbosulfan and carbofuran in vegetables were extracted with hexane/propan-2-ol or hexane/acetone and the partitioned extract was cleaned up on a Florisil or aminopropyl SPE cartridge. The compounds were determined by GC with NPD, GC-MS, LC-MS/MS or HPLC with post-column reaction/fluorescence detection. The LOQ ranged from 0.01 to 0.05 mg/kg.

In a method developed in 2000, carbosulfan and carbofuran were determined by HPLC using post-column reaction, using H_2SO_4 to hydrolyze carbosulfan and carbofuran, then basic hydrolysis to liberate methylamine and finally reaction with *o*-phthalaldehyde and *N,N*-dimethyl-2-mercaptoethylamine to form a fluorescent derivative of the methylamine. The LOQ was 0.05 mg/kg.

The extraction of 3-hydroxycarbofuran in vegetables was with acid hydrolysis, and was followed by partition with dichloromethane and further clean-up on a Florisil cartridge. In another method, with an alumina clean-up, carbosulfan, carbofuran and hydroxycarbofuran were determined without acid hydrolysis.

Phenolic fractions were derivatized with pentafluorobenzyl bromide (PFBBr), and 3-hydroxy-7-phenols also by ethylation, before determination. Dibutylamine fractions were derivatized with dansyl chloride. Both the phenolic and dibutylamine derivatives were determined by GC-MS with single ion monitoring.

Validation data were provided for tobacco, potatoes, a leafy vegetable, cotton seed, maize, sugar beet and rice (LOQ 0.05 mg/kg).

Results from supervised residue trials

Potatoes. Ten trials were conducted in France with soil application of carbosulfan at the maximum GAP rate (1.25 kg ai/ha). Residues were <0.01 (3), <0.03 (4), <0.05 and 0.02 (2) mg/kg carbosulfan. Six trials were conducted at 1.85 kg ai/ha and also showed no detectable residues.

In 4 trials in Italy according to GAP (0.75 kg ai/ha soil treatment), carbosulfan residues were <0.05 mg/kg.

In 2 trials conducted in Japan at the GAP rate (1.8 kg ai/ha, soil treatment), residues were <0.005 mg/kg. Two other trials conducted in Japan at a higher rate gave the same results.

One trial conducted in the Philippines with foliar application at 0.3 kg/ha (GAP 0.2 kg ai/ha) gave residues of <0.05 mg/kg. One trial in Brazil according to GAP (0.24 kg ai/ha and 21 days PHI) also gave residues of <0.05 mg/kg, as did two trials at 0.48 kg ai/ha.

Sixteen trials complying with GAP, using soil application, gave residues of <0.005 (2), <0.01 (3), <0.03 (4), <0.05 (5) and 0.02 (2) mg/kg. Samples were also analyzed for residues of carbofuran and 3-hydroxycarbofuran. No residues of 3-hydroxycarbofuran were found (<0.005, <0.01 or <0.05 mg/kg).

The Meeting estimated a maximum residue level of 0.05 mg/kg and an STMR of 0.03 mg/kg for carbosulfan in potatoes. The only measurable value of 0.02 mg/kg was taken as the HR.

Residues of carbofuran + 3-hydroxycarbofuran (median underlined) were <0.005 (2), <0.01 (4), <0.05 (5), 0.02, 0.03, 0.06, 0.07 and 0.11 mg/kg.

The Meeting estimated a maximum residue level of 0.2 mg/kg, an STMR of 0.05 mg/kg and an HR of 0.11 mg/kg for carbofuran in potatoes.

Sugar beet. Field trials on sugar beet were reported from France (GAP 0.75-1 kg ai/ha, soil treatment), Belgium (GAP 0.75 kg ai/ha, soil treatment), Spain and Italy (0.6 kg ai/ha, soil treatment).

Thirteen trials conducted in France, with soil treatment according to GAP, gave carbosulfan residues of <0.05 (9), 0.06 (2), 0.15 and 0.18 mg/kg.

In two trials in Belgium, according to GAP for soil treatment, residues were <0.02 mg/kg. Four trials in Spain and Italy, with soil application according to GAP, gave residues of <0.05 mg/kg.

Six trials in France, 2 in Switzerland and 1 in Hungary were conducted above the GAP rate.

Nineteen trials according to GAP, with soil application, gave carbosulfan residues (median underlined) of <0.02 (2), <0.05 (13), 0.06 (2), 0.15 and 0.18 mg/kg.

The Meeting estimated a maximum residue level of 0.3 mg/kg and an STMR of 0.05 mg/kg for carbosulfan in sugar beet (roots).

Samples from the same trials were analyzed for carbofuran and 3-hydroxycarbofuran. All residues were below the LOQ, except in one trial where the residue of 3-hydroxycarbofuran was 0.06 mg/kg. Residues of carbofuran + hydroxy-carbofuran were <0.05 (18) and 0.11 mg/kg.

The Meeting estimated a maximum residue level of 0.2 mg/kg and an STMR of 0.05 mg/kg for carbofuran in sugar beet (roots).

Maize. Field trials with soil treatment on maize were reported from Belgium (GAP 0.6 kg ai/ha, 2 trials), France (GAP 0.5 to 0.75 kg ai/ha, 9 trials), Germany (no GAP for soil application, 3 trials) and Italy (0.5 kg ai/ha, 2 trials). In the eight trials according to GAP, residues were <0.05 (8) mg/kg.

Residues in four other trials, conducted at a higher rate (1.5 kg ai/ha), were also not detectable. No residues of carbofuran or 3-hydroxycarbofuran were found in any of the trials (<0.05 mg/kg).

Field trials were conducted with seed treatment in the Philippines (GAP 5g ai/kg seed, 1 trial) and Brazil (GAP 0.5 to 0.7 kg ai/100 kg seed, 14 trials). Residues in grain from 8 trials according to GAP, in 6 trials at a higher rate in Brazil and in the 1 the Philippines, were <0.01 or <0.05 mg/kg.

The Meeting agreed that soil application is the critical use and estimated a maximum residue level of 0.05* mg/kg and an STMR of 0, for both carbosulfan and carbofuran, in maize grain.

Rice. Three trials with soil application in India, complying with GAP (1 kg ai/ha, 37 days PHI), gave residues of <0.01 (2) and 0.02 mg/kg carbosulfan in grain. Three other trials at double the application rate gave residues of <0.01 to 0.03 mg/kg.

Of 4 trials in Korea with soil application, only one was according to GAP, giving residues of <0.02 mg/kg in husked rice.

In 8 trials in Japan with seedling treatment, 4 were according to GAP, giving carbosulfan residues in husked rice of <0.005 mg/kg. Four trials conducted at half or twice the rate gave the same results.

Eight trials were carried out in China (GAP 0.75 kg ai/ha, 30 days PHI, foliar application) but the PHI was ≥69 days. The residues were <0.002 mg/kg.

In 7 trials in Brazil, with seed treatment within GAP (5g ai/kg seed), no residues occurred in grain (<0.01 or <0.05 mg/kg). Eleven trials at a higher application rate gave the same results.

In 11 trials in China, above the GAP rate for seed treatment, residues were also <0.01 mg/kg in husked rice.

Trials using soil application according to GAP were too few to support a recommendation.

Residues from the seed treatment trials according to GAP in Brazil were <0.01 (2) and <0.05 mg/kg (5). With the support of trials conducted at a higher rate in Brazil, the Meeting estimated a maximum residue level of 0.05* mg/kg and an STMR of 0 for carbosulfan in rice grain.

Two field trials according to GAP in Brazil gave residues of carbofuran and 3-hydroxycarbofuran of <0.01 mg/kg in grain. Residues in husked rice in 35 trials in China, Korea and Japan, at a higher rate than the recommended GAP, were all below the LOQs. The residues resulting from the uses of carbosulfan gave residues covered by the uses of carbofuran in husked rice.

The Meeting recommended maintaining the recommendation of the 2002 JMPR for carbofuran of 0.1 mg/kg in husked rice.

Cotton seed. Twelve trials were carried out in Greece and Spain according to GAP (0.375 kg ai/ha, 2 applications, 28 days PHI, foliar application). The residues of carbosulfan, carbofuran and 3-hydroxycarbofuran were all <0.05 mg/kg.

In 5 trials in Australia according to GAP (0.5 to 1 kg ai/ha, foliar application), carbosulfan residues were <0.05 (4) and 0.03 mg/kg.

In 3 trials in Brazil complying with GAP (0.12 kg ai/ha, foliar application) residues of carbosulfan were <0.01 (2) and <0.05 mg/kg. In the 2 trials with results for carbofuran and 3-hydroxycarbofuran, their residues were <0.01 mg/kg.

In 2 trials carried out in Brazil using seed treatment according to GAP (7g ai/kg), residues were <0.05 mg/kg.

Trials according to GAP with foliar treatment gave residues of <0.01 (2), <0.05 (17) and 0.03 mg/kg.

The Meeting estimated a maximum residue level and an STMR of 0.05 mg/kg for carbosulfan in cotton seed.

Fourteen trials according to GAP gave residues of carbofuran + 3-hydroxycarbofuran of <0.01 (2) and <0.05 (12) mg/kg.

The residues resulting from the uses of carbofuran were at the same levels as those from the uses of carbosulfan in cotton seed. The Meeting confirmed the recommendation of the 2002 JMPR for carbofuran in cotton seed of 0.1 mg/kg.

Sugar beet leaves and tops. Residues of carbosulfan from trials according to GAP in Belgium, Spain, Italy and France were (median underlined) <0.02 (2) and <0.05 (17) mg/kg. Trials at a double rate of application gave the same results.

As no residues are expected in sugar beet tops, even at higher rates, the residues, allowing for 23% dry matter (DM) (FAO Manual, 2002), would probably be below the LOQ.

The Meeting estimated a maximum residue level of 0.05* mg/kg and an STMR of 0 for carbosulfan in sugar beet leaves or tops.

Residues of carbofuran + 3-hydroxycarbofuran in the same trials were (median underlined) 0.05 (17), 0.10 and 0.13 mg/kg.

Allowing for 23% DM, the median and highest residues in sugar beet forage were calculated to be 0.217 mg/kg and 0.56 mg/kg, respectively.

The Meeting estimated a maximum residue level of 0.7 mg/kg and an STMR of 0.217 mg/kg for carbofuran in sugar beet leaves or tops.

Maize forage (whole plant). In 2 trials in Brazil according to GAP (seed treatment), residues were <0.01 mg/kg. Thirteen trials conducted in Belgium, France, Germany and Italy according to GAP showed residues of <0.05 mg/kg in whole plants. In 4 trials at a higher rate of application the results were the same.

Residues of carbosulfan in trials according to GAP were <0.01 (2) and <0.05 (13) mg/kg. Allowing for 40% DM, the median and the highest residue of carbosulfan in maize forage would be (<)0.13 mg/kg but, as no residues are expected in maize forage, even at higher rates, the residues allowing for 40% DM would probably be below the LOQ.

The Meeting estimated a maximum residue level of 0.05* mg/kg and an STMR of 0 for carbosulfan in maize forage, on a dry weight basis.

Fifteen trials conducted according to GAP gave residues of carbofuran + 3-hydroxycarbofuran of (median underlined) <0.01 (2), <0.05 (11), 0.11 and 0.14 mg/kg.

Allowing for 40% DM, the median and highest residues in maize forage were calculated to be (<)0.13 mg/kg and 0.35 mg/kg, respectively.

The Meeting estimated a maximum residue level of 0.5 mg/kg and an STMR of 0.13 mg/kg for carbofuran in maize forage, on a dry weight basis.

Rice straw. In 2 field trials conducted according to GAP in Brazil (seed treatment) residues were <0.01 mg/kg for carbosulfan, carbofuran and 3-hydroxycarbofuran. There were too few trials according to GAP to make a recommendation.

Processing

No new information was provided.

Animal feeding studies

In one feeding study, evaluated by the JMPR in 1997, dairy cows were dosed at 1, 3 and 50 ppm carbosulfan in the feed, for 28 days. At the 50 ppm feeding level, residues were <0.05 mg/kg in kidney, liver and muscle, 0.012 mg/kg in milk and 0.076 mg/kg in fat. Except for one sample of milk produced at the 10 ppm feeding level (containing 0.007 mg/kg of 3-hydroxy carbofuran), no residues were found at the lower feeding levels in any milk sample. No information was provided on the residues in fat at lower feeding levels.

Farm animal dietary burden

The Meeting estimated the farm animal maximum and STMR dietary burdens for carbosulfan, based on the residues in animal feeds resulting from its use (Tables 22 and 23).

Table 22. Estimated farm animal maximum dietary burdens of carbosulfan.

Commodity	Group	Residue mg/kg	Basis	%dry matter	Residue, mg/kg DM basis	% of diet			Residue contribution mg/kg		
						Beef	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Maize	GC	0.05	MRL	88	0.06			80			0.05
Maize forage	AF	0.05	MRL	40	0.13	5	50	0	0.01	0.065	0
Sugar beet leaves or tops	AV	0.05	MRL	23	0.22	20	10	0	0.04	0.02	0
Dry citrus pulp	AB	0.1	MRL	91	0.11						
Potatoes	VR	0.05	MRL	20	0.25	75	40	0	0.19	0.10	0
Rice	GC	0.05	MRL	88	0.06						
Maximum dietary burden									0.24	0.185	0.05

Table 23. Estimated farm animal STMR dietary burdens of carbosulfan.

Commodity	Group	Residue mg/kg	Basis	%dry matter	Residue, mg/kg DM basis	% of diet			Residue contribution mg/kg		
						Beef	Dairy cattle	Poultry	Beef cattle	Dairy cattle	Poultry
Maize	GC	0	STMR	88	0						0
Maize forage	AF	0	STMR	40	0						
Sugar beet leaves or tops	AV	0	STMR	23	0	20	10	0	0	0	
Dry citrus pulp	AB	0.008	STMR-P	91	0.009		20			0.002	
Potatoes	VR	0.03	STMR	20	0.15	75	40		0.11	0.06	0
Rice	GC	0	STMR	88	0						
STMR dietary burden									0.11	0.062	0

Residue levels in animal commodities

Cattle. No carbosulfan was detected in liver, kidney or meat of cattle at a 50 ppm feeding level, which is over 200 times the estimated dietary burden. Carbosulfan was present in fat and in milk (0.076 and 0.012 mg/kg) at this feeding level.

The Meeting agreed that it was unlikely that residues of carbosulfan would be detected in products from animals fed with commodities treated with this compound.

The Meeting estimated a maximum residue level of 0.05* mg/kg, an STMR of 0 and an HR of 0 in for carbosulfan in meat (fat) and edible offal of mammals, and a maximum residue level of 0.03* mg/kg and an STMR and HR of 0 for carbosulfan in milks.

Poultry. In a metabolism study in hens, no residues of carbosulfan or the metabolites carbofuran and 3-hydroxycarbofuran were found, at a feeding level of 0.5 ppm, in tissues (<0.002 mg/kg). Residues in eggs were 0.18 mg/kg eq in yolks and 0.014 mg/kg in whites, at a 5 ppm feeding level. In yolks, 85% of the radioactivity was due to unknown products of high molecular weight (>500). Residues of carbosulfan were <0.002 mg/kg.

The Meeting agreed that it was unlikely that residues of carbosulfan would be detected in products from poultry fed with commodities treated with this compound.

The Meeting estimated a maximum residue level at the limit of quantification, 0.05* mg/kg, and an STMR and HR of 0 for carbosulfan in eggs, meat and offal of poultry.

The ruminant dietary burden of carbofuran estimated by the 1997 JMPR (Report p. 50) was based on a diet containing 80% of alfalfa fodder and there are few animal feed items.

The Meeting agreed to confirm the 1997 recommendations of 0.05* mg/kg for carbofuran in a range of animal commodities.

RECOMMENDATIONS

On the basis of the data from supervised trials the Meeting estimated the maximum residue levels, STMRs and HRs listed in Tables 24 and 25. The maximum residue levels are recommended for use as maximum residue limits.

Carbosulfan

Definition of the residue for compliance with MRLs and for dietary risk assessment: *carbosulfan.*

Table 24. Summary of recommendations for carbosulfan.

Commodity		MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg
CCN	Name	New	Previous		
SO 0691	Cotton seed	0.05	-	0.05	
PE 0112	Eggs	0.05*		0	0
MO 0105	Edible offal, mammalian	0.05*	-	0	0
GC 0645	Maize	0.05*	-	0	
AF 0645	Maize forage	0.05* (dry wt.)	-	0	
MM 0095	Meat (from mammals other than marine mammals)	0.05* (fat)	-	0	0
ML 0106	Milks	0.03*		0	0
VR 0589	Potatoes	0.05		0.03	0.02
PM 0110	Poultry meat	0.05*	-	0	0
PO 0112	Poultry, edible offal of	0.05*	-	0	0
GC 0649	Rice	0.05*	-	0	
VR 0596	Sugar beet	0.3		0.05	
AV 0659	Sugar beet leaves or tops	0.05*		0	

Carbofuran

Definition of the residue for compliance with MRLs: *sum of carbofuran and 3-hydroxycarbofuran*.

For dietary risk assessment: *sum of carbofuran, 3-hydroxycarbofuran and conjugated 3-hydroxycarbofuran*.

Table 25. Summary of recommendations for carbofuran.

Commodity		MRL, mg/kg		STMR or STMR-P, mg/kg	HR or HR-P, mg/kg
CCN	Name	New	Previous		
GC 0645	Maize	0.05*	W	0	
AF 0645	Maize forage	0.5 (dry wt.)	-	0.13 (dry wt.)	0.35 (dry wt.)
VR 0589	Potatoes	0.2	0.1*	0.05	0.11
VR 0596	Sugar beet	0.2	W	0.05	
AV 0659	Sugar beet leaves or tops	0.7 (dry wt.)	W	0.217 (dry wt.)	0.56 (dry wt.)

DIETARY RISK ASSESSMENT

Carbosulfan

Long-term intake

The ADI for carbosulfan is 0-0.01 mg/kg body weight/day. International estimated daily intake (IEDI) was calculated for commodities for human consumption for which STMRs were estimated by the present Meeting. The results are shown in Table 26.

IEDIs for the five GEMS/Food regional diets, based on estimated STMRs, ranged from 0 to 1% of the ADI. The Meeting concluded that the intake of residues of carbosulfan resulting from its uses that were considered by the JMPR is unlikely to present a public heath concern.

Table 26. International Estimated Dietary Intakes (IEDIs) of carbosulfan for the five GEMS/Food regional diets (ADI = 0-0.01 mg/kg bw/day).

Code	Commodity	MRL, mg/kg	STMR or STMR-P mg/kg	Diets: g/person/day. Intake = daily intake: µg/person									
				Mid-East		Far-East		African		Latin American		European	
				diet	Intake	diet	intake	diet	intake	diet	intake	diet	intake
SO 0691	Cotton seed	-	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PE 0112	Eggs	-	0	14.6	0.0	13.1	0.0	3.7	0.0	11.9	0.0	37.6	0.0
MO 0105	Edible offal (mammalian)	-	0	4.2	0.0	1.4	0.0	2.8	0.0	6.1	0.0	12.4	0.0
GC 0645	Maize (fresh)	-	0	16.5	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0
MM 0095	Meat from mammals other than marine mammals	-	0	37.0	0.0	32.8	0.0	23.8	0.0	47.0	0.0	155.5	0.0
FC 0004	Oranges, sweet, sour (incl. orange-like hybrids)	-	0.01	31.5	0.3	4.0	0.0	4.8	0.0	31.0	0.3	29.8	0.3
VR 0589	Potatoes	-	0.03	59.0	1.8	19.2	0.6	20.6	0.6	40.8	1.2	240.8	7.2
PM 0110	Poultry meat	-	0	31.0	0.0	13.2	0.0	5.5	0.0	25.3	0.0	53.0	0.0
PO 0111	Poultry, edible offal of	-	0	0.1	0.0	0.1	0.0	0.1	0.0	0.4	0.0	0.4	0.0
GC 0649	Rice	-	0	48.8	0.0	279.3	0.0	103.4	0.0	86.5	0.0	11.8	0.0
VR 0596	Sugar beet	-	0.05	0.5	0.0	0.0	0.0	0.0	0.0	0.3	0.0	2.0	0.1
			Total intake (µg/person)=	2.1			0.6		0.7		1.5		7.6
			Bodyweight per region (kg bw) =	60			55		60		60		60
			ADI (µg/person)=	600			550		600		600		600
			%ADI=	0.4			0.1		0.1		0.3		1.3
			Rounded %ADI=	0			0		0		0		1

Short-term intake

International estimated short-term intakes (IESTIs) of carbosulfan were calculated for commodities for which STMR and HR values were estimated in this evaluation and for which data on consumption (large portion and unit weight) were available. The results are shown in Tables 27 and 28. The acute RfD for carbosulfan is 0.02 mg/kg. The IESTIs represented 0 to 4% of the acute RfD for children and 0 to 2% of the acute RfD for the general population. The Meeting concluded that the short-term intake of residues of carbosulfan, from uses on the commodities that have been considered by the JMPR, is unlikely to present a public health concern.

Table 27. Assessment of risk to the general population from the short-term dietary intake of residues of carbosulfan (acute RfD = 0.02 mg/kg bw, i.e. 20 µg/kg bw/day).

Codex Code	Commodity	STMR or STMR-P mg/kg	HR or HR-P mg/kg	Large portion diet				Unit weight		Variability factor	Case	IESTI µg/kg bw/day	% acute RfD rounded
				Country	Body wt (kg)	Large portion, g/person	Unit wt, g	Country	Unit wt, edible portion, g				
PE 0840	Chicken eggs	0	-	FRA	62.3	219	-	-	ND	ND	1	0.00	0
SO 0691	Cotton seed	0.05	-	USA	65.0	3	-	-	ND	ND	1	ND	-
MO 0105	Edible offal (mammalian)	0	-	FRA	62.3	277	-	-	ND	ND	1	ND	-
GC 0645	Maize (fresh, flour, oil)	0	-	FRA	62.3	260	-	-	ND	ND	1	0.00	0

Codex Code	Commodity	STMR or STMR-P mg/kg	HR or HR-P mg/kg	Large portion diet			Unit weight			Variab-ility factor	Case	IESTI µg/kg bw/day	% acute RfD rounded
				Coun-try	Body wt (kg)	Large portion, g/person	Unit wt, g	Coun-try	Unit wt, edible portion, g				
MM 0095	Meat from mammals other than marine mammals	0	-	AUS	67.0	521	-	-	ND	ND	1	0.00	0
ML 0106	Milks	0	-	USA	65.0	2466	-	-	ND	ND	3	0.00	0
FC 0004	Oranges, sweet, sour (incl. orange-like hybrids)	-	0.01	USA	65.0	564	190	FRA	137	3	2a	0.13	1
VR 0589	Potatoes	0.03	0.02	NLD	63.0	687	200	FRA	160	3	2a	0.32	2
PM 0110	Poultry meat	0	-	AUS	67.0	431	-	-	ND	ND	1	0.00	0
PO 0111	Poultry, edible offal of	0	-	USA	65.0	248	-	-	ND	ND	1	0.00	0
GC 0649	Rice	0	-	FRA	62.3	312	-	-	ND	ND	1	0.00	0
VR 0596	Sugar beet	0.05	-	-	-	ND	-	-	ND	ND	ND	ND	-

Table 28. Assessment of risk to children up to 6 years, from the short-term dietary intake of residues of carbosulfan (acute RfD = 0.02 mg/kg bw, i.e. 20 µg/kg bw/day).

Codex code	Commodity	STMR or STMR-P mg/kg	HR or HR-P mg/kg	Large portion diet			Unit weight			Variab-ility factor	Case	IESTI µg/kg bw/day	% acute RfD rounded
				Coun-try	Body wt, kg	Large portion, g/person	Unit wt, g	Coun-try	Unit wt, edible portion, g				
PE 0840	Chicken eggs	0	-	FRA	17.8	134	-	-	ND	ND	1	0.00	0
SO 0691	Cotton seed	0.05	-	USA	15.0	1	-	-	ND	ND	1	ND	-
MO 0105	Edible offal (mammalian)	0	-	FRA	17.8	203	-	-	ND	ND	1	ND	-
GC 0645	Maize (fresh, flour, oil)	0	-	FRA	17.8	148	-	-	ND	ND	1	0.00	0
MM 0095	Meat from mammals other than marine mammals	0	-	AUS	19.0	261	-	-	ND	ND	1	0.00	0
ML 0106	Milks	0	-	USA	15.0	1286	-	-	ND	ND	3	0.00	0
FC 0004	Oranges, sweet, sour (incl. orange-like hybrids)	-	0.01	USA	14.5	495	190	FRA	137	3	2a	0.53	3
VR 0589	Potatoes	0.03	0.02	SAF	14.2	300	200	FRA	160	3	2a	0.87	4
PM 0110	Poultry meat	0	-	AUS	19.0	224	-	-	ND	ND	1	0.00	0
PO 0111	Poultry, edible offal of	0	-	USA	15.0	37	-	-	ND	ND	1	0.00	0
GC 0649	Rice	0	-	FRA	17.8	223	-	-	ND	ND	1	0.00	0
VR 0596	Sugar beet	0.05	-	-	-	ND	-	-	ND	ND	ND	ND	-

Carbofuran

Long-term intake

Recommendations made by the Meeting for carbofuran, arising from the uses of carbosulfan, do not affect the assessment performed by the 2002 JMPR for this compound.

Short-term intake

International estimated short-term intakes (IESTIs) for carbofuran were calculated for commodities for which STMR and HR values were estimated by the present Meeting and for which data on consumption (large portion and unit weight) were available. The results are shown in Tables 29 and 30.

The acute RfD for carbofuran is 0.009 mg/kg. The IESTIs represented 0 to 50% of the acute RfD for children and 0 to 20% of the acute RfD for the general population. The Meeting concluded that the short-term intake of residues of carbofuran, arising from uses of carbosulfan on the commodities that have been considered by the JMPR, is unlikely to present a public health concern.

Table 29. Assessment of risk to children up to 6 years, from the short-term dietary intake of residues of carbofuran (acute RfD = 0.009 mg/kg bw, i.e. 9 µg/kg bw/day).

Codex code	Commodity	STMR or STMR-P mg/kg	HR or HR-P mg/kg	Large portion diet			Unit weight			Variability factor	Case	IESTI µg/kg bw/day	% acute RfD rounded
				Country	Body wt, kg	Large portion, g/person	Unit wt, g	Country	Unit wt, edible portion, g				
GC 0645	Maize (fresh, flour, oil)	0	-	FRA	17.8	148	-	-	ND	ND	1	0.00	0
VR 0589	Potatoes	0.05	0.11	SAF	14.2	300	200	FRA	160	3	2a	4.80	50

Table 30. Assessment of risk to the general population from the short-term dietary intake of residues of carbofuran (acute RfD = 0.009 mg/kg bw, i.e. 9 µg/kg bw/day).

Codex code	Commodity	STMR or STMR-P mg/kg	HR or HR-P mg/kg	Large portion diet			Unit weight			Variability factor	Case	IESTI µg/kg bw/day	% acute RfD rounded
				Country	Body wt, kg	Large portion, g/person	Unit wt, g	Country	Unit wt, edible portion, g				
GC 0645	Maize (fresh, flour, oil)	0	-	FRA	62.3	260	-	-	ND	ND	1	0.00	0
VR 0589	Potatoes	0.05	0.11	NLD	63.0	687	200	FRA	160	3	2a	1.76	20

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