DICHLORVOS (025)

The first draft was prepared by Prof. Árpád Ambrus, National Food Chain Safety Office, Budapest Hungary

EXPLANATION

Dichlorvos is an organophosphate insecticide. It combines both contact and stomach action and has a marked vapour action. It is effective against a broad spectrum of insect pests in stored products. It is also used in public health vector control and in animal health for ectoparasite control. It was evaluated by JMPR 1965 (T, R), 1970 (T, R), 1993 (T, R), and in 2011 (T) as the periodic re-evaluation. The ADI for Dichlorvos was established as 0–0.004 mg/kg bw and acute reference dose was 0.1 mg/kg bw. Dichlorvos was scheduled at the Forty-third session of the CCPR (2011) for the periodic re-evaluation of residues by the 2012 JMPR.

The manufacturer submitted results of metabolism studies on goat, laying hens and residue data on raw agricultural commodities stored in bulk, packed or bagged, cattle (milk, meat, fat, edible offal), laying hens (egg, meat, fat, edible offal). Additional non-GLP studies on metabolism of dichlorvos in animals and plants, residues in stored and processed commodities and animal tissues reported in the scientific literature and their evaluation were provided by the Australian Pesticides and Veterinary Medicines Authority.

IDENTITY

ISO common name: Dichlorvos

IUPAC name: 2,2-dichlorovinyl dimethyl phosphate

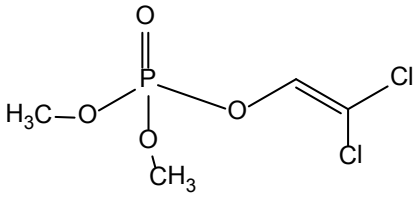
Chemical Abstract name: 2,2- dichloroethenyl dimethyl phosphate

CAS No.: 62-73-7

Synonyms: DDVP

Molecular Formula: $C_4H_7Cl_2O_4P$

Structural Formula:



Molecular Weight: 221

PHYSICAL AND CHEMICAL P[ROPERTIES

Technical dichlorvos

Chemical/physical property	Guideline(s)	Results	Reference
Melting point	EC A.1 OECD 102	No melting point temperature (Freezing not observed above -90ºC)	Brekelmans, 2009 (500-PCH-055)
Relative density Density at 20 ºC	EC A.3 OECD 109	1.42 1.42 g/cm^3	Brekelmans, 2009 (500-PCH-055)
Vapour pressure at 20 ºC	EC 1.4 OECD 104	2.19 Pa = 1.64 x 10^{-2} mmHg (by isothermal thermogravimetry)	Brekelmans, 2009 (500-PCH-055)
Flash point	EC A.9 ISO 2719 ASTM D 93 (Pensky-Martens	No flammable vapour/air mixture was produced at temperatures below boiling, that was observed visually at 150 ºC.	Brekelmans, 2009 (500-PCH-055)

Chemical/physical property	Guideline(s)	Results	Reference
	closed cup)		
Flammability (contact with water)	EC A.12	Not highly flammable	Brekelmans, 2009 (500-PCH-055)
Pyrophoric properties	EC A.13	Not pyrophoric	Brekelmans, 2009 (500-PCH-055)
Explosive properties	EC A.14 (shock and thermal sensitivity)	No danger of explosion	Brekelmans, 2009 (500-PCH-055)
Auto-ignition temperature at 1013.1 – 1020.8 hPa	EC A.15 DIN 51794 IEC 79-4	470 ºC	Brekelmans, 2009 (500-PCH-055)
Viscosity	OECD 114	14 mPa.s at 20 ºC 11 mPa.s at 40 ºC	Brekelmans, 2009 (500-PCH-055)
Free acidity	CIPAC MT31.2	0.571% (w/w) calculated as H_2SO_4	Brekelmans, 2009 (500-PCH-055)
Solubility in water	EC A.6 OECD 105	19.0 g/l at 10 ºC 16.4 g/l at 20 ºC 15.7g/l at 30 ºC	Brekelmans, 2009 (500-PCH-057)
Solubility in organic solvents	EC A.6 OECD 105	Ethyl acetate: Miscible in a 1:4 (w:w) ratio at 20 ºC n-Hexane: 138 g/l at 10 ºC 245 g/l at 20 ºC >221 g/l at 30 ºC	Brekelmans, 2009 (500-PCH-057)
Partition coefficient	EC A.8 OECD 117	Log Pow: 2.0 at 10 ºC Log Pow: 2.0 at 20 ºC Log Pow: 2.0 at 30 ºC	Brekelmans, 2009 (500-PCH-057)

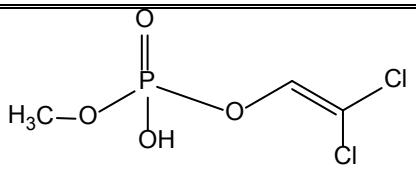
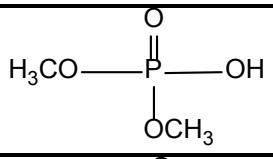
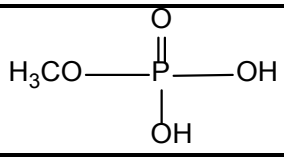
Formulations

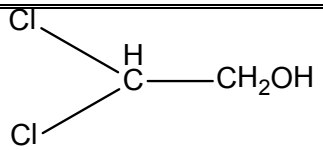
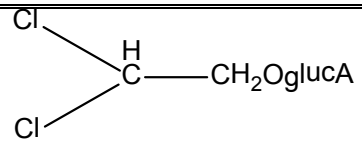
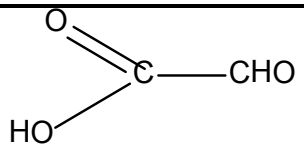
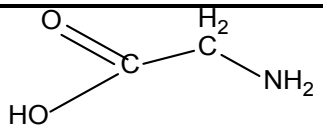
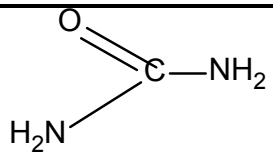
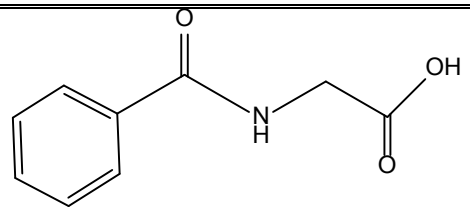
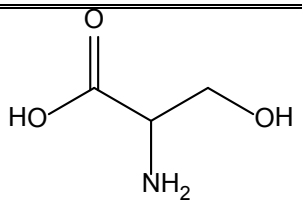
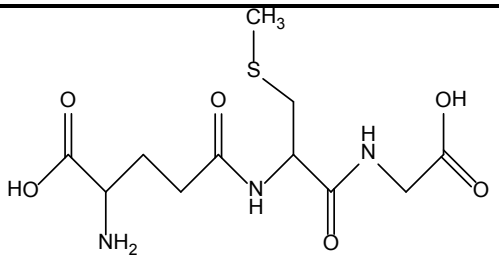
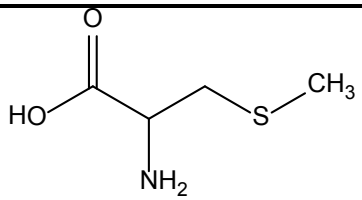
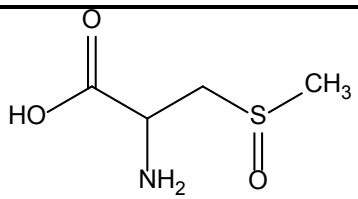
Formulations of dichlorvos include pressurized liquids (PrL 5% or 20%), emulsifiable concentrates (20%), and impregnated materials such as resin strips (65 and 85 g). Dichlorvos is applied with aerosols, fogging and sprays equipment, and through slow release from impregnated materials, such as resin strips.

METABOLISM AND ENVIRONMENTAL FATE

The metabolism of dichlorvos in goats, swine and laying hens as well as in plants was evaluated by the present meeting. The chemical structures of the major degradation compounds from the metabolism of dichlorvos are provided in Table 1.

Table 1 List of metabolites and degradation compounds of dichlorvos

Compound Name	Structure	Found in:
Desmethyl dichlorvos		Plants, Animals
Dimethyl phosphate		Plants, animals
Methyl phosphate		Plants

Compound Name	Structure	Found in:
Dichloroethanol		Plants, animals
Glucuronide		Animals
Glycolic acid		Animals
Glycine		Animals
Urea		Animals
Hippuric acid		Animals
Serine		Animals
S-methylglutathione		Animals
S-methylcysteine		Animals
S-methylcysteine oxide		Animals
Dichloroacetaldehyde		Animals

METABOLISM

Reports of studies on the metabolism of dichlorvos had been submitted covering dermal applications using goats and laying hens. The metabolism following oral application of dichlorvos in cows and swine and metabolism in wheat grain; cotton leaves; bean, tomato and potato plants; faba and soya beans was reviewed based on the open scientific literature.

Laboratory animals

The 2011 JMPR reported the biotransformation of dichlorvos in laboratory animals and concluded that it is rapidly absorbed by all routes of exposure and rapidly degraded. Metabolites are rapidly excreted or incorporated into natural products. The first pathway involves the oxidative *O*-demethylation of dichlorvos to produce desmethyl-dichlorvos by a glutathione-dependent enzymatic system. Hydrolysis of the *O*-demethylated metabolite yields methylphosphate, phosphoric acid and methanol. The second (predominant) pathway involves the ester hydrolysis of the oxygen–vinyl bond of dichlorvos to generate dimethylphosphate and dichloroacetaldehyde. The latter is further metabolized to dichloroethanol or dichloroacetic acid, and then to dichloroethanol glucuronide, hippuric acid, urea and carbon dioxide.

Animal metabolism following dermal treatment

Lactating Goats

Two lactating goats were treated dermally (Report 500-RES-001) twice daily for three consecutive days with vinyl-^{14}C-dichlorvos (14.2 μCi/mg or 31524 dpm/g) at the target dose rate of 10 mg/kg body weight/day. The position of the radiolabel is shown in Figure 1.

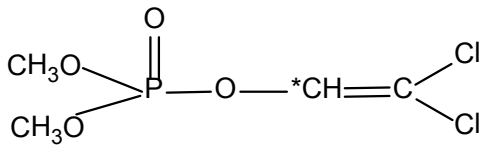


Figure 1 Radiolabel Position of Dichlorvos

To dose at an exaggerated rate, the application site of one goat was shaved and occluded with a Teflon patch immediately after each treatment ("occluded goat"). The other treated goat was treated normally, that is, the application site was not shaved nor occluded ("non-occluded").

The goats, kept in stainless steel metabolism cages, were hand-milked twice daily at regular morning and evening intervals throughout the acclimation and treatment periods. The amount of milk produced during each collection period was determined gravimetrically and weights recorded. Urine and faces samples were collected once daily beginning approximately 24 hours prior to the first administered dose.

Treated goats were sacrificed 16–18 hours after the final dose. Immediately following sacrifice, the goats were necropsied and the entire liver, kidneys, composite muscle, composite fat, skin and hair were collected. For the treated animals, separate muscle, fat, skin and hair (where applicable) samples were taken from areas that were proximal and distal to the application site. Tissue sample weights were taken and recorded and the samples were stored frozen (approximately -20 °C) until processed.

Liver, kidney, muscle, and fat tissue samples were partially thawed, weighed and manually minced into small pieces. Due to potential volatility of the incurred residues, only a portion of the entire sample was randomly selected and homogenized. The remaining portions of non-homogenized samples were returned to frozen storage. Subsamples were homogenized in a frozen state with dry ice

in a small commercial food grinder. Processed tissue samples were transferred into labelled storage bags and returned to the freezer overnight to allow for the sublimation of the dry ice.

The total radioactive residue (TRR) levels and percent of dose in selected tissues were determined by combustion analysis. The results are shown in Table 2.

Table 2 Total radioactive residues (TRR) in tissues following dermal exposure with dichlorvos of lactating goats

Tissues	Occluded Goat (mg/kg)	Non-occluded goat (mg/kg)
Liver	36.07 (2.8%)	9.13 (0.5%)
Kidney	13.45 (0.1%)	3.23 (0.0%)
Distal muscle	2.30 (3.6%)	0.65 (0.8%)
Proximal muscle	2.56 (0,1%)	0.55 (0.0%)
Distal fat	0.69 (0.1%)	0.13 (0.0%)
Proximal Fat	0.64 (0.0%)	0.43 (0.0%)
Milk 0-24 hrs	6.09 (1.1%)	0.62 (0.1%)
Milk 24-48 hrs	10.76 (1.5%)	1.33 (0.2%)
Milk 48hr-Sac	8.37 (0.9%)	1.82 (0.3%)

Radioactivity excreted in the urine accounted for 17.5 and 2.4% of the administered dose in the occluded and non-occluded goats, respectively. Similarly, radioactivity excreted in the faeces accounted for 1.3 and 0.3% of the administered dose. Material balance for this study accounted for 52.1 and 42.2% of the administered dose for the occluded and non-occluded goats, respectively.

The metabolic fate of vinyl-1-^{14}C-dichlorvos in the goat was examined in the edible tissues and milk by a combination of organic solvent extraction, acid and base hydrolysis, chemical derivatisation, HPLC, TLC and GC/MS analyses.

Since tissue and milk samples from the occluded goat contained higher residue levels than the non-occluded goat, all samples extracted were taken from the occluded goat. Homogenized samples were initially extracted within four weeks after sample collection and then again approximately 10 months after collection. The results indicate that the TRR of the incurred residues had not changed during frozen storage.

Radioactivity in the extracts was quantified by direct radioassay of triplicate aliquots. Radioactivity remaining in post-extracted solids (PES) and post-hydrolysed solids (PHS) were quantified by combustion analysis. The organo-soluble fractions of tissues and milk were further characterized by saponification by refluxing in a methanolic potassium hydroxide solution for 3 hours. After saponification, the methanol was removed by rotary evaporation and the residue re-dissolved in a minimum amount of water. The aqueous solution was extracted three times with diethyl ether (1: 1, v/v). The diethyl ether ("non-saponifiable") fraction was analysed by HPLC. The aqueous fraction was adjusted to pH 3.0 with 4 N sulphuric acid and extracted twice with diethyl ether (1: 1, v/v) and twice with petroleum ether (l:l, v/v). The acidified ether ("saponifiable") fractions were combined and analysed for free fatty acids. The remaining aqueous ("saponified non-extractable") fraction was analysed for glycerol by HPLC and by TLC systems. Tissue and milk PES acid hydrolysates were neutralized and analysed for amino acids.

Solvent extraction of tissues and milk resulted in extraction efficiencies ranging between 30.7 and 70.5 percent of the TRR. Subsequent acid and/or base hydrolyses of the post-extracted solids quantitatively solubilized the "bound" residues. The distributions of radioactive residues into the various sample fractions are summarized below.

Table 3 Distribution of radioactive residues in milk and tissues of lactating goats following dermal exposure to dichlorvos

Sample	TRR (mg/kg)	% into organic	% into aqueous	% into 1N HCl	% into 1N NaOH	% not released
Liver	36.746	5.2	25.5	41.5	27.1	0.7
Kidney	13.700	4.7	32.5	49.8	11.9	1.1

Sample	TRR (mg/kg)	% into organic	% into aqueous	% into 1N HCl	% into 1N NaOH	% not released
Muscle	2.604	2.7	48.5	20.0	28.4	0.4
Fat	0.690	60.0	7.2	32.8	N/A	0
Milk	10.763	7.3	63.2	21.0	8.5	0

Chromatographic analysis of the aqueous extracts demonstrated that neither dichlorvos nor any of the known metabolites of dichlorvos (i.e., desmethyl dichlorvos, 2,2-dichloroacetic acid, 2,2 dichloroacetaldehyde and 2,2-dichloroethanol) were present. Mass spectral analyses of the water-soluble residues suggested that the residues were dechlorinated and had molecular weights which ranged between 147 to 276 m/e. Based on the chromatographic and mass spectral findings, it was concluded that the polar residues found in the tissues represented incorporation of the dechlorinated vinyl portion of dichlorvos into relatively high-molecular weight natural products.

Milk aqueous extract was shown to contain a single radioactive residue which was identified as ^{14}C-lactose by co-chromatography in two chromatographic systems with authentic standard.

The organo-soluble residues were further characterized by saponification which resulted in comparatively similar distributions in all samples, with approximately 30–50% of the sample radiocarbon distributed into the “non-saponifiable” (lipid) fraction and the remaining radiocarbon distributed into the “saponified aqueous” (glycerol) fraction. Virtually none of the radiocarbon was distributed into the “saponifiable” (fatty acid) fraction. Analysis of the saponified-aqueous fractions from milk, liver and fat ^{14}C-glycerol accounted for 100, 28.6 and 23.1% of the radiocarbon present in the fraction, respectively.

In all tissue and milk samples, a large portion of the TRR remained unextracted in the post extraction solid (PES). These “bound” residues were quantitatively solubilized after acid and/or base hydrolysis. Derivatisation, solvent distribution and chromatographic results showed that the solubilized residues were chemically and chromatographically similar to amino acids.

The proposed metabolite distribution in goat tissues and milk is as follows:

Table 4 Metabolite distribution in organo-soluble fraction [a] of goat tissues and milk following dermal exposure (% of TRR)

Tissue	TRR (mg/kg)	Water soluble products [b]	Non-saponifiable	Saponifiable	Saponified-aqueous		Acid released products [c]	Unident. [d]
					Glycerol	Others		
Liver	36.746	20.6	1.4	0.0	1.1	2.7	68.6	5.6
Kidney	13.700	24.3	1.7	0.1	0.0	2.9	61.7	9.3
Muscle	2.604	48.5	0.8	0.0	0.0	1.9	48.4	0.4
Fat	0.690	7.2	23.6	0.0	8.4	28.0	32.8	0.0
Milk	10.763	63.2	4.1	0.1	3.0	0.0	29.5	0.1

[a] Organo-soluble products in non-saponifiable fraction characterized as unidentified endogenous fats. Unidentified product (other) in saponified-aqueous fraction characterized as a polar hydrolytic product of endogenous fat.

[b] Water-soluble product in skim milk identified as lactose by co-chromatography. Products in tissues characterized as mixture of dechlorinated polar compounds (M W > 147) by mass spectral analysis.

[c] Acid released products characterized as chemically and, in part, chromatographically similar to amino acids.

[d] Most of the unidentified residues in liver and kidney were accounted for as water-soluble products removed from the aqueous fraction during sample clean-up prior GC/MS analysis.

To evaluate the radiochemical stability of parent dichlorvos in tissue and milk matrices, control goat kidney, muscle and milk samples were spiked with dichlorvos at a concentration of approximately 500,000 dpm/g. Spiked samples were immediately extracted and the extracts concentrated and analysed as described for treated tissue and milk samples. Limits of quantitation (LOQ) for all tissue TRR levels were 0.01 mg/kg. After summation of like metabolites found in the two (aqueous and organic) extracts, HPLC results demonstrated that 12.0, 88.6 and 77.0 percent of the TRR was accounted for as parent dichlorvos in kidney, muscle and milk extracts, respectively. The only major degradate seen was 2,2-dichloroacetaldehyde, which accounted for 81.3, 8.0 and 13.1

percent of the TRR, respectively. Sum of dichlorvos and 2,2-dichloacetaldehyde amounts to 90–97% TRR which suggests that dichlorvos is mainly degraded to 2,2-dichloacetaldehyde. Des-methyl dichlorvos or other unknowns accounted for less than 3.0 percent of the TRR.

These findings suggested that dichlorvos was rapidly degraded to 2,2-dichloroacetaldehyde in enzymatically and/or chemically reactive tissues, where degradation rates were in the order of kidney > milk > muscle.

Laying Hens

The metabolism of dichlorvos following dermal application on laying hens was studied in 1993 (Report 500-RES-003). Ten white Leghorn laying hens were treated dermally twice daily for three consecutive days with vinyl-1-^{14}C-dichlorvos (19.3 μCi/mg or 42,846 dpm/g) at the dose rate of 18.7 mg/kg body weight/day. The position of the radiolabel is shown in Figure 1.

To maximize absorption of the applied dose, the feathers and down on the application site (vent and fluff area) were clipped-off prior to the first treatment. Treated hens were sacrificed approximately 20-21 hours after the final dose and the total radioactive residue (TRR) levels in selected tissues, determined by combustion analysis are shown in Table 5.

Table 5 Total radioactive residues (TRRs) in selected tissues

Sample	TRR (mg/kg)	% dichlorvos	% desmethyl dichlorvos
Liver	1.482	0.0	0
Breast muscle	0.391	1.1	7.7
Thigh muscle	0.343		
Proximal fat	0.494	7.8	0
Distal fat	0.184		
Egg, white	0.876	0	0
Egg, yolk	0.863	0	0
Blood	0.324		

Radioactivity found in the internal tissues accounted for 0.3% of the administered dose. Radioactivity found on the proximal and distal skin accounted for 20.0 and 0.8% of the administered dose, respectively. TRR levels found in egg yolks ranged from < 0.014 to 0.863 mg/kg. Similarly, TRR levels found in egg whites ranged from 0.015 to 0.876 mg/kg.

Cumulative radioactivity in eggs did not account for any measurable percentage (0.1%) of the administered dose. Radioactivity found in the excreta of the treated hens accounted for 9.0% of the administered dose. Based on the radioactivity recovered in the tissue, egg and excreta samples analysed, material balance for this study accounted for 30.1% of the administered dose. Radioactivity unaccounted for was attributed to volatilization of the vinyl-1-^{14}C-dichlorvos from the application site.

The metabolic fate of vinyl-1-^{14}C-dichlorvos in the hen was examined in the edible tissues and eggs by combination of organic solvent extraction, acid and base hydrolysis, chemical derivatisation, HPLC, TLC and GC/mass spectral analyses.

Solvent extraction of tissues and eggs resulted in extraction efficiencies ranging between 8.6 and 93.5% of the TRR. Subsequent acid and base hydrolysis of the post-extracted solids quantitatively solubilized the “bound” residues. The distributions of radioactive residues into the various sample fractions are summarized below.

Table 6 Distribution of radioactive residues in eggs and tissues of laying hens following dermal exposure to dichlorvos

Sample	TRR (mg/kg)	% into organic	% into aqueous	% into 1N HCl	% into 1N NaOH	% not released
Liver	1.482	3.8	19.0	63.4	13.2	0.5
Breast muscle	0.391	16.9	47.7	22.7	12.4	0.4
Fat	0.494	23.1	70.4	6.5	NA	0.0[a]
Egg white	0.876	NA	8.6	27.4	63.7	0.3

Sample	TRR (mg/kg)	% into organic	% into aqueous	% into 1N HCl	% into 1N NaOH	% not released
Egg yolk	0.863	NA	19.7	38.6	16.1	25.6

NA = not applicable

[a] No pellet remained.

Chromatographic analysis of the aqueous extracts demonstrated that no dichlorvos or any of the possible metabolites of dichlorvos (i.e., des-methyl dichlorvos, 2,2-dichloroacetic acid, 2,2-dichloroacetaldehyde and 2,2-dichloroethanol) were present. Mass spectral analyses of representative water-soluble metabolites suggested that they were dechlorinated and had molecular weights which ranged between 256 and 282 m/e. Based on the chromatographic and mass spectral findings, it was concluded that the polar residues found in the tissues represented incorporation of the dechlorinated vinyl portion of dichlorvos into relatively high-molecular weight natural products.

Extraction and chromatographic analysis demonstrated that fat contained a minimal amount of unchanged dichlorvos (7.8% TRR, 0.039 mg/kg) and that breast muscle contained dichlorvos (1.1% TRR, 0.004 mg/kg) and des-methyl dichlorvos (7.7% TRR, 0.030 mg/kg). The presence of these compounds in the muscle and fat just below the skin of the application site was attributed to simple diffusion of the applied dichlorvos through the skin, and related to the "exaggerated" dose used in this study. In contrast, residues found in samples distal to the application site (liver, egg white and egg yolk) contained only residues that were extensively metabolized and incorporated into natural products.

The organo-soluble residues were further characterized by saponification which resulted in comparatively similar distributions in all samples, with approximately 19–52% of the sample radiocarbon distributed into the "non-saponifiable" (lipid) fraction and approximately 22–51% of the sample radiocarbon distributed into the "saponified aqueous" (glycerol) fraction. The remainder of the radiocarbon (0.9–9.6%) was distributed into the "saponifiable" (fatty acid) fraction. Analysis of the "saponified aqueous" fractions from liver, proximal fat and egg yolk demonstrated that ^{14}C-glycerol accounted for 22.7, 24.6 and 73.8% of the sample radiocarbon, respectively.

In liver, breast muscle, egg white, and egg yolk, a large portion of the TRR remained unextracted in the PES. These "bound" residues were quantitatively solubilised after acid and/or base hydrolysis. Derivatisation, solvent distribution and chromatographic results showed that the acid-solubilized residues were chemically and chromatographically similar to amino acids.

Although structural assignments were not made for representative water-soluble residues extracted from tissues, three relatively high-molecular weight polar compounds, which lacked chlorine atoms, were confirmed by mass spectral analysis. Bound residues solubilised by acid hydrolysis were tentatively identified as amino acids. The proposed metabolite distributions in poultry tissues and egg components are summarized in Table 7.

Table 7 Metabolite distribution in poultry tissues and eggs following dermal application of dichlorvos (% of TRR)

Tissue (TRR, mg/kg)	Dichlorvos	Des-methyl dichlorvos	Water-soluble products [a]	Organo-soluble products [b]	Saponified aqueous		Acid released products [c]	Unident. [d]
					Glycerol	Others		
Liver (1.482)	0.0	0.0	19.0	3.8	0.5	1.7	76.7	2.1
Breast muscle (0.391)	1.1	7.7	47.7	16.9	6.7	NA	35.1	8.4
Fat (0.494)	7.8	0.0	70.4	23.1	15.3	0.0	6.5	0.0
Egg white (0.876)	0.0	0.0	8.6	NA	NA	NA	63.7	27.7
Egg yolk (0.863)	0.0	0.0	19.7	17.8	7.5	2.7	54.7	15.4

[a] Representative water-soluble products in tissues characterized as mixture of dechlorinated polar compounds (MW ≥256) by mass spectral analysis.

[b] Organo-soluble products in Non-saponifiable and saponifiable fractions characterized as unidentified endogenous fats. Unidentified product (other) in saponified aqueous fraction characterized as a polar hydrolytic product of endogenous fat.

[c] Acid released products characterized as chemically and chromatographically similar to amino acids.

[d] Most of the unidentified residues were unextracted or part of the organic fraction not identified.

Results of this study confirm that the metabolic pathway of dichlorvos following dermal application to hens is identical to goats (Figure 2).

Oral application

Cows

In an early study four cows were treated with phosphorus^{32}-labelled dichlorvos for studying the residues in milk (Casida 1961). The cows received on the first day 1 mg/kg bw dose in capsule, which was followed by a 20 mg/kg bw dose after 7 days. Milk was secreted continuously from the time of administrations. Following the 1 and 20 mg/kg bw oral doses the total radioactivity in milk reached an approximate plateau at 0.6 mg/kg dichlorvos equivalent between 12 and 24 hours, and at 10.5–11.1 mg/kg between 8 and 12 hours, respectively. The residues in milk declined continuously to 1.3 mg/kg dichlorvos equivalent after 6 days. The organosoluble residues were much lower reaching the maximum of 0.077 mg/kg after one hour of administration of 20 mg/kg bw dose.

In another experiments four cows were administered ^{32}P-dichlorvos (Casida *et al*., 1962) for milk residue studies. The cows were treated as follows: intravenous administration in a propylene glycol-saline mixture of 1.00 mg/kg of dichlorvos to a 612 kg. cow; subcutaneous administration in a propylene glycol-saline mixture of 1.00 mg/kg of dichlorvos to a 518 kg cow; oral administration on bran in gelatine capsules of 1.00 mg/kg of dichlorvos to a 484-kg cow: followed after 7 days by a 20.0 mg/kg oral treatment of dichlorvos to the same cow; oral administration on bran in gelatine capsules of 20.0 mg/kg of dibrom to a 530 kg cow; and subcutaneous administration in a propylene glycol-saline mixture of 1.52 mg/kg of dichlorvos to a 60 kg goat. The animals were stanchioned and catheterized to allow separate and total collection of urine and faeces. The majority (68–100%) of radioactivity was eliminated in urine and faeces within a week of administration. The majority of radioactivity in urine was present as mono- or di-methyl phosphates (70–98%) and desmethyl dichlorvos (0–30%). Approximately 12 hours after administration the radioactivity eliminated in milk of cows peaked at 0.61 mg/kg and 11.1 mg/kg dichlorvos equivalent after 1 mg/kg and 20 mg/kg dose respectively. It was concluded that dichlorvos was rapidly metabolised *in vivo* predominantly *via* cleavage of the P-O (vinyl) bond.

Swine

The Metabolic fate of dichlorvos in swine was studied by short and long-term oral and inhalation exposure utilising ^{32}P-, ^{36}Cl- and ^{14}C-labelled dichlorvos (Page et al 1972). In the oral studies, ^{14}C-dichlorvos was administered as slow release polyvinylchloride (PVC) pellets. Pregnant sows were fed a nominal dose of 4 mg/kg bw per day of ^{14}C-dichlorvos for up to 4 weeks before birth. Radioactivity was retained in tissues of both sows and piglets (levels not specified), but analysis showed that dichlorvos, demethyl dichlorvos, dichloroacetaldehyde or dichloroacetic acid were absent. Liver and muscle tissues were further analysed to identify major radioactive metabolites. Metabolites were identified as ^{14}C-carbon dioxide, glycine and serine, and radioactivity was also found in a number of intermediates derived from these, including glucose, fatty acids, choline, ribonucleic acid and cholesterol. Similar experiments using ^{36}Cl-dichlorvos demonstrated that radioactivity was present as chloride ion and not as organochlorine compounds directly related to dichlorvos.

In three separate trials pregnant sows were fed non-labelled, and ^{14}C- and ^{36}Cl-labelled dichlorvos separately and in combination during the last third of the sows' gestation period at a rate of 4 mg of dichlorvos per kg of body weight per day (Potter *et al*. 1972). In all the trials the dichlorvos was formulated in polyvinyl chloride pellets containing 20–21% dichlorvos. After farrowing, the sows

and piglets were held for periods as long as 21 days before being sacrificed. During this period the piglets nursed from their own mothers.

The daily rates of excretion of ^{14}C from the sows which had been dosed with dichlorvos-^{14}C only were as follows: faeces, 5.4%; the pellets recovered from the faeces, 53.6%; urine, 4.3%; and expired air, 6.7%. The recovery of ^{36}Cl from the sows dosed with dichlorvos and dichlorvos-^{36}Cl was as follows: faeces, 5.5%; the pellets recovered from the faeces, 56.5%; urine, 26.1%; and sow carcass,8.1%.

Samples of brain, kidney, liver, quadriceps muscle, and mesenteric fat from the sows, and muscle and liver from the piglets were analysed using the GC method. The average recoveries of dichlorvos, demethyl dichlorvos, dichloroacetaldehyde, dichloroacetic acid and dichloroethanol at 0.2–0.5 (0.25) concentration ranges given were between 90% and 105%.

No residues of dichlorvos, demethyl dichlorvos, dichloroacetaldehyde, dichloroacetic acid, or dichloroethanol were found in the tissues of the sows and piglets, although the tissues contained ^{l4}C and ^{36}Cl residues ranging from 0.3 to 18.0 mg/kg equivalents. The ^{14}C and ^{36}Cl residues in the tissues were assumed to be due to degradation of the vinyl group in dichlorvos into ^{36}Cl ions and the incorporation of the ^{14}C into normal tissue constituents such as glycine, serine, creatine, glucose, glycogen, fatty acids, cholesterol, choline, lecithin, and ribonucleic acid.

The proposed metabolic pathway of dichlorvos in animals is shown in figure 2.

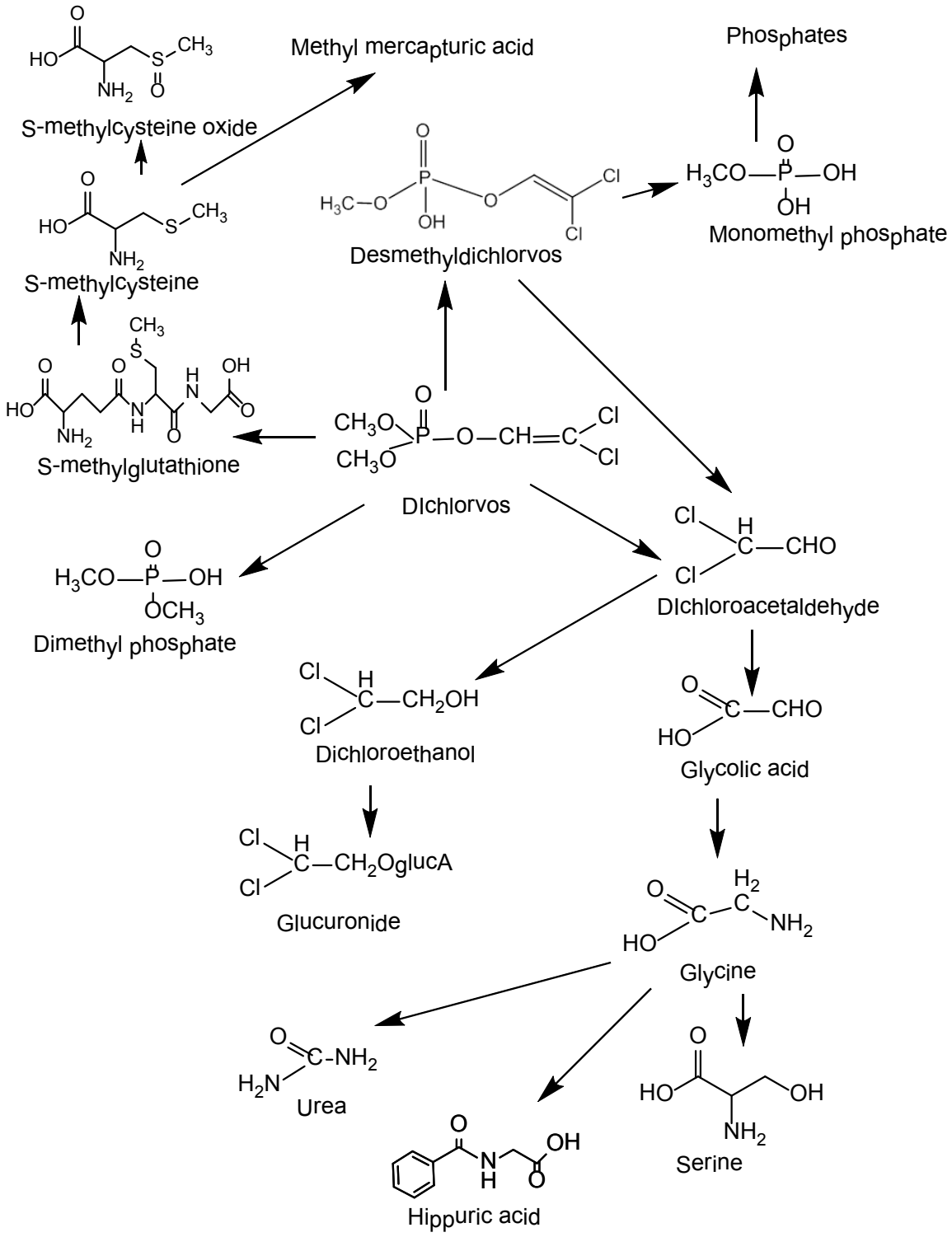


Figure 2 Proposed metabolic pathway of dichlorvos in animals

Plant metabolism

Wheat grains equilibrated to moisture level of 18.0% and 10.6% were topically treated with ^{14}C-dichlorvos (Rowlands 1970). Some of the grains were dissected manually into pericarp, endosperm, and germ, and the total radioactivity in each fraction was determined. Other part of grain was not dissected but were crashed and extracted with (a) chloroform, (b) acetone, (c) saline. The saline

extract and remaining part of the grains extracts were digested with protease and assayed for ^{14}C. The results show that dichlorvos rapidly diminished after the grains saturated and the protein was phosphorylated. Dichlorvos amounted to 24%, 8% and 3% of radioactivity in chloroform 2, 7 and 14 days after treatment. The protease extract did not contain dichlorvos. The dichlorvos degraded to dimethyl phosphate and fairly stable phosphorylated protein derivatives.

^{32}P-labelled trichlorfon and dichlorvos were applied to cotton leaves by petiole injection (Bull and Ridgway 1969). Leaf samples were collected after application then residues extracted by partitioning into chloroform and water. Radioactive resides were identified by two dimensional TLC and comparison against authentic reference materials.

Major components of radioactivity following trichlorfon administration include trichlorfon, phosphoric acid and mono- and di-methyl phosphates. Forty-eight hours after application approximately 35% of applied radioactivity was present as an unidentified metabolite and approximately 28% of applied radioactivity was lost, presumably by volatilisation. Dichlorvos was present in low concentrations amounting to 0.8%, 0.9% and 0.1% of applied dose 1, 24 and 48 hours after trichlorfon administration.

Following dichlorvos application, more than 80% of the applied radioactivity was lost within 48 hours of treatment, presumably due to volatilisation. Dichlorvos was the predominant residue immediately after application (37% of applied radioactivity), but declined to less than 0.1% of applied radioactivity after 48 hours. Dimethyl phosphate was detected at up to approximately 13% of applied radioactivity after 24–48 hours.

The half-lives of dichlorvos degradation were determined in cotton, bean, tomato and potato plants following treatment with ^{32}P-labelled dichlorvos (Dedek *et al*. 1979). The plants, with or without roots, were placed in a formulated 0.1–0.2% ^{32}P-dichlorvos solution or given a foliar application by dipping the whole plants into solutions of the labelled material. Between 60–80% of radioactivity was lost from the plants by volatilisation. In cotton, dichlorvos was degraded with a half-life of 4.6 hours, while half-lives of dichlorvos degradation of 6.8, 4.6 and 6.8 hours were determined for beans, tomatoes and potatoes, respectively. It was stated, without giving full details of characterization, that dimethyl phosphate was the predominant radioactive species identified.

Faba and soya beans of 11% and 12% moisture content were treated with ^{14}C-labelled dichlorvos at 12 mg/kg and 24 mg/kg dose rate (Zayed *et al*., 2007). The well mixed grains were stored for 30 weeks under simulated local storage conditions (relative humidity 65–70% and storage temperature 25–30 ^{o}C). The residues on the seed coat (external extract) were removed with a mixture of water and acetone (3:1). Washed beans were then crushed in a mortar and Soxhlet extracted with 95% methanol for 24 h. The residues were analysed with TLC, HPLC and after removal of 1 cm increments from the TLC plate by LSC.

The surface residues decreased with storage time and amounted to 15–21% of the actual applied dose for both beans by the end of the experiment. The radioactivity in the internal extract increased from 20% to 57% for faba beans and from 36 % to 62% for soya beans in relation to the actual doses of 12 and 24 mg/kg applied, respectively.

Non-extractable residues slowly increased with time, and amounted to 8–10% for faba beans and 9–11% for soya beans of the actual applied doses after 30 weeks. The total recovered radioactivity was over 81% of the applied doses.

Dichlorvos alone was present in the external extracts. In addition to parent dichlorvos, desmethyl-dichlorvos, dimethylphosphate and monomethylphosphate were the main degradation products of ^{14}C-dichlorvos in the internal extract. Desmethyl-dichlorvos could only be extracted after acid hydrolysis indicating that it was present in conjugated form. The isolated metabolites suggested that dichlorvos is degraded in both stored faba and soya beans via two main pathways to give a number of metabolites. The major degradation pathway is cleavage of the P-O-CH3 bond to give desmethyl dichlorvos. Hydrolysis of desmethyl dichlorvos gave monomethyl phosphate. The minor pathway is the hydrolysis of the P-O-vinyl ester linkage to give dimethyl phosphate.

The proposed pathway of metabolism of dichlorvos in plants is shown in Figure 3.

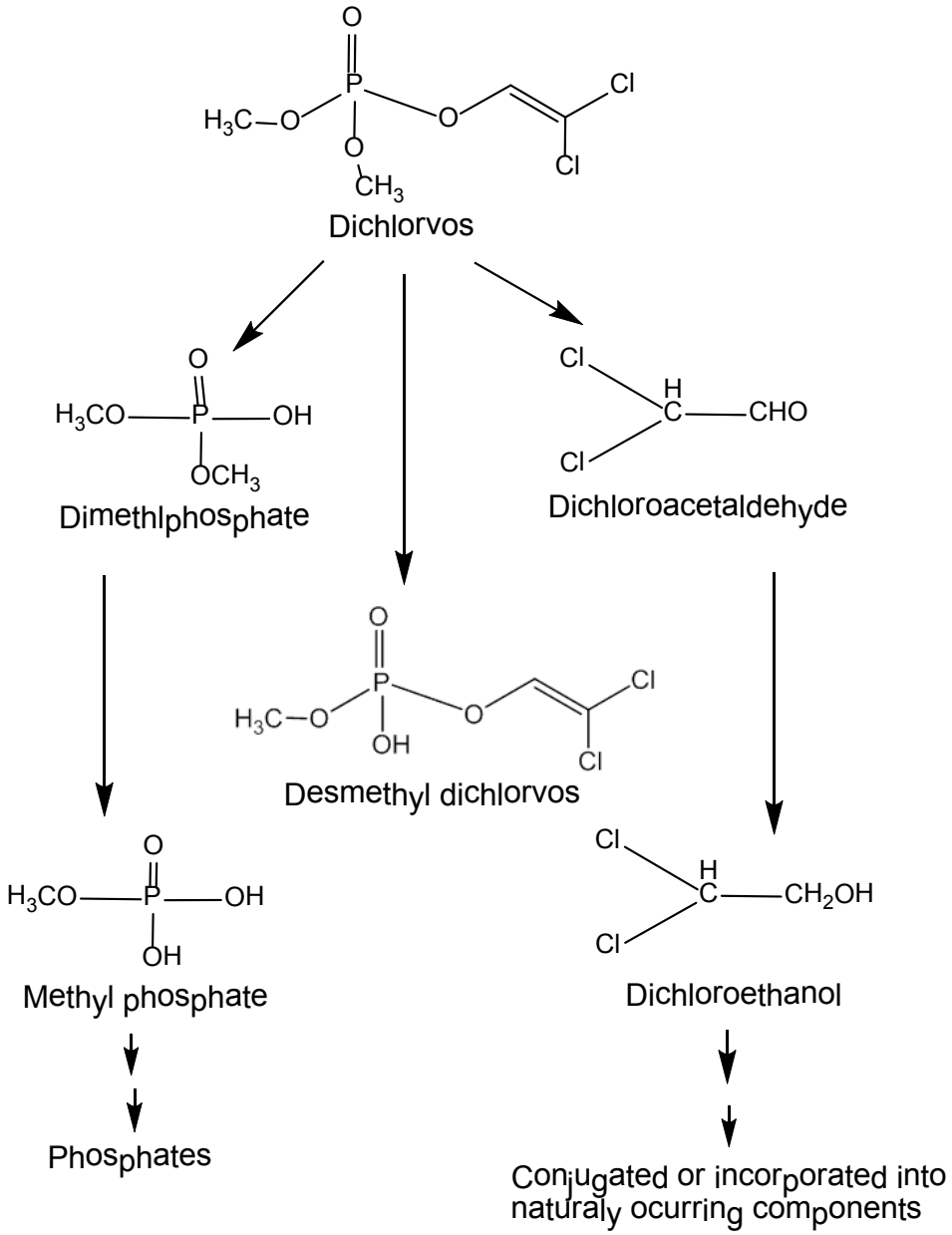


Figure 3 Proposed metabolic pathway of dichlorvos in plants

ENVIRONMENTAL FATE IN SOIL AND WATER

All the uses for dichlorvos evaluated by the present meeting involve indoor or postharvest treatments; therefore, data on environmental fate in soil and water are not relevant.

METHODS OF RESIDUE ANALYSIS

The analytical methods used for the trials are included in the respective reports. A summary of the general analytical method used for the analysis of dichlorvos in various samples is presented below.

Dichlorvos residues in plant materials are extracted by blending the sample with a solution of acetonitrile: water (4:1, v:v). After filtration of the extract, the volume is adjusted to a known level using acetonitrile. The acetonitrile from all sample types is diluted with a brine solution and

partitioned three times against methylene chloride. The methylene chloride extracts are pooled and dried by passing through anhydrous sodium sulphate. The extracts are rotary evaporated just to dryness then re-dissolved in a known volume of gel-permeation chromatography (GPC) solvent. An aliquot of the sample extract is submitted to clean-up using an automated GPC system. The GPC eluates are rotary evaporated just to dryness then brought to volume using isooctane. Dichlorvos in the final extract is quantified by gas chromatography using a flame photometric detector (phosphorous filter, 525 nm band pass).

The method was validated with an LOQ of 0.01 mg/kg. In addition, concurrent recoveries from control samples fortified with known amounts of dichlorvos were shown to be within the acceptable range of 70–120% and a relative standard deviation (RSD) < 20%. Summaries of method validation and concurrent recovery data are presented in Tables 8 and 9 below.

Milk samples were homogenized with a blender and an aliquot was taken and weighed into a screw-cap culture tube containing sodium oxalate. Ethanol was added to the culture tube and mixed; followed by additions of diethyl ether and petroleum ether. After mixing, the culture tube was centrifuged and the organic (top) layer drawn off by a pipette and dried through a small cone of sodium sulphate into a round bottom flask. The sample was extracted twice with ethyl alcohol/ ethyl ether solution (1/1, v/v) and ethyl ether/ petroleum ether solution (1/1; v/v). The organic extracts were dried through sodium sulphate and collected in the same flask. Isooctane was added to the combined organic extracts to aid in the removal of the alcohol. The sample was rotary evaporated just to dryness. The residue was dissolved in methylene chloride/isooctane solution (1/1, v/v), and filtered through a syringe filter. The filtered solution was loaded on a GPC column and the eluates were rotary evaporated to dryness and reconstituted in isooctane. The extracts were analysed by gas chromatography with flame photometric detection, phosphorus mode.

Dichlorvos residues in animal tissue samples were extracted with methylene chloride and after filtration, the samples evaporated to dryness. The residues were transferred and brought to a known volume with GPC solvent. The samples were filtered and processed through automated GPC clean-up. The eluates were evaporated to dryness and reconstituted in isooctane. The extracts were analysed by gas chromatography with flame photometric detection, phosphorus mode.

Residues of dichlorvos in egg samples were extracted with acetone and after filtration the acetone was used to bring the volume to a known amount. An aliquot was diluted with brine and partitioned against methylene chloride. The methylene chloride fractions (containing the dichlorvos residues) were collected through anhydrous sodium sulphate and evaporated to dryness. The residues were re-dissolved in GPC solvent and processed through automated GPC clean-up. The GPC eluates were evaporated to dryness and reconstituted in isooctane. The extracts were analysed by gas chromatography with flame photometric detection, phosphorus mode.

The LOQ for each of the above methods was 0.01 mg/kg for all matrices. Method validation and concurrent recovery data are summarized in Tables 8 and 9 below.

Table 8 Summary of recoveries obtained as part of method validation

Commodity	Fortification mg/kg	n	Range Recovery (%)	Mean recovery (%)	% RSD	Method	Reference
Plant commodities							
Oats	0.01- 0.25	4	96-110	101	5.8	GC-FPD	500-RES-019
Whole groats	0.01- 0.25	4	83-100	92	9.8	GC-FPD	500-RES-019
Flaked oats	0.01- 0.25	4	75-90	80	8.5	GC-FPD	500-RES-019
Whole peanuts	0.01- 1.05	4	91-107	101	7.7	GC-FPD	500-RES-013
Corn	0.01- 0.25	4	82-110	97	15.6	GC-FPD	500-RES-023
Blended cake mix	0.01- 0.5	4	74-81	78	3.9	GC-FPD	500-RES-025
Dried egg	0.01- 0.26	3	91-107	96	9.5	GC-FPD	500-RES-025
Dried milk	0.01- 0.26	2	97-116	106	12.6	GC-FPD	500-RES-025
Sugar	0.05- 0.13	2	89-101	95	8.9	GC-FPD	500-RES-025
Flour	0.01- 0.26	2	85-93	89	6.4	GC-FPD	500-RES-025
Shortening	0.03- 0.26	2	101-115	110	6.4	GC-FPD	500-RES-025

Commodity	Fortification mg/kg	n	Range Recovery (%)	Mean recovery (%)	% RSD	Method	Reference
Animal tissues, milk and eggs							
Milk	0.01- 0.5	6	75-100	89	11.7	GC-FPD	500-RES-015
Muscle	0.01- 0.1	4	80-90	83	5.5	GC-FPD	500-RES-015
Kidney	0.01- 0.1	4	80	80	0	GC-FPD	500-RES-015
Liver	0.01- 0.1	4	70-80	75	5.6	GC-FPD	500-RES-015
Fat	0.01- 0.1	4	70-91	84	12.6	GC-FPD	500-RES-015
Eggs	0.01- 0.5	6	74-110	95	19.9	GC-FPD	500-RES-015
Thigh muscle	0.01- 0.5	6	73-82	79	4.5	GC-FPD	500-RES-016
Breast muscle	0.01- 0.5	6	81-90	84	4.5	GC-FPD	500-RES-016
Poultry kidney	0.01- 0.5	6	70-120	90	22	GC-FPD	500-RES-016
Poultry liver	0.01- 0.5	6	70-85	77	6.8	GC-FPD	500-RES-016
Poultry Fat	0.01- 0.5	6	84-110	97	10.6	GC-FPD	500-RES-016

Table 9 Summary of Concurrent Recovery Data

Commodity	Fortification mg/kg	n	Range Recovery (%)	Mean recovery (%)	% RSD	Method	Reference
Plant commodities							
Oats samples (oats, groats, hulls, steel cut)	0.01- 0.25	14	70-100	90	11.1	GC-FPD	500-RES-019
Oats – steel cut	0.5- 20	3	90-92	91	1.3	GC-FPD	500-RES-019
Oats samples (steel cut, groats, flaked oats)	0.01- 30	7	76-100	91	8.9	GC-FPD	500-RES-021
Peanuts	10.5- 75.5	5	78-97	94	8.6	GC-FPD	500 RES-013
Peanut nutmeat	0.01- 2.9	4	75-87	81	6.0	GC-FPD	500-RES-013
Peanut Meal	0.01- 75	6	95-114	103	7.5	GC-FPD	500-RES-013
Peanut Crude oil	0.01- 1.05	4	76-103	88	14.5	GC-FPD	500-RES-013
Peanut Soapstock	0.01- 1.05	4	86-101	94	8.6	GC-FPD	500-RES-013
Corn oil	0.01-5.0	2	100	100	0	GC-FPD	500-RES-014
Corn starch	0.01- 6	2	80-91	86	9.0	GC-FPD	500-RES-014
Corn meal	0.01- 6	2	73-80	76	13.0	GC-FPD	500-RES-014
Soya bean meal	0.01- 50	4	70-89	82	12.4	GC-FPD	500-RES-014
Soya bean hulls	0.01- 100	4	90-115	`102	12.6	GC-FPD	500-RES-014
Soya bean soapstock	0.01- 1.0	2	91-100	96	6.6	GC-FPD	500-RES-014
Soya bean oil	0.01- 20	3	100-103	102	2.1	GC-FPD	500-RES-014
Whole wheat	0.05-22	4	91-109	99	8.8	GC-FPD	500-RES-014
Wheat bran	0.01- 20	3	92-121	104	15.1	GC-FPD	500-RES-014
Wheat flour	0.05- 2.6	2	75-92	84	14.3	GC-FPD	500-RES-014
Wheat middlings	0.01- 5.3	4	77-98	88	8.4	GC-FPD	500-RES-014
Wheat shorts	0.01- 5.3	5	89-125	100	14.7	GC-FPD	500-RES-014
Whole rice	0.05- 22	2	93-108	100	10.6	GC-FPD	500-RES-014
Rice hulls	0.01- 20	2	70-87	83	6.8	GC-FPD	500-RES-014
Rice bran	0.01- 22	2	80-119	100	27.6	GC-FPD	500-RES-014
Polished rice	0.05- 5	2	102-124	113	13.8	GC-FPD	500-RES-014
Cottonseed	0.01- 96	4	74-118	86	24.5	GC-FPD	500-RES-014
Cottonseed meal	0.01- 22	2	93-94	94	0.7	GC-FPD	500-RES-014
Cottonseed hulls	0.01- 66	2	75-86	80	9,8	GC-FPD	500-RES-014
Cottonseed soapstock	0.01- 1.09	2	72-76	74	3.7	GC-FPD	500-RES-014
Cottonseed oil, crude	0.05- 20	2	75-118	96	31.6	GC-FPD	500-RES-014
Peanuts	0.01- 78	16	77-118	94	13	GC-FPD	500-RES-017
Peanut nutmeat	0.01- 3	6	95-133	106	13.5	GC-FPD	500-RES-017
Ground corn	0.01-5	6	74-110	92	13.7	GC-FPD	500-RES-023
Whole corn	0.01- 0.25	3	70-120	100	26	GC-FPD	500-RES-023
Cereals	0.01- 0.26	4	80-95	87	8	GC-FPD	500-RES-027
Cocoa beans	0.01- 1.05	4	81-98	89	7.8	GC-FPD	500-RES-027
Coffee beans	0.01-1.0	4	72-100	87	7.3	GC-FPD	500-RES-027
Cookies	0.01- 0.26	4	76-99	87	13.8	GC-FPD	500-RES-027

Commodity	Fortification mg/kg	n	Range Recovery (%)	Mean recovery (%)	% RSD	Method	Reference
Crackers	0.01- 0.26	4	72-75	73	1.4	GC-FPD	500-RES-027
Dried beans	0.01-0.25	7	71-110	83	18.1	GC-FPD	500-RES-027
Field corn	0.01- 1.0	4	70-90	82	11	GC-FPD	500-RES-027
Flour	0.01- 0.26	4	74-106	91	16.5	GC-FPD	500-RES-027
Oats	0.01-1.0	4	72-90	79	10..1	GC-FPD	500-RES-027
Peanut nutmeats	0.01- 1.95	2	81-94	88	10.3	GC-FPD	500-RES-027
Soya beans	0.01- 1.0	4	70-76	72	4.2	GC-FPD	500-RES-027
Sugar	0.01- 0.26	4	78-84	82	3.7	GC-FPD	500-RES-027
Tree nuts	0.01- 0.25	4	76-80	79	2.5	GC-FPD	500-RES-027
Whole peanuts	0,01- 10.5	6	69-100	85	14.1	GC-FPD	500-RES-027
Cocoa beans	0.01- 0.26	2	102-106	104	2.7	GC-FPD	500-RES-029
Coffee beans	0.01- 2.0	3	70-96	81	16.7	GC-FPD	500-RES-029
Dried beans	0.01-2.0	4	70-84	77	7.7	GC-FPD	500-RES-029
Field corn	0.01- 1.0	2	80-110	95	22	GC-FPD	500-RES-029
Flour	0.01- 10.5	4	94-109	102	6.0	GC-FPD	500-RES-029
Oats	0.01- 1.0	2	80-82	81	1.7	GC-FPD	500-RES-029
Soya beans	0.01- 0.25	3	70-88	79	11.4	GC-FPD	500-RES-029
Sugar	0.01- 1.05	2	82- 89	86	5.7	GC-FPD	500-RES-029
Tree nuts	0.01- 0.25	2	72- 100	86	23	GC-FPD	500-RES-029
Wheat	0,01- 1.0	2	90- 92	91	1.5	GC-FPD	500-RES-029
Animal tissues, milk and eggs							
Milk	0.01- 0.2	26	70- 100	81	9.8	GC-FPD	500-RES-015
Muscle	0.01- 0.1	2	80- 89	85	7.5	GC-FPD	500-RES-015
Kidney	0.01- 0.1	2	80- 83	82	2.6	GC-FPD	500-RES-015
Liver	0.01- 0.1	2	77- 80	79	2.7	GC-FPD	500-RES-015
Fat	0.01- 0.1	2	80- 85	83	4.3	GC-FPD	500-RES-015
Eggs	0.01- 0.25	24	73-115	84	10	GC-FPD	500-RES-015
Thigh muscle	0.01- 0.04	2	70- 78	74	7.6	GC-FPD	500-RES-016
Breast muscle	0.01- 0.05	2	80- 98	89	14..3	GC-FPD	500-RES-016
Poultry kidney	0.01- 0.05	2	90	90	0	GC-FPD	500-RES-016
Poultry liver	0.01- 0.05	2	78- 100	89	17.4	GC-FPD	500-RES-016
Poultry Fat	0.01- 0.1	2	84-90	87	4.9	GC-FPD	500-RES-016

Adequate enforcement analytical methods are available in PAM I and II. Dichlorvos is recovered by PAM I Luke multiresidue method (protocol D), provided “early eluter” conditions are used. The Pesticide Analytical Manual (PAM) Vol. II lists a GC method (Method I) with flame photometric detection for the determination of dichlorvos in plant and animal commodities. An additional GC method (Method II) using electron capture detection is listed for the determination of dichlorvos in plant and animal commodities. A gas chromatography method using microcoulometric detection is listed as Method A. This method determines residues of dichlorvos.

Dichlorvos residues can also be determined with the widely used QuEChERS method (Lehotay et al 2005a and 2005b) applying LC/MS/MS and GCMS/MS which were validated for various fruits and vegetables, and meat, milks and eggs representing the commodity groups which should be included in the validation protocol of multi residue methods (DG SANCO, 2009)

Stability of residues in stored analytical samples

Peanuts

A study was carried out in 1993 where the stability of residues of dichlorvos in bulk stored peanuts was investigated (Report 500-RES-018). Peanut samples were obtained from a facility which was treated for 9 months at the daily rate of 18 g ai/1000 m^3) air space. Two sets of samples of peanuts, taken on the eighth month of treatment, were frozen at -20 ºC. The maximum period of storage prior to analysis of all the bulk peanut samples in the facility was 134 days

For the frozen storage stability study, the peanut samples were analysed for residues of dichlorvos. Each analytical set included control and fortified-control matrices which were analysed

parallel with the samples. The results, shown in Table 10, demonstrate that residues of dichlorvos in peanuts and other high oil content commodities are stable up to 136 days under frozen conditions.

Table 10 Residues of dichlorvos in peanuts following storage at -20 ºC

Period of storage (days)	Dichlorvos residues (mg/kg) (Mean)	% residues remaining	Concurrent recovery (%)		
			Fortification (mg/kg)	% Recovery	Mean %
0	2.07, 2.51, 2.38 (2.32)	100	79 79	93 89	91
39	2.44, 2.29 (2.37)	102	0.01 10.3	134 94	114
136	2.15, 2.40, 2.51 (2.35)	101	0.01 10.3	128 101	114
0	4.43, 4.30 (4.36)	100	79 79	93 89	91
39	3.59, 8.44* (3.59)	82	0.01 10.3	134 94	114
74	3.71, 2.36 (3.04)	70	0.01 10.3	101 86	94
136	3.11, 3.89, 4.63 (3.88)	89	0.01 10.3	128 101	114

* Not included in calculations.

Winter wheat of about 12% moisture content was transferred to storage bins of about 3.5 m^3 with a wide-belt conveyor and treated at a 15 mg/kg calculated deposit rate (Vardell, 1973). After storage at + 27 °C for one week, the bins were stored at ambient temperature for 16 weeks. The monthly average temperatures during the period of the test were 18, 12.7, 8.7, 8.0, and 10.8 °C. The stored wheat was sampled after 0, 0.5 weeks and then at weekly intervals up to 12 weeks and analysed. At each sampling occasion a portion of the wheat was placed in a closed container and stored at -18 °C for three months. The residues measured in samples at various storage intervals are shown in Table 11.

Table 11 Residues of dichlorvos in wheat following storage at ambient and -18 ºC temperature

Sampling time (weeks after treatment)	Dichlorvos residues [mg/kg]		Percentage remaining
	When collected at sampling time indicated	After storage for 3 months at -18 °C	
0	4.6	4.1	89%
0.5	3.0	1.6	53%
1	1.3	1.2	92%
2	1.1	0.8	73%
3	0.9	1.3	144%
4	0.9	0.4	44%
5	0.7	0.6	86%
6	0.4	0.7	175%
8	0.7	0.4	57%

Wheat grains moisture was adjusted to 9.3%, 11.1%, 12.9% and 13.7% wet basis and treated with diluted EC formulation of dichlorvos at a nominal initial concentration of 50 mg/kg. After thorough mixing the treated grains were place in screw cap jars and stored at - 15 ºC. After 11 month of storage the remaining dichlorvos residues were 49 mg/kg, 43 mg/kg, 34 mg/kg and 34 mg/kg, respectively (Minett and Belcher, 1970).

The commodities evaluated by the present Meeting were also frozen immediately after collection and maintained frozen at about -20ºC until analysis. The samples from studies 500-RES-019, 500-RES-023, 500-RES-026 and 500-RES-028 were analysed within 30 days, for study 500-RES-029 within 31 and 70 days, and for study 500-RES-014 between 55 and 122 days. The stability of residues in commodities for which residue levels could be estimated were supported by the reported storage stability tests

USE PATTERN

Dichlorvos is registered worldwide for a variety of uses. Since the last review by JMPR, there have been considerable changes in the use pattern of dichlorvos. Currently, the major use of dichlorvos is as a postharvest fumigant for control of various pests in food and feed handling establishments, in farm animal production facilities and in bulk food storage facilities. In this section only the postharvest uses for which supervised trials are available, are considered. These uses include treatment in storage areas for bulk, packaged and bagged raw and processed agricultural commodities, and in food manufacturing/processing plants. The details of the postharvest use patterns are summarized in Table 12.

Table 12 Summary of post-harvest uses of dichlorvos

Country	Situation	Pests controlled	Formulation	Rate	Remarks
Australia	Stored cereal grains	Stored grain pests including flat grain beetle, rust red flour beetle, confused flour beetle, saw-toothed grain beetle, granary weevil, rice weevil	1140 g ai/L EC	6 g ai/ton grain	Apply by surface spray in auger or conveyor ; or as fumigant Do not use treated grain for human consumption or animal feed within 7 days of treatment
				12 g ai/ton grain	Apply by surface spray in auger or conveyor or as fumigant. Do not use treated grain for human consumption or animal feed within 28 days of treatment
Australia	Food factories, stores, mills, warehouses	Carpet beetles, ants, spiders, silverfish, cockroaches, flies, warehouse beetles, Mediterranean flour moth, saw-tooth grain beetle	500 g ai/L EC	70 g ai/1000 m^3 or 3.5 g ai/50 m^2	Apply as a fog
Australia	Stored grain	Topical warehouse moth	500 g ai/L EC	25 g ai/100 m^2	Apply as surface spray
Australia	Bagged and stored potatoes	Potato tuber moth	500 g ai/L EC	10g ai/16 bags	Apply as surface spray
Canada	Food processing plants, industrial plants, warehouses	Confused flour beetle, cocoa been moth, fruit flies, flour beetle, gnats, rice weevil, wasps	200 g ai/L oil concentrate	15-35 g ai/ 1000 m^3	Apply as a fog. As often as needed, but not more often than once a week.

Country	Situation	Pests controlled	Formulation	Rate	Remarks
USA	Food warehouses, silos, bulk bins, food/feed processing/ manufacturing, le storage plants containing non-perishable raw and processed agricultural commodities, bagged, packed, and bulk food commodities.	Stored product insects: Granary weevils, rice weevils, yellow meal worm, moths, confused flour beetles, silverfish, water bugs, ants, spiders, silverfish, cocoa bean moth, saw-toothed beetle,	20% aerosol	15-~70 g ai/1000 m^3	Use only with automatic application device; Apply as a fog. Keep minimum of 7 day intervals between applications except on cocoa beans and whole peanuts where daily applications should not exceed 17.7 g ai/1000 m^3 of head space. If bulk unpacked food/feed are exposed remove or cover before treatment begins.

Residues in stored products

Studies (coded as 500-RES-XXX), submitted by the manufacturer for consideration by the present Meeting involve:

- Treatment of non-perishable raw or processed agricultural commodities that are bagged, packed or stored in bulk in warehouses; or
- Treatment of commodities in food manufacturing/processing facilities.

In all the trials, dichlorvos was applied by fogging, using either commercially available equipment or ready to use aerosol canisters. Although the application details varied in each facility, the general procedures were similar.

Following collection of a sample, the sample container with re-sealable lid was placed into a cooler containing blue ice before transfer to a freezer. Samples were immediately frozen after collection, shipped frozen and maintained in frozen conditions at -20 ºC until analysis.

All samples were analysed using the method, described in section on Methods of residue analysis, which had been validated with an LOQ of 0.01 mg/kg. Concurrent recoveries from control samples fortified with dichlorvos and analysed together with the treated samples were within the acceptable range of 70–120% and RSD < 20%.

The relevant conditions of the studies reported in the scientific literature are summarized for each report.

Trials on bagged and packaged commodities treated according to US GAP

The US GAP specifies minimum of 7 day intervals between applications at 15-70 g ai/1000m^3 except on cocoa beans and whole peanuts where daily applications should not exceed 18 g ai/1000 m^3 of head space. Bulk unpacked food and feed should be removed or covered before the treatment begins. The US GAP does not specify the pre-harvest intervals.

Study 1

During 1992 a simulated warehouse trial was carried out in USA to determine dichlorvos residues in or on food resulting from treatments at the maximum label rate of 70 g ai/1000 m^3 (Report 500-RES-027).

The test site was a single-floor facility which provided a large unobstructed area that could be used to simulate a commercial warehouse. During the conduct of the study, the walls and ceiling of the simulated warehouse were lined with plastic sheeting to reduce loss of the test material following application. One window was not covered with sheeting to allow for an unobstructed view of the fogger during application. The final dimensions of the simulated warehouse were 11.3 m × 17.4 m × 2.4 m. Commodities were arranged inside the simulated warehouse on pallets, stocked from 4 to 7 tiers high, depending on the size of the packed or bagged material. All materials remained on pallets in their original commercial packaging, except any shrink film was removed from a pallet of material prior to application. The overall temperature during the course of the study ranged from 7 to 17 ºC.

The test site received four sequential applications of dichlorvos, formulated as a 5% PrL, using a commercial fogger. The four applications were made at one week intervals at the nominal maximum GAP rate of 35 g ai/1000 m^3 for each application. Thirteen commodities (cereal, cocoa beans, coffee beans, cookies, crackers, dried beans, field corn, flour, oats, peanuts, soya beans, sugar and walnuts) representative of materials routinely stored in a warehouse were selected for evaluation to provide data on typical residues to be expected following storage at the facility.

Pre-treatment samples were collected prior to application of the test substance. The sampling technique used for an individual commodity varied depending on the size and nature of the packaging.

Collection of post-application samples began approximately six (6) hours after each application. Samples were collected from the top layer of a pallet following all applications as well as immediately prior to the fourth application. After collection of samples following the first three applications, the packaging was resealed and left on the pallet in order to maintain the same pallet size/integrity. Subsequent samples were not removed from a case that had been sampled previously. After collection of the top layer samples from the fourth application, an additional series of samples representative of commodities from the interior and side of the pallet were also collected. The interior and side samples were collected by removing the top layer(s) of samples and collecting samples from the lower tier of packages or bags. Replicate samples were removed from individual outer packages located on opposite sides of the pallet.

The maximum storage period for all samples from collection to analysis ranged from 30 to 32 days. The residues measured in replicate samples and average residues given in brackets are summarized in Table 13.

Table 13 Dichlorvos residues in packed and bagged commodities following 4 fogging treatments of storage facility at 70 g ai/1000 m^3 at weekly intervals 500-RES-027

Country, Year	Sample	Sampling after treatment	Dichlorvos residue, mg/kg (Mean)
Missouri, USA, 1992	Cocoa beans	0	< 0.01, < 0.01 (< 0.01)
		T1- top	< 0.01, < 0.01, (< 0.01)
		T2- top	< 0.01, < 0.01 (< 0.01)
		T3- top	0.01, < 0.01 (< 0.01)
		T4- top	0.01, < 0.01 (< 0.01)
		T4- side	0.01, < 0.01 (< 0.01)
		T4- interior	0.01, < 0.01 (< 0.01)
	Coffee beans	0	< 0.01, < 0.01 (< 0.01)
		T1- top	0.06, 0.09 (0.08)
		T2- top	0.41, 0.02 (0.22)
		T3- top	0.14, 0.16 (0.15)
		T4- top	0.18, 0.68 (0.43)
		T4- side	0.11, 0.06 (0.09)
		T4- interior	0.03, < 0.01 (0.02)

Country, Year	Sample	Sampling after treatment	Dichlorvos residue, mg/kg (Mean)
	Cookies	0	< 0.01, < 0.01 (< 0.01)
		T1- top	< 0.01, < 0.01 (< 0.01)
		T2- top	0.01, 0.03 (0.02)
		T3- top	< 0.01, < 0.01 (< 0.01)
		T4- top	0.07, 0.04 (0.06)
		T4- side	0.03, < 0.01 (0.02)
		T4- interior	0.01, < 0.01 (0.01)
	Crackers	0	< 0.01, < 0.01 (< 0.01)
		T1- top	< 0.01, < 0.01 (< 0.01)
		T2- top	0.01, 0.03 (0.02)
		T3- top	0.07, 0.03 (0.05)
		T4- top	0.30, 0.03, (0.17)
		T4- side	0.32, 0.26 (0.29)
		T4- interior	< 0.01, < 0.01 (< 0.01)
	Dried beans	0	< 0.01, < 0.01 (< 0.01)
		T1- top	0.02, < 0.01 (0.02)
		T2- top	0.05, 0.05 (0.05)
		T3- top	0.04, 0.03 (0.04)
		T4- top	0.07, 0.16 (0.12)
		T4- side	0.08, 0.16 (0.12)
		T4- interior	< 0.01, < 0.01 (< 0.01)
	Soya beans	0	< 0.01, < 0.01 (< 0.01)
		T1- top	< 0.01, < 0.01 (< 0.01)
		T2- top	0.03, 0.01 (0.02)
		T3- top	0.06, 0.05 (0.06)
		T4- top	0.16, 0.10 (0.13)
		T4- side	0.04, 0.10 (0.07)
		T4- interior	< 0.01, 0.02 (0.02)
	Sugar	0	< 0.01, < 0.01 (< 0.01)
		T1- top	0.05, 0.01 (0.03)
		T2- top	0.04, 0.01 (0.03)
		T3- top	0.04, 0.02 (0.03)
		T4- top	0.05, 0.02 (0.04)
		T4- side	0.03, 0.03 (0.03
		T4- interior	0.01, 0.03 (0.02)
	Walnut, shelled	0	< 0.01, < 0.01 (< 0.01)
		T1- top	< 0.01, < 0.01 (< 0.01)
		T2- top	< 0.01, < 0.01 (< 0.01)
		T3- top	< 0.01, < 0.01 (< 0.01)
		T4- top	< 0.01, < 0.01 (< 0.01)
		T4- side	< 0.01, < 0.01 (< 0.01)
		T4- interior	< 0.01, < 0.01 (< 0.01)
	Cereals (Cheerios brand)	0	< 0.01, < 0.01 (< 0.01)
		T1- top	< 0.01, < 0.01 (< 0.01)
		T2- top	< 0.01, < 0.01 (< 0.01)
		T3- top	< 0.01, < 0.01 (< 0.01)
		T4- top	< 0.01, 0.01 (0.01)
		T4- side	0.02, < 0.01 (0.02)
		T4- interior	< 0.01, < 0.01 (< 0.01)

Country, Year	Sample	Sampling after treatment	Dichlorvos residue, mg/kg (Mean)
	Field corn	0	< 0.01, < 0.01 (< 0.01)
		T1- top	0.07, 0.09 (0.08)
		T2- top	0.35, 0.32 (0.34)
		T3- top	0.54, 0.78 (0.66)
		T4- top	0.6, 0.58 (0.59)
		T4- side	< 0.01, 0.15 (0.08
		T4- interior	< 0.01, < 0.01 (< 0.01)
	Flour	0	< 0.01, < 0.01 (< 0.01)
		T1- top	0.07, 0.04 (0.06)
		T2- top	0.21, 0.62 (0.42)
		T3- top	0.57, 0.32 (0.45)
		T4- top	0.14, 0.12 (0.13)
		T4- side	0.16, 0.13 (0.15)
		T4- interior	< 0.01, < 0.01 (< 0.01)
	Oats	0	< 0.01, < 0.01 (< 0.01)
		T1- top	0.03, < 0.01 (0.02)
		T2- top	0.23, 0.25 (0.24)
		T3- top	0.37, 0.39 (0.38)
		T4- top	0.69, 0.61 (0.65)
		T4- side	0.02, 0.17 (0.09)
		T4- interior	0.02, < 0.01 (0.02)
	Peanuts	0	< 0.01, < 0.01 (< 0.01)
		T1- top	0.38, 0.49 (0.44)
		T2- top	1.05, 0.29 (0.67)
		T3- top	0.52, 0.69 (0.61)
		T4- top	0.97, 1.48 (1.23)
		T4- side	0.08, 6.89 (3.49)
		T4- interior	3.84, 0.32 (2.1)
	Nutmeat	T4- top	0.02, 0.05 (0.04)
		T4- side	< 0.01, 0.55 (0.28)
		T4- interior	0.28, 0.03 (0.16)

Study 2

A study was conducted in a warehouse of the Georgia Ports Authority located near Savannah (GA, USA) to determine the residues deposited on various packaged commodities exposed to weekly applications of dichlorvos, and the biological efficacy of dichlorvos applications (500-RES-045). The warehouse measured 30.5 × 27.5 × 4.3 m with a total capacity of 3570 m^3.

The commodities used in the tests were wheat flour, polished rice, granulated sugar, white beans, raisins, egg noodles, and shelled peanuts. Except for the rice, the commodities were in conventional packages normally used for domestic shipment and storage. The rice was held in water-resistant, multiwall-paper baler bags of the type used by the Navy for ocean shipment. The commodities were stacked on 6 × 1 × 9 × 2 m wooden pallets in 5 locations in the warehouse. A vapour dispenser was used to introduce the dichlorvos vapour. The dispenser was operated continuously for 6 h after working hours. Dichlorvos was applied weekly for 21 weeks at a rate of about 53 g/1000 m^3. Samples were collected before applications 2, 8 and 16 and after applications 1, 3, 5, 9, 13, 17 and 21.

The extent of the distribution and concentrations of dichlorvos vapour in the warehouse were determined based on the total phosphorus per volume of sample. Dichlorvos residues in the

commodities and on the packaging materials were determined by an enzyme inhibition-spectrophotometric method with an LOQ of 0.1 mg/kg. The residues measured on the package surface and in the packed commodities are summarized in Table 14.

Table 14 Average dichlorvos residue on packaging materials and in commodities just after weekly applications of dichlorvos vapour at about 53g ai/1000 m^3 in a 3570 m^3 warehouse

		Dichlorvos residues			
		Top unit		Bottom unit	
Commodity	No. of applications	Package surface µg/dm^2	Commodity bland mg/kg	Package surface µg/dm^2	Commodity bland mg/kg
Beans	1	85.7	< 0.1	0.8	< 0.1
	3	56.5	< 0.1	1.1	< 0.1
	5	49.5	< 0.1	1.0	< 0.1
	9	58.8	< 0.1	0.1	< 0.1
	13	87.0	< 0.1	0.8	< 0.1
	17	94.9	< 0.1	0.9	< 0.1
	21	121.4	< 0.1	1.4	< 0.1
Flour (45.4 kg)	1	65.6	< 0.1	1.3	< 0.1
	3	85.1	< 0.1	1.5	< 0.1
	5	81.8	< 0.1	1.4	< 0.1
	9	106.1	< 0.1	0.3	< 0.1
	13	176.5	< 0.1	0.6	< 0.1
	17	155.0	< 0.1	0.3	< 0.1
	21	193.8	0.1	0.2	0.1
Flour (22.7 kg)	1	48.4	< 0.1	0.4	< 0.1
	3	59.7	< 0.1	1.5	< 0.1
	5	51.1	< 0.1	0.3	< 0.1
	9	74.9	< 0.1	0.1	< 0.1
	13	122.3	< 0.1	0.6	< 0.1
	17	106.1	< 0.1	0.1	< 0.1
	21	127.0	0.1	0.9	< 0.1
Noodles	1	98.O	< 0.1	16.1	< 0.1
	3	87.7	< 0.1	11.4	< 0.1
	5	59.2	< 0.1	9.8	< 0.1
	9	137.8	< 0.1	9.4	< 0.1
	13	174.4	< 0.1	16.4	< 0.1
	17	120.6	< 0.1	13.1	< 0.1
	21	163.6	< 0.1	17.8	< 0.1
Peanuts	1	119.7	0.1	2.0	0.2
	3	142-l	0.2	1.5	0.2
	5	143.2	0.3	1.4	0.2
	9	241.1	1.1	2.7	0.3
	13	301.4	0.7	6.8	0.5
	17	294.9	1.1	0.9	0.6
	21	419.8	1.6	0.6	0.8

Raisins, rice and sugar samples did not contain detectable residues just after dichlorvos applications.

Only the peanut samples taken before 2, 8 and 16 applications contained residues which were 0.1, 0,2 and 1.0 mg/kg in the blended samples taken from the top of the piles, while samples taken from the bottom contained < 0.1, 0.2 and 0.4 mg/kg, respectively.

Study 3

A study was conducted in USA during 1993 at a simulated warehouse to determine dichlorvos residues in or on food resulting from treatment of the establishment with dichlorvos at the maximum labelled rate of 70 g ai/1000 m^3 (Report 500-RES-029). The air temperature at the time of application ranged from 7.2 to 10 ºC measured at floor height to 10 to 12 °C measured at a height of four feet.

The materials selected for the study included cocoa beans, coffee beans, dried beans, field corn, flour, oats, soya beans, sugar, tree nuts (walnuts) and wheat. The contents from commercial sized bags were emptied into individual cardboard tote bins measuring 1.22 m × 1.22 m × 1.22 m. After the tote bins had been filled, the surface area within the bins was divided into 4 to 16 subsections depending on the number of samples to be collected. Wire mesh baskets approximately 1.2 m tall and 7.5 cm in diameter were partially filled with walnuts prior to placement in the tote bin. The cages were suspended in the tote bin while the rest of the walnuts were added.

In addition to samples placed in open tote bins, another series of representative samples were placed in tote bins then covered with plastic sheeting. The plastic sheeting used was a clear polyethylene plastic of 4 mm thickness. The surface area of the closed bins was subdivided into four subsections. The tote bins were arranged in three rows with the closed totes positioned next to the open totes for the respective commodities.

Post-application samples were collected within a day of application. The majority of study samples were collected using a brass probe (grain thief). However, replicate walnut samples were obtained by removing two adjacent wire mesh baskets from the tote bin. The baskets were individually removed and inverted to empty the contents into a pre-labelled residue can. The maximum storage period for all samples from collection to analysis ranged from 31 to 70 days. The results are summarized in Table 15.

Table 15 Dichlorvos residues in bulk commodities following fogging treatment of storage facility with 70 g ai/1000 m^3 applying 5% PrL formulation in the USA (500-RES-029)

Country Year	Sample	Sampling position	Dichlorvos residue, mg/kg (Mean)
Missouri, USA, 1993	Cocoa beans	0	< 0.01, < 0.01 (< 0.01)
		6 (open)	0.02, < 0.01 (0.02)
		6 (closed)	< 0.01, < 0.01 (< 0.01)
	Coffee beans	0	< 0.01, < 0.01 (< 0.01)
		6 (open)	1.4, 1.85 (1.63)
		6 (closed)	0.02, 0.02 (0.02)
	Dried beans	0	< 0.01, < 0.01 (< 0.01)
		6 (open)	0.8, 0.86 (0.83)
	Soya beans	0	< 0.01, < 0.01 (< 0.01)
		6 (open)	0.31, 0.44 (0.38)
		6 (closed)	< 0.01, < 0.01 (< 0.01)
	Sugar	0	< 0.01, < 0.01 (< 0.01)
		6 (open)	0.41, 0.31 (0.36)
		6 (closed)	< 0.01, < 0.01 (< 0.01)
	Walnuts	0	0.01, < 0.01 (< 0.01)
		6 (open)	0.01, < 0.01 (< 0.01)
	Wheat	0	< 0.01, < 0.01 (< 0.01)
		6 (open)	0.30, 0.23 (0.27)
	Oats	0	< 0.01, < 0.01 (< 0.01)
		6 (open)	0.73, 0.99 (0.86)
	Field corn	0	< 0.01, < 0.01 (< 0.01)
		6 (open)	0.84, 0.44 (0.64)
		6 (close)	< 0.01, < 0.01 (< 0.01)
	Flour	0	< 0.01, < 0.01 (< 0.01)

Country Year	Sample	Sampling position	Dichlorvos residue, mg/kg (Mean)
		6 (open)	0.29, 0.50 (0.40)
		6 (close)	0.02, 0.01 (0.02)

Studies complying with Australian GAP

In Australia dichlorvos can be used as surface spray or fumigant for protection of stored grains applying EC formulation at 6 g ai /ton grain or 12 g ai/tonne grain with withholding periods of 7 and 28 days respectively. It can also be applied as fog at 70 g ai/1000 m^3 or 3.5 g ai/50 m^2.

Study 4

In laboratory scale experiments wheat (*ca.* 1 kg samples) was treated with dichlorvos (1140 g/L EC) at 6 and 12 mg ai/kg then stored at 0, 20 or 30°C for up to 8 weeks in closed screw cap jars. Recovery of dichlorvos at 0.95–9.48 mg/kg spike level ranged from 82–110%. Further details of the analytical methods used were not provided. Residues are summarized in Table 16.

Table 16 Dichlorvos residues in/on stored wheat following treatments at 6 g/t and 12 g/t rate

Rate (g ai/t)	Storage temp (°C)	Dichlorvos residues (mg/kg) after storage (weeks)				
		0	1	2	4	6
6	NS*	4.4	4.1	5.0	1.3	
6	20	5.0	2.8	1.2	0.5	0.3
6	30	5.0	0.7	0.1		
12	NS*	8.4	7.2	2.2	2.2	0.4
12	20	12.3	4.7	4.7	1.4	
12	30	12.3	2.0	2.0		0.5

* NS = not specified

Paddy rice

Study 5

Fate of dichlorvos residues on stored paddy rice was studied at commercial rice storage facilities and laboratory scale experiments in Australia (Anonym). Dichlorvos was applied to paddy rice at 6 or 12 g ai/tonne then stored for up to 28 days after application, and samples were taken at various times during the storage period and analysed for dichlorvos residues. The results from the four trials are summarized in Table 17.

Table 17 Dichlorvos residues in/on paddy rice following treatments at 6 g/t and 12 g/t rate

Trial location	Rate	Dichlorvos residues (mg/kg) and WHP (days)							
		0	3-4	7	11-13	16-17	20-22	24	27-28
Griffith depot	12 g/t	11.4	11.6	4.1	7.4	12.1	7.0	5.8	5.2
Walsh depot	12 g/t	3.6	2.6	2.5	5.3		2.4	2.0	2.8
Lab 1	12 g/t	6.4	5.3	4.6	3.2	2.8	1.9		1.9
Lab 2	6 g/t	5.1	3.8	2.9					

Study 6

Dichlorvos was applied as a direct spray application with diluted EC formulation at 5, 10 and 15 mg/kg paddy rice in a jar and small bin tests (McGoughey 1970). All samples were held at 27 °C and 60% relative humidity. The results are summarized in Table 18.

Table 18 Dichlorvos residues in/on paddy rice following treatments with dichlorvos

Application rate [mg/kg]	Dichlorvos residues [mg/kg] in paddy rice at days after application			
	1	10	20	30
5	1.6	0.90	0.38	0.22
10	4.6	1.1	1.5	0.77
15	7.3	3.0	2.7	0.87

Trials on unpacked and bulk commodities which do not comply with current US GAPs

Peanuts

The study was conducted in1992 at a commercial warehouse in Georgia USA to determine residues of dichlorvos in whole peanuts, nutmeats, and other fractions (Report 500-RES-013). The test site was selected as a representative facility routinely involved in peanut storage.

The stored peanut received 88 headspace applications of dichlorvos, using commercial foggers with 20% PrL formulation, during the three month storage period. The applications were made at a rate of 18 g ai/1000 m^3. For the processing part of the study, a 47× rate was used (843 g ai/1000 m^3). The air temperature at the time of application ranged from 10 to 20 °C at a height of 1.22 m.

Samples were collected prior entry to the warehouse and after three months of dichlorvos exposure (88) treatments. Additional sample was collected before and after the exaggerated rate treatment. The results are summarized in Table 16.

In a separate study on peanuts in a commercial warehouse in Georgia in 1992, the facility was treated with 20% dichlorvos PrL contained within three fogging canisters hung above the peanut pile and continued on a daily basis for the duration of the peanut storage period (500-RES-017). The test site received 273 applications of dichlorvos varying from 18 to 22.5 g ai/1000 m^3 over the approximately nine month period of storage. The applicators were set to release daily at approximately 6:00 p.m. At application, air temperatures ranged from 1 ^oC to 39 ºC.

Peanut samples were collected monthly for the nine month storage period from randomly selected positions on the surface (0–7.5 cm) of the peanut pile. In addition, subsurface samples were collected from depths of approximately 15, 30, 45 and 90 cm depth after 1, 3, 5, 7 and 9 months of storage. Results of the trial are included in Table 19.

Table 19 Dichlorvos residues (average values in brackets) in whole uncovered peanuts following fogging treatment with 20% PrL formulation in bulk storage facility

Country Year (facility)	Sample	Application Rate g ai /1000 m^3	Sampling intervals (months)	Dichlorvos residue, mg/kg, (Mean)	Ref
Georgia, USA 1992 (Food processing facility)	Peanuts	18	0 3	ND 18, 54 (36)	500-RES-013
Georgia, USA, 1992 (Bulk storage warehouse)	Peanuts (0-7.5 cm depth samples)	18-22.5	0 1 2 3 4 5 6 7 8 9	< 0.01, < 0.01 < 0.01) 0.46, 0.19 (0.33) 0.38, 1.33 (0.86) 1.64, 2.27 (1.96) 46, 34.7 (40) 14.5, 3.51 (9.0) 2.27, 14.95 (8.61) 2.62, 5.36 (3.99) 2.32, 4.36 (3.34) 1.19, 0.92 (1.06)	500-RES-017

Country Year (facility)	Sample	Application Rate g ai /1000 m^3	Sampling intervals (months)	Dichlorvos residue, mg/kg, (Mean)	Ref
	Peanuts (15 cm. depth samples)		1 3 5 7 9	1.03, 0.13 (0.58) 0.03, 0.03 (0.03) 0.04, 1.41 (0.73) 3.47, 1.74 (2.6) 0.78, 0.88 (0.83)	
	Peanuts (30 cm. depth samples)		1 3 5 7 9	0.02, 0.01 (0.02) < 0.01, < 0.01 (< 0.01) 0.014, 0.44 (0.23) 0.24, 0.41 (0.33) 0.05, 0.07 (0.06)	
	Peanuts (45 cm. depth samples)		1 3 5 7 9	0.01, 0.02 (0.02) < 0.01, < 0.01 (< 0.01) < 0.01, 0.03 (0.02) 0.02, 0.19 (0.02) 0.02, 0.02 (0.02	
	Peanuts (90 cm. depth samples)		3 5 7 9	< 0.01, < 0.01 (< 0.01) 0.01, < 0.01 (< 0.01) 0.01, < 0.01 (< 0.01) 0.01, < 0.01 (< 0.01)	500-RES-017
	Nutmeat (0-7.5 cm. depth samples)		0 1 2 3 4 5 6 7 8 9	< 0.01, < 0.01 (< 0.01) 0.01, < 0.01 (< 0.01) 0.03, 0.09 (0.06) 0.01, 0.08 (0.05) 0.75, 0.72 (0.74) 2.73, 0.21 (1.47) 0.16, 0.40 (0.28) 0.29, 0.59 (0.44) 0.32, 0.72 (0.52) 0.20, 0.16 (0.18)	500-RES-017

Trials in food manufacturing/processing plants

Four trials were conducted in food manufacturing/processing plants (two on oats, one on field corn and processed fractions, and one on miscellaneous commodities) in the United States during 1992. The main features of the trials were practically the same and can be summarized as follow.

The site used for the trial, 500-RES-019/020, was an established grain processing mill involved in processing of uncleaned raw commodity into a product from which a final product will be made. The temperature inside the facility at the time of application was 15.5°C. Following normal application practices, the ventilation system was turned off prior to application. Post-application ventilation of the facility was initiated approximately 7.5 hours following initiation of application.

The duplicate samples collected were representative of the different processed materials prior to dichlorvos application and at periods representative of the time required for the material to pass through the processing equipment at the facility from initiation to completion of a particular process (turn over period). Sampling took place following one, three and six turnovers of the material.

Oats

The test site was treated with dichlorvos, formulated as a 5% PrL, at a rate of 81 g ai/ 1000 m^3 (maximum label rate is 70 g ai/1000 m^3) (500-RES-019). Due to the size of the facility, multiple (19) commercial fogging units were used to ensure distribution of the test material throughout the facility.

The maximum storage period for all samples from collection to analysis was less than 30 days, except for fine groats, which was 43 days. The results are summarized in Table 19.

In the second study on oats processed fractions (Report 500-RES-021) the test site was treated on by application of dichlorvos, formulated as a 5% PrL, at the rate of 81 g ai/1000 m^3. All samples were analysed within five weeks of their receipt at the laboratory. Results from these trials are also included in Table 20.

Table 20 Dichlorvos residues in oats and oats processed fractions following treatment of manufacturing and processing facilities with 81 g ai/1000 m^3 applying 5%PrL formulation in the USA

Year (facility)	Sample	Sampling intervals	Dichlorvos residue, mg/kg (Mean)
Iowa, USA [a], 1992 (Food processing establishment)[b]	Oats, un-cleaned	-T	< 0.01, < 0.01 (< 0.01)
		T1	< 0.01, < 0.01 (< 0.01)
		T3	< 0.01, < 0.01 (< 0.01)
		T6	< 0.01, < 0.01 (< 0.01)
	Cleaned oats	-T	< 0.01, < 0.01 (< 0.01)
		T1	0.16, 0.63 (0.40)
		T3	0.03, 0.04 (0.04)
		T6	0.04, 0.14 (0.09)
	Fine groats	-T	0.05, 0.06 (0.06)
		ES0	1.89, 2.17 (1.99)
		ES1	4.28, 6.08 (5.18)
		ES3	8.10, 3.30 (5.7)
	Whole groats	-T	< 0.01, < 0.01 (< 0.01)
		T1	0.63, 0.36 (0.50)
		T3	0.16, 0.14 (0.15)
		T6	0.09, 0.08 (0.09
	Oat hull	-T	< 0.01, < 0.01 (< 0.01)
		T1	1.34, 0.6 (0.97)
		T3	0.47, 0.36 (0.42)
		T6	0.35, 0.43 (0.39)
	Oats Steel cut	-T	< 0.01, < 0.01 (< 0.01)
		T1	1.01, 0.95 (0.98)
		T3	0.43, 0.49 (0.46)
		T6	0.53, 0.54 (0.54)
Iowa, USA[c], 1992 (Food manufacturing facility)[d]	Steel cut (from storage)	-T	< 0.01, < 0.01 (< 0.01)
	Steel cut (Prior to steamer)	-T	< 0.01, < 0.01 (< 0.01)
		C1[d]	0.42, 0.07 (0.25)
		C2[d]	0.02, 0.03 (0.03)
		C3[d]	0.03, 0.03 (0.03)
	Fine groats	-T	< 0.01, 0.02 (0.02)
		ES1	0.14, 0.10 (0.12)
		ES2	12.2, 8.63 (10.4)
	Flaked oats	-T	< 0.01, < 0.01 (< 0.01)
		T1	0.97, 0.86 (0.92)
		T3	0.37, 0.37 (0.37)
		T6	0.37, 0.42 (0.40)

[a] Ref: 500-RES-019

[b] Intervals: -T = Samples collected prior to application

Tl, T3 and T6 = Sample collection after one, three and six turnovers of the commodity equipment start up.

ES0 = Sample collection from first flush of fine groats through the system

ES1 = Sample collection approximately 1 hour after first flush

ES3 = Sample collection approximately 3 hours after first flush

[c] Ref: 500-RES-021

[d] Intervals: Cl = Sample collection after first flush of the commodity after equipment start-up

C2 = Sample collection approximately 30 minutes following Cl

C3 = Sample collection approximately 75 minutes following Cl

ES1 = Sample collection from first flush of fine groats (flaked oats) through the system after equipment start-up

ES2= Sample collection at an interval when sufficient material had accumulated

Corn

The third study was conducted during 1992 at a commercial food processing establishment in Iowa, USA to determine dichlorvos residues in or on corn and ground corn resulting from treatment of the establishment with dichlorvos at the rate of 81 g ai/1000 m^3. The materials sampled were whole corn and ground corn (Report 500-RES-023/024). Sampling and analysis were performed the same way as in case of oat. The samples were analysed within 5 weeks of sampling and receipt by the laboratory. The results are summarized in Table 21.

Table 21 Dichlorvos residues in whole and ground corn following treatment of processing facility with 81 g ai/1000 m^3 applying 5%PrL formulation in the USA (500-RES-023)

Country Year (facility)	Sample	Sampling intervals [a]	Dichlorvos residue, mg/kg (Mean)
Iowa, USA, 1992 (Food processing establishment)	Whole corn	-T	< 0.01, < 0.01 (< 0.01)
		T1	0.01, < 0.01 (0.01)
		T3	0.01, 0.01 (0.01)
		T6	< 0.01, < 0.01 (< 0.01)
	Ground corn	-T	< 0.01, < 0.01 (< 0.01)
		T1	0.14, 0.06 (0.10)
		T3	0.04, 0.02 (0.03)
		T6	0.02, 0.02 (0.02)

[a] Interval: -T = Samples collected prior to application

Tl = Sample collection after one turnover of the commodity after equipment start-up

T3 = Sample collection after three turnovers of the commodity after equipment start-up

T6 = Sample collection after six turnovers of the commodity after equipment start-up

Flour, Sugar, Dried Milk, Dried Egg

The test site was treated with dichlorvos, formulated as a 5% PrL, at a rate of 85.7 g ai/1000 m^3 (500-RES–025). The temperature was between 22 °C and 25 °C at the time of application.

Flour and sugar samples were removed using a plastic scoop from a scale after sufficient material had entered the scale to allow for a representative sample. Milk and egg samples were collected from previously opened bags. Each post-application replicate was removed from a separate bag.

Samples of shortening were obtained from a bulk tank at a site adjacent to the mixer after the tank agitator had been turned off. Samples of shortening collected at the mixer were obtained by positioning the residue container under a spigot next to the mixer. A valve was opened and the shortening allowed to flow directly into the container. Samples identified as batch 1 or 3 were removed at intervals approximating the time required for the first or third batch of material to be produced.

Collection of post-application exposed commodity samples began approximately 6.5 hours following termination of application. The last exposed commodity sample was collected approximately 27 hours following termination of application. The maximum storage period for all samples from collection to analysis was less than 30 days. The results of analyses are summarized in Table 18.

The overall half-life calculated from the exposed commodity samples (4.3 hours; r squared = 0.878) represents a weighted average of the other individual half-life values observed. Based on values interpolated from regression analysis, the rate of deposition/re-deposition would be projected to change over time from 0.18 µg/g/h (0.22 µg/cm^2/h) at fifteen hours post-application to 0.03 µg/g/h (0.04 µg/cm^2/h) at twenty-seven hours post application.

Table 22 Dichlorvos residues in uncovered flour, sugar, dried milk, and dried eggs following treatment of processing facility at 85.7 g ai/1000m^3 applying 5% PrL formulation in the USA (500-RES-025)

Country Year (facility)	Sample	Sampling intervals [a]	Dichlorvos residue, mg/kg (Mean)
Illinois, USA, 1992 (Food processing establishment)	Flour	-T	< 0.01, < 0.01 (< 0.01)
		T1	0.08, 0.06 (0.07)
		T3	0.06, 0.03 (0.045)
	Sugar	-T	< 0.01, < 0.01 (< 0.01)
		T1	0.09, 0.07 (0.08)
		T3	0.02, 0.03 (0.03)
	Dried milk	-T	< 0.01, ND (< 0.01)
		T1	0.06, 0.05 (0.06)
		T3	0.1, 0.07 (0.09)
	Dried eggs	-T	ND, < 0.01 (< 0.01)
		T1	0.03, 0.04 (0.04)
		T3	0.09, 0.12 (0.11)

[a] Intervals: T1 = Sample collection from 1st batch following application

T 3= Sample collection from 3rd batch following application

Potato

Potatoes were sprayed with a mixed solution containing dichlorvos (0.2%), chlorpropham (0.1%) and pyrethrins (0.4%), then stored either at ambient temperature (average 19.7 °C) in the dark or at 5 °C in a refrigerator for 85 days. A spray volume of 50 mL (100 mg ai) was used for 8.7 kg of potatoes, giving a theoretical maximum residue of 11.5 mg/kg (Tsumura-Hasegawa *et al*., 1992).

The initial residues in potatoes (unwashed) were approximately 1.1 mg/kg, about one tenth of the applied rate. After storage for 85 days at 5 °C in the dark, dichlorvos residues in potatoes were approximately 0.5 mg/kg. The decline in residues in potatoes stored at 5 °C was determined as single phase, with a half-life of 45 days. When stored at approximately 20 °C in the dark, residues declined to approximately 0.01 mg/kg after 15 days. The decline in residues was determined as biphasic. A half-life of 1.6 days was calculated for the first phase (0–10 days) and 11 days for the second phase (day 11 onwards).

FATE OF RESIDUES IN PROCESSING

Study P1

As part of the study on residues in bulk peanuts, an exaggerated 40× rate was used (843 g ai/1000 m^3) (Report 500-RES-013). By simulating industrial practice as closely as possible, the whole peanut samples were processed into fractions of meal, crude oil, refined oil, and soapstock. Briefly, peanut samples were dried, then cleaned by aspiration and screening. A shelter was used to mechanically crack the hull surrounding the kernel (nutmeat). Aspiration was used to separate the hull and kernel fractions. The raw peanut kernels were heat-conditioned and pressed in an expeller for the purpose of liberating a majority of the crude oil. After pressing, the press cake was flaked. The residual crude oil remaining in the solid material (press cake) exiting the expeller was later extracted with hexane. The

solvent was removed from the press cake. The crude oil recovered from the expeller and solvent extract was combined and refined.

Study P2

Processing studies were carried out in 1993 in the USA (500-RES-014). Field corn, wheat, rice, cottonseed, and soya beans were treated with dichlorvos at an exaggerated 10× rate of 842 g ai/1000 m^3 in a simulated warehouse. The test substance was applied, via fogging equipment, to the space above the commodities using the 20% PrL formulation. The processing of treated samples closely followed commercial practices. All samples, including the processed fractions were stored at -20 ºC until analysis.

The results are summarized in Table 23. Appropriate processing factors were estimated from the data.

Table 23 Residues in processed fractions of commodities previously treated with dichlorvos during storage in USA

Processed Fractions	Residues mg/kg	Processing factor	Reference
Whole peanut	63, 73	-	500-RES-013
Nutmeat	0.76, 1.18	0.014	
Crude oil	< 0.01	< 0.00015	
Refined oil	< 0.01	< 0.00015	
Soapstock	< 0.01	< 0.00015	
Whole corn (RAC)	2.74	-	500-RES-014
Crude oil	0.03	0.01	
Refined oil	< 0.01	0.004	
Whole corn	2.98	-	500-RES-014
Crude oil	3.68	1.2	
Refined oil	0.41	0.14	
Meal	0.63	0.21	
Coarse meal	1.65	0.55	
Flour	1.74	0.58	
Whole wheat	15.64	-	500-RES-014
Bran	15.05	0.96	
Flour	1.4, 1.81	0.11	
Whole rice	4.26	-	500-RES-014
Hulls	14.16	3.3	
Bran	1.88	0.44	
Polished rice	0.023	0.005	
Cottonseed	60.04	-	500-RES-014
Meal	0.43	0.007	
Hulls	27.73	0.46	
Soapstock	< 0.01	0.0001	
Crude oil	15.13	0.25	
Refined oil	1.23	0.02	
Whole Soya beans	16.1	-	500-RES-014
Meal	0.37	0.023	
Hulls	55.1	3.4	
Soapstock	< 0.01	0.001	
Crude oil	9.9	0.61	
Refined oil	< 0.01	0.001	

Study P3

Residues in various wheat grain and milled products were determined in pilot scale trials (2 tonnes of grain treated at each rate). Wheat was treated with dichlorvos at rates of 6, 12 and 20 g ai/tonne (Webly 1993). Treated grain was bagged 4 days after application and milled 6 days later (i.e., 10 days after application). The second milling was 90 days after treatment. Cooked products were prepared 6 days after the first milling. Treated grain was stored at 20 °C after application and initial residues in

treated grain were determined 2 days after application. The results from milling and cooking are shown in the Tables 24 and 25.

Table 24 Dichlorvos residues (mg/kg) in wheat and milled products derived from treated grain stored for 10 or 90 days at 20 °C

Commodities	Storage time (days) prior to milling	Dichlorvos residues (mg/kg)		
		Applied at 6 mg/kg	Applied at 12 mg/kg	Applied at 20 mg/kg
Wheat*	Initial	3.4, 3.3	8.3, 6.5	14.8
Wheat	10	2.3, 2.6	5.2, 5.3, 5.1	6.4, 5.7, 6.5
Bran	10	4.0, 3.8, 3.4, 5.2	6.0, 9.0, 6.6, 7.5	11.2, 11.8, 10.8, 12.3
Germ	10	1.7, 2.2, 3.6, 2.6	4.0, 4.3, 6.1, 5.3	6.0, 6.1, 7.9, 7.8
Flour	10	0.4, 0.2, 0.2, 0.3	0.1, 0.5, 0.4, 0.5	0.5, 0.7, 0.7, 0.5
Pollard	10	2.0, 1.5, 1.7, 2.0	3.1, 3.8, 4.2, 4.3	5.1, 5.6, 5.8, 7.1
Whole meal	10	1.4, 1.1	1.4, 2.1	1.8, 2.4
Wheat	90	ND	0.8, 0.9	0.8, 0.9, 1.1
Bran	90	0.6, 0.4, 0.6, 0.4	1.0, 1.0, 1.0, 1.0	1.1, 1.3, 1.5, 1.5
Germ	90	0.2, 0.2, 0.4, 0.4	0.7, 0.7, 0.8, 0.8	0.8, 0.8, 1.2, 1.3
Flour	90	< 0.1, < 0.1, < 0.1, < 0.1	0.1, 0.1, < 0.1, < 0.1	0.1, 0.1, 0.1, 0.1
Pollard	90	0.2, 0.3, 0.2, 0.3	0.5, 0.6, 0.5, 0.5	0.6, 0.6, 0.9, 1.0
Whole meal	90	0.1, 0.1	0.2, 0.2	0.2, 0.3

* Residues in wheat following treatment with *ca.* 65% of the theoretical applied amount.

LOQ is 0.1 mg/kg. ND = not determined.

Table 25 Dichlorvos residues (mg/kg) in processed products derived from grain stored for 10 days prior to milling.

Commodities*	Dichlorvos residues (mg/kg)		
	Applied at 6 mg/kg	Applied at 12 mg/kg	Applied at 20 mg/kg
Wheat (initial residues)**	3.4, 3.3	8.3, 6.5	14.8
Flour	0.3	0.3	0.5
Wholemeal	1.4	1.4	1.8
White bread	< 0.1	0.2, 0.2	< 0.1
Wholemeal bread	0.1, 0.2	0.3, 0.2	0.3, 0.2
Flat bread	0.3, 0.3	0.5, 0.5	0.6, 0.6
Chinese steamed bread	0.1, 0.2	0.2, 0.3	0.2, 0.2
Yellow alkaline noodles	< 0.1	< 0.1	< 0.1
White noodles	0.2, 0.2	< 0.1	0.3, 0.3

* Preparation of pan breads involved cooking at 240°C for 32 minutes. Noodles may be raw or cooked for 7 minutes in boiling water. Steamed bread is steamed for 20 minutes and flat bread is baked for 33 seconds at 550°C.

** Initial wheat residues are for wheat sampled 2 days after application of dichlorvos.

Dichlorvos residues were also determined in milled and cooked products from grain stored for 90 days before milling. Dichlorvos residues were < 0.1 mg/kg in all commodities except wholemeal and flour (see Table 26).

Table 26 Dichlorvos residues (mg/kg) in processed products derived from grain stored for 90 days prior to milling

Commodities	Dichlorvos residues (mg/kg)		
	Applied at 6 mg/kg	Applied at 12 mg/kg	Applied at 20 mg/kg
Wheat (initial residues)*	3.4, 3.3	8.3, 6.5	14.8
Flour		0.1	0.1
Wholemeal	0.1	0.2	0.2

* Initial wheat residues are for wheat sampled 2 days after application of dichlorvos.

Study P4

Winter wheat of about 12% moisture content was transferred to storage bins of about 3.5 m^3 with a wide-belt conveyor and treated at a 15 mg/kg calculated deposit rate with a mixture diluted emulsifiable concentrate of dichlorvos and 10% Triton X-100 (Vardell 1972). Samples of the treated wheat were collected after 0, 0.5, 1, 2, 3, 4, 5, 6, 8, 12, and 16 weeks of storage. About 2.3 kg of the composite sample was used for determining dichlorvos residues in the milling fractions and in bread made from the patent flour fraction. Control samples were taken before treatment. The samples were analysed with an enzyme inhibition-spectrophotometric method providing an LOQ of 0.1 mg/kg. The residues measured in whole wheat grain and processed products are shown in Table 27.

Table 27 Residues on the milling fractions and in bread from wheat treated with dichlorvos at 15 mg/kg and stored in 3.5 m^3 bins

Sampling time (weeks after treatment	Dichlorvos residues on					
	Whole grain	Milling fractions				
		Bran	Shorts	Flour (low grade)	Flour (patent)	Bread
0	4.6	3.5	1.7	0.2	0.1	0.1
0.5	3.0	3.1	2.9	0.2	0.2	0.1
1	1.3	3.1	1.6	0.3	0.1	0.1
2	1.1	1.8	1.5	0.1	0.2	0.2
3	0.9	1.6	1.2	0.1	0.J	0.2
4	0.9	1.3	1.4	0.1	0.1	0.1
5	0.7	1.3	1.3	0.1	0.1	0.2
6	0.4	1.0	0.9	0.1	< 0.1	0.1
8	0.7	0.8	0.8	0.1	< 0.1	0.1
12	0.3	0.9	0.8	0.1	< 0.1	0.1
16	0.2	0.7	0.7	0.1	< 0.1	0.1
Control	< 0.1	0.1	0.1	< 0.1	< 0.1	0.1

Study P5

Two commercial and two laboratory scale trials on rice were conducted (Anon., 1997). The commercial trials were carried out at storage depots in NSW (Griffith and Walsh) on approximately 1000 tonnes of paddy rice, while laboratory trials were on 1 kg samples. Rice was treated at 12 g ai/tonne in commercial trials and 6 or 12 g ai/tonne in laboratory trials. Dichlorvos residues were determined in paddy rice, brown rice, white rice, hulls and bran by GC and summarized in Table 28. The limit of detection was stated as 0.1 mg/kg. No details of the analytical method used or recovery data were available.

Table 28 Dichlorvos residues (mg/kg) in rice and processed commodities after treatment of grain at 6 or 12 g ai/tonne

	Dichlorvos residues (mg/kg)				
WHP (days post-treatment)	Paddy rice	Brown rice	White rice	Hulls	Bran
Griffith Depot Shed 5 Bin 1 (12 g ai/tonne)					
0	11.4	1.4	0.1	42.0	10.5
3	11.6	1.3	< 0.1	44.5	9.6
7	4.1	1.0	< 0.1	41.9	7.3
11	7.4	1.0	< 0.1	38.9	1.8
16	12.1	0.7	< 0.1	31.7	6.7
20	7	0.6	< 0.1	38.3	5.8
24	5.8	0.7	< 0.1	29.7	3.6
28	5.2	0.4	< 0.1	26.0	7.1
Walsh Depot Shed 3 Bin 1 (12 g ai/tonne)					
0	3.6	0.8	< 0.1	20.2	5.5
4	2.6	0.5	< 0.1	18.9	3.1

	Dichlorvos residues (mg/kg)				
WHP (days post-treatment)	Paddy rice	Brown rice	White rice	Hulls	Bran
7	2.5	0.4	< 0.1	16.7	2.6
11	5.3	0.9	< 0.1	23.4	4.4
14	3.7	0.5	< 0.1	16.4	2.6
20	2.4	0.3	< 0.1	1.4	3.2
24	2.0	0.3	< 0.1	16.4	3.7
27	2.8	0.4	< 0.1	17.2	3.1
Laboratory Treatment (12 g ai/tonne)					
0	6.4	1.6	< 0.1	29.1	12.1
3	5.3	1.2	< 0.1		5.5
7	4.6	0.6	< 0.1	28.8	5.4
13	3.2	0.4	< 0.1	19.3	2.3
17	2.8	0.3	< 0.1	16.1	2.5
22	1.9	0.2	< 0.1	14.5	2.0
27	1.9	0.2	< 0.1	15.0	1.1
Laboratory Treatment (6 g ai/tonne)					
0	5.1	1.3	< 0.1	21.6	11.0
1	2.8	0.6	< 0.1	20.0	5.7
2	2.7	0.7	< 0.1	22.1	4.7
3	2.9	0.6	< 0.1	19.3	4.6
4	3.8	0.6	< 0.1	19.8	4.0
5	3.2	0.4	< 0.1	19.6	3.7
6	3.1	0.5	< 0.1	15.5	4.4
7	2.9	0.4	< 0.1	15.9	3.3
8	2.6	0.4	< 0.1	13.0	2.3

Study P6

Soya beans with 11.89% moisture content were treated with water emulsion of dichlorvos at an intended rate of 20 mg/kg. The treated seeds were stored in fibre drums for 7 days at temperature ranging between 25.5 and 28.8 ^{o}C (La Hue *et al*., 1973). Treated beans were milled and the meal extracted for oil with large-scale laboratory equipment representing the industrial process. Residues of dichlorvos were measured in RAC and processed fractions with a GC method. The reported LOQ was 0.002 mg/kg and the recoveries ranged between 91–96%. The residues measured in RAC and processed commodities are summarized in Table 29.

Table 29 Residues in milling and processing fractions of soya bean treated with 20 mg/kg dichlorvos 7 days before processing

Sample	Average [mg/kg]	Range [mg/kg]
Whole beans	0.92	0.84-1.00
Hulls	5.70	5.40-6.00
Toasted hulls	< 0.02	
Dehulled meats	0.39	0.36-0.43
Flakes .	0.20	0.18-0.21
Miscella	0.38	0.27-0.42
Hexane from oil [a]	0.16	0.13-0.21
Hexane from meal [b]	0.04	0.03-0.05
Crude oil .	0.55	0.50-0.060
Refined oil	< 0.02	
Refined bleached oil	< 0.02	
Meal .	0.05	0.02-0.12
Toasted meal	< 0.02	

[a] Stripper hexane recycle

[b] D-T condensate hexane

Study P7

Potatoes were sprayed with a mixed solution containing dichlorvos (0.2%), (Tsumura-Hasegawa *et al*., 1992). Initial residues in unwashed potatoes were 0.92 mg/kg. Washing for 1 minute in water removed > 96% of residues. No dichlorvos residues (< 0.001 mg/kg) were detected in wet or dry starch.

RESIDUES IN ANIMAL COMMODITIES

Farm animal feeding studies

Lactating dairy cows

A cattle feeding study was conducted in 1993 in the USA (500-RES-015). Nine Holstein cows were orally dosed with encapsulated test material for 28 days at 2, 6, and 20 ppm nominal dose levels, based upon dry matter (DM) intake, after a 14-day acclimation period to the test facility. The capsules were prepared every seven days to ensure stability of the test compound during the time of dosing. In addition, three cows were maintained as controls and received placebo doses.

Milk samples were collected in the morning and in the evening daily for 28 days, with the exception of some days where only one sampling was made. The evening milk sample was stored overnight in a refrigerator until composited with the morning sample. A composite sample contained equal amounts of the morning sample and the evening sample.

Within 15 hours after administering the last dose, all cows were sacrificed by electrocution and submitted for necropsy. Muscle, perirenal and omental fat, liver, and kidneys tissues were collected from all cows. All samples collected, including milk, were stored frozen at -20 ºC until analysed.

Residues of dichlorvos were determined in milk and tissue samples following the methods described in Section on Method of residue analysis. The methods were validated with an LOQ of 0.01 mg/kg for tissues and 0.001 mg/kg for milk. In addition, concurrent recoveries from freshly fortified samples analysed at the same time as the test samples were within the acceptable range of 70–120% and RSD < 20%. Milk and tissue samples were analysed within 30 days; therefore, no storage stability study was necessary for these samples.

The results of the study show that dichlorvos residues are not transferred to milk and animal tissues. Table 30 summarizes the results in milk and Table 31 on tissues.

Table 30 Residues of dichlorvos in milk from dairy cows dosed for 28 days

	1× dose group (2 ppm)			3× dose group (6 ppm)			10× dose group (20 ppm)		
	Cow 2	Cow 10	Cow 12	Cow 5	Cow 9	Cow 14	Cow 3	Cow 8	Cow 11
-1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
1	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
2	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
3	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
4	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
7	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
10	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
14	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
21	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
28	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

All control animals had < 0.01 mg/kg dichlorvos residues in all milk samples.

Table 31 Residues of dichlorvos in tissues from dairy cows dosed for 28 days

Tissue	1× dose group (2 ppm)			3× dose group (6 ppm)			10× dose group (20 ppm)		
	Cow 2	Cow 10	Cow 12	Cow 5	Cow 9	Cow 14	Cow 3	Cow 8	Cow 11
Muscle	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Liver	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Kidney	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Fat	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01

In another study three lactating Holstein dairy cows were topically treated with 57 g of a 1% dichlorvos solution per day for 31 consecutive days (equivalent to approximately 1.1 mg/kg bw/day assuming a 500 kg body weight). The spray was applied using a mist sprayer to the back, flanks and legs. One control animal was used (Ivey & Eschle, 1979). Milk was sampled from each cow were collected several days before the first application and at 2 hours then 1, 2, 4, 8, 16, 24 and 31 days after the first application. Morning and evening milking's were combined for each animal (except the 2 hour sample) and analysed within 36 hours. Animals were slaughtered 1 day after the last treatment and samples taken were stored frozen prior to analysis within 31 days of sampling. Samples were extracted and analysed by GC. Recovery of dichlorvos at 0.01 mg/kg spike level was 93–97% (milk), 80–85% (fat and muscle) and 86% (blood). Recovery of dichlorvos from spiked liver and kidney samples was low (approximately 0–40%) if the samples were not extracted immediately. No dichlorvos was detected in any of the milk samples (< 0.003 mg/kg) or tissues (< 0.002 mg/kg) from treated cows.

Horse

Two male and one female horses were orally administered dichlorvos/PVC granules pellets in a sachet at a rate approximating 16.6 g ai/animal (equivalent to approximately 37 mg ai/kg bw or 1850 ppm in feed assuming a 500 kg animal consumes 10 kg dry matter per day) (Meyrial 1974). One animal was sacrificed 24 hours after administration of dichlorvos and another was sacrificed 48 hours post dose. Tissues and organs were taken from these animals and analysed for dichlorvos residues. The third treated horse was used for blood, urine and faeces samples. An untreated control animal was included in the trial. Tissues and excreta were extracted with solvent (ethyl ether, ethyl acetate or ethanol) then analysed by GC with electron capture detection. No dichlorvos residues were detected in any tissues or organs (< 0.001 mg/kg). Traces of dichloroethanol were found in perirenal and connective fat 24 hours after dosing of one animal.

Laying hens

A poultry feeding study was conducted in 1993 in the USA (500-RES-016). After a 16-day acclimation period, 32 white leghorn laying hens in three treatment groups consisting of two groups of 10 hens and one group of 12 hens were orally dosed with encapsulated dichlorvos for 42 days. Each capsule contained half a dose and each hen received two capsules per day, one in the morning and one in the evening. In addition, one group of 10 hens was maintained as a control group and received placebo doses. Nominal dose concentrations were 0.0 ppm (controls), 2.0 ppm (l×), 6.0 ppm (3×), and 20.0 ppm (10×). Capsule analysis indicated that the dichlorvos intake for days 8–17 was lower than anticipated. To meet the study criterion of 28 days of dose at 2, 6, and 20 ppm, the study was extended 14 days for a total of 42 dose days.

Eggs were collected daily and sampled on days -1, 1, 2, 3, 4, 7, 10, 14, 21, 28, 35, and 42. Whole eggs (yolks and albumin) were collected as one sample; egg shells were discarded. Eggs within each group were pooled to form one composite sample and weighed.

All hens were sacrificed on day 43. The following tissues were collected from each hen: muscle (breast and thigh), liver, peritoneal fat, and kidneys. The liver and kidneys were collected in their entirety; enough muscle and fat tissues were removed from every bird to ensure sufficient

sample for analysis. All samples were immediately frozen and kept in freezes at -20 ºC until analysis. Samples were analysed within 30 days of collection.

Residues of dichlorvos were determined in egg and tissue samples using the methods described in Section on Methods of residue analysis. The LOQ for the methods was 0.01 mg/kg for all matrices. Concurrent recoveries were within the acceptable range of 70–120% and RSD < 20%.

The results are shown in Tables 32 and 33.

Table 32 Residue of dichlorvos in eggs following dosing for 42 days

Day	Residues, mg/kg			
	Control	2 ppm	6 ppm	20 ppm
-1	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
1	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
2	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
3	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
4	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
7	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
10	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
14	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
21	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
28	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01
35	< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01, < 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01,	< 0.01, < 0.01, < 0.01,
42	< 0.01, < 0.01, < 0.01		< 0.01, < 0.01, < 0.01	< 0.01, < 0.01, < 0.01

Table 33 Residue of dichlorvos in poultry tissues following dosing for 42 days

Tissue	Residues, mg/kg			
	Control	2 ppm	6 ppm	20 ppm
Thigh muscle	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01
Breast muscle	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01
Liver	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01
Kidney	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01 < 0.01
Fat	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01	< 0.01 < 0.01 < 0.01

Two hundred and eighty eight 10-month old pullets and 288 18-month old hens in 48 groups of 12 birds were used in a study to examine the effect of dichlorvos residues in feed on the egg production and residues in eggs and tissues (Pym *et al*., 1984). Hens were fed at a nominal dose level of 1 × 0, and 4 × 30 ppm dichlorvos sprayed on feed for 35 days followed by 21 days recovery period when they received untreated feed. Food consumption was significantly reduced in all groups given feed containing 30 ppm dichlorvos. Egg production was proportional to feed consumption. 12 eggs were taken weekly from each group, and one bird was sacrificed after four weeks of treatment and one after 14 days of recovery period. Breast muscle and abdominal fat was taken for analyses applying a method with 0.01 mg/kg LOQ. No residues were detected in egg or tissue samples.

APPRAISAL

Dichlorvos is an organophosphate insecticide. It is effective against a broad spectrum of insect pests in stored products. It is also used in public health vector control and in animal health for the control of ectoparasites. It was evaluated by JMPR 1965 (T, R), 1970 (T, R), 1993 (T, R), and in 2011 (T) as part of the periodic review programme. The ADI and acute reference dose for dichlorvos were established as 0–0.004 mg/kg bw and 0.1 mg/kg bw, respectively. Dichlorvos was scheduled at the Forty-third Session of the CCPR (2011) for the periodic re-evaluation of residues by the 2012 JMPR.

Animal metabolism

Information on the metabolism of dichlorvos has been evaluated in goats following dermal and oral dosing, in swine and laying hens after dermal application of dichlorvos. The latter information was obtained from studies published in the scientific literature.

Dermal treatment

Two lactating goats were treated dermally twice daily for three consecutive days with vinyl-^{14}C-dichlorvos at the target dose rate of 10 mg/kg body weight/day. To dose at an exaggerated rate, the application site of one goat was shaved and occluded with a Teflon patch immediately after each treatment ("occluded goat"). The other treated goat was treated normally, that is, the application site was not shaved nor occluded ("non-occluded"). Treated goats were sacrificed 16–18 hours after the final dose.

The following TRR levels (mg/kg) were found in various tissues of occluded and non-occluded goat, respectively: distal and proximal muscle 2.30 mg/kg (3.6%)–2.56 mg/kg (0.1%) and 0.65 (0.8)–0.55 mg/kg (0.0%); liver 36.1 mg/kg (2.8%)–9.13 mg/kg (0.5%); kidney 13.5 mg/kg (0.1%) and 3.23mg/kg (0.0%); distal and proximal fat 0.69 mg/kg (0.1%)–0.64 mg/kg (0.0%), and 0.13 mg/kg (0.0%)–0.43 mg/kg (0.0%). The cumulate TRR found in the tissues accounted for 6.7% and 1.3% of the administered dose, for the occluded and non-occluded goats, respectively.

TRR levels found in milk from the occluded goat ranged from 6.09 to 10.76 mg/kg and accounted for 3.5% of the administered dose. The TRR levels found in milk from the non-occluded goat ranged from 0.618 to 1.821 mg/kg and accounted for 0.6% of the administered dose.

Comparison of the TRR levels in proximal and distal muscle and fat samples from both treated animals demonstrated that residue levels were not any higher in the proximal samples, suggesting that dermally absorbed residues were quantitatively distributed throughout the animal's body by the circulatory system.

Material balance for this study, including residues in urine and faeces, accounted for 52.1% and 42.2% of the administered dose for the occluded and non-occluded goats, respectively.

The metabolic fate of vinyl-1-^{14}C-dichlorvos in the occluded goat was examined in the edible tissues and milk. Solvent extraction of tissues and milk removed between 30.7 and 70.5 percent of the TRR. Subsequent acid and/or base hydrolyses of the post-extracted solids quantitatively solubilized the "bound" residues.

Chromatographic analysis of the aqueous extracts demonstrated that neither dichlorvos nor desmethyl dichlorvos, 2,2-dichloroacetic acid, 2,2 dichloro acetaldehyde and 2,2-dichloroethanol were present. Mass spectral analyses of the water-soluble residues suggested that the polar residues found in the tissues represented incorporation of the dechlorinated vinyl portion of dichlorvos into relatively high-molecular weight natural products.

Milk aqueous extract was shown to contain a single radioactive residue which was identified as ^{14}C-lactose.

The organo-soluble residues were further characterized by saponification. Analysis of the saponified-aqueous fractions from milk, liver and fat revealed that ^{14}C-glycerol accounted for 100%, 28.6% and 23.1% of the radiocarbon present in the fraction, respectively.

The "non-saponifiable" (lipid) fraction accounted for approximately 30–50% of radioactivity. These "bound" residues were quantitatively solubilised after acid and/or base hydrolysis resulting in compounds similar to amino acids.

Results from this study showed that vinyl-l-^{14}C-dichlorvos was extensively metabolized in the goat so that the vinyl portion of the molecule was incorporated into various natural products. Natural products identified in this study were lactose (in skim milk) and glycerol, resulting from the saponification of triglycerides present in milk, muscle and fat organo-soluble fractions. Although structural assignments were not made for the water-soluble residues extracted from tissues, five relatively high molecular weight polar compounds, which lacked chlorine atoms, were confirmed by mass spectral analysis. Bound residues solubilised by acid hydrolysis were tentatively identified as amino acids.

Laying hens

The metabolism of dichlorvos was studied on laying hens treated dermally twice daily for three consecutive days with vinyl-1-^{14}C-dichlorvos at the dose rate of 18.7 mg/kg body weight/day.

To maximize absorption of the applied dose, the feathers and down on the application site (vent and fluff area) were clipped-off prior to the first treatment. Treated hens were sacrificed approximately 20–21 hours after the final dose and the total radioactive residue (TRR) levels in selected tissues, were determined by combustion analysis.

The TRRs were 1.48 mg/kg in liver, 0.39 mg/kg in breast muscle, 0.49 mg/kg in fat, 0.88 mg/kg in egg white and 0.86 mg/kg egg yolk. Radioactivity found in the internal tissues and on the proximal and distal skin accounted for 0.3%, 20.0% and 0.8% of the administered dose, respectively.

Solvent extraction of tissues and eggs recovered between 8.6% and 93.5% of the TRR. Subsequent acid and base hydrolysis of the post-extracted solids quantitatively solubilised the "bound" residues.

The parent dichlorvos (0.004 mg/kg, 1.1% of TRR) and des-methyl dichlorvos (0.039 mg/kg, 7.8% of TRR) were identified in breast muscle and fat.

Results from this study showed that vinyl-1-^{14}C-dichlorvos was extensively metabolized in poultry. Majority of the radioactivity was incorporated into water-soluble natural products, amino acids and glycerol (fats), resulting from the saponification of triglycerides present in the organic extracts of liver, fat, and egg yolk.

Oral application of dichlorvos

Cows

In an early non GLP study four cows were treated with ^{32}P-labelled dichlorvos on the first day with 1 mg/kg bw dose in capsule and followed after 7 days by a 20 mg/kg bw dose. Following the 1 and 20 mg/kg bw oral doses the total radioactivity in milk reached an approximate plateau (0.6 mg/kg dichlorvos equivalent) between 12 and 24 hours and 10.5–11.1 mg/kg between 8 and 12 hours, respectively. The radioactive residues in milk declined continuously to 1.3 mg/kg dichlorvos equivalent after 6 days. The organosoluble residues in milk were much lower reaching the maximum of 0.077 mg/kg after one hour of administration of 20 mg/kg bw dose.

In another experiment cows were administered ^{32}P-dichlorvos at 1 mg/kg bw and 20 mg/kg bw. Following oral administration, the majority (68–100%) of radioactivity was eliminated in urine and faeces within a week of administration. The majority of radioactivity in urine was present as mono- or di-methyl phosphates (70–98%) and desmethyl dichlorvos (0–30%). Radioactivity eliminated in milk of cows peaked at 0.61 mg/kg and 11.1 mg/kg dichlorvos equivalent approximately 12 hours after administration of 1 mg/kg and 20 mg/kg dose, respectively. It was concluded that dichlorvos was rapidly metabolised *in vivo* predominantly via cleavage of the P-O (vinyl) bond.

Swine

The Metabolic fate of dichlorvos in swine was studied by short and long-term oral and inhalation exposure utilising ^{32}P-, ^{36}Cl- and ^{14}C-labelled dichlorvos. Pregnant sows were administered, in the form of slow release polyvinylchloride pellets, a nominal dose of 4 mg/kg bw per day of ^{14}C-dichlorvos for up to 4 weeks before birth of piglets. Radioactivity was retained in tissues of both sows and piglets (levels not specified), but analysis showed that dichlorvos, demethyl dichlorvos, dichloroacetaldehyde or dichloroacetic acid were absent. Metabolites in liver and muscle tissues were identified as ^{14}C-carbon dioxide, glycine and serine, and a number of intermediates derived from these, including glucose, fatty acids, choline, ribonucleic acid and cholesterol. Similar experiments using ^{36}Cl-dichlorvos demonstrated that radioactivity was present as chloride ion and not as organochlorine compounds directly related to dichlorvos.

In three separate trials pregnant sows were fed non-labelled, and ^{14}C- and ^{36}Cl-labelled dichlorvos separately and in combination during the last third of the sows' gestation period at a rate of 4 mg of dichlorvos per kg of body weight per day. Samples of brain, kidney, liver, quadriceps muscle, and mesenteric fat from the sows, and muscle and liver from the piglets were analysed with GC method. No residues of dichlorvos, demethyl dichlorvos, dichloroacetaldehyde, dichloroacetic acid, or dichloroethanol were found in the tissues of the sows and piglets (LOQ was not given), although the tissues contained ^{14}C and ^{36}Cl residues ranging from 0.3 to 18.0 mg/kg equivalents. The ^{14}C and ^{36}Cl residues in the tissues were assumed to be due to degradation of the vinyl group in dichlorvos into ^{36}Cl ions and the incorporation of the ^{14}C into normal tissue constituents such as glycine, serine, creatine, glucose, glycogen, fatty acids, cholesterol, choline, lecithin, and ribonucleic acid.

In summary, vinyl-l-^{14}C-dichlorvos was extensively metabolized. Neither dichlorvos nor desmethyl dichlorvos, 2,2-dichloroacetic acid, 2,2 dichloro acetaldehyde and 2,2-dichloroethanol were present in detectable concentrations in tissues, milk and eggs, except dichlorvos (0.004 mg/kg, 1.1% of TRR) and des-methyl dichlorvos (0.039 mg/kg, 7.8% of TRR) in poultry breast muscle and fat following extremely high dose. The phosphorus moiety of the molecule was excreted via urine and faeces as mono- or di-methyl phosphates and desmethyl dichlorvos. The dechlorinated vinyl portion of dichlorvos was incorporated into various natural products such as amino acids and glycerol (fats). Organochlorine compounds deriving from the vinyl moiety were not present.

Plant metabolism

Wheat grains were topically treated with ^{14}C-dichlorvos. Some of the grains were dissected manually into pericarp, endosperm, and germ, and the total radioactivity in each fraction was determined. Other part of grain was crushed and extracted with (a) chloroform, (b) acetone, (c) saline. The saline extract and remaining part of the grains extracts were digested with protease and assayed for ^{14}C. The results show that dichlorvos rapidly diminished after the grains saturated and the protein was phosphorylated. Dichlorvos amounted to 24%, 8% and 3% of radioactivity in chloroform 2, 7 and 14 days after treatment. The protease extract did not contain dichlorvos. The dichlorvos degraded to dimethyl phosphate and fairly stable phosphorylated protein derivatives.

^{32}P-labelled trichlorfon and ^{36}Cl-dichlorvos were applied to cotton leaves by petiole injection. Leaf samples were collected after application then residues extracted by partitioning into chloroform and water. Dichlorvos was present in low concentrations amounting to 0.8%, 0.9% and 0.1% of applied dose 1, 24 and 48 hours after trichlorfon administration.

Following dichlorvos application, more than 80% of the applied radioactivity was lost within 48 hours of treatment, presumably due to volatilisation. Dichlorvos was the predominant residue immediately after application (37% of applied radioactivity), but declined to less than 0.1% of applied radioactivity after 48 hours. Dimethyl phosphate was detected at up to about 13% of applied radioactivity after 24–48 hours.

The half-lives of dichlorvos degradation were determined in cotton, bean, tomato and potato plants following treatment with ^{32}P-labelled dichlorvos. The plants, with or without roots, were placed in a formulated 0.1–0.2% ^{32}P-dichlorvos solution or given a foliar application by dipping the whole

plants into solutions of the labelled material. Between 60–80% of radioactivity was lost from the plants by volatilisation. In cotton, dichlorvos was degraded with a half-life of 4.6 hours, while half-lives of dichlorvos degradation of 6.8, 4.6 and 6.8 hours were determined for beans, tomatoes and potatoes, respectively. It was stated, without giving full details of characterization, that dimethyl phosphate was the predominant radioactive species identified.

Faba and soya beans were treated with ^{14}C-labelled dichlorvos at 12 mg/kg and 24 mg/kg dose rate. The treated grains were stored for 30 weeks under simulated local storage conditions. The residues on the seed coat (external extract) were removed with a mixture of water and acetone (3:1). Washed beans were then crushed in a mortar and Soxhlet extracted with 95% methanol for 24 h.

The surface residues decreased with storage time and amounted to 15–21% of the actual applied dose for both beans by the end of the experiment. The radioactivity in the internal extract increased from 20% to 57% for faba beans and from 36% to 62% for soya beans in relation to the actual doses of 12 and 24 mg/kg applied, respectively. Non-extractable residues slowly increased with time, and amounted to 8–10% and 9–11% of the actual applied doses in faba beans and soya beans after 30 weeks. The total recovered radioactivity was over 81% of the applied doses.

Dichlorvos alone was present in the external extracts. Desmethyl-dichlorvos, dimethylphosphate and monomethylphosphate were the main degradation products of ^{14}C-dichlorvos in the internal extract. Desmethyl-dichlorvos could only be extracted after acid hydrolysis indicating that it was present in conjugated form. The isolated metabolites suggested that dichlorvos is degraded in both stored faba and soya beans via two main pathways to give a number of metabolites. The major degradation pathway is cleavage of the P-O-CH_3 bond to give desmethyl dichlorvos. Hydrolysis of desmethyl dichlorvos gave monomethyl phosphate. The minor pathway is the hydrolysis of the P-O-vinyl ester linkage to give dimethyl phosphate.

In summary dichlorvos is rapidly metabolized, with a half-life in cotton, beans, potato and tomato of about 4.6–6.8 hours and in cereals of 27–54 hours. Most of the radioactivity was lost by volatilization. The main routes of degradation of dichlorvos in plants were found to be: (i) hydrolysis to form the major metabolite dimethyl phosphate and dichloroacetaldehyde; (ii) demethylation of dimethyl phosphate to monomethyl phosphate and inorganic phosphates; (iii) conversion of dichloroacetaldehyde to 2,2-dichloroethanol, which is then conjugated and/or incorporated into naturally occurring plant components; and (iv) loss by volatilization.

Methods of residue analysis

The methods used in the studies carried out with stored plant commodities were similar and based on extraction with a 4:1 mixture of acetonitrile: water followed by partitioning into dichloromethane, the concentrated extract was purified by gel permeation chromatography and analysed by GC-FPD (flame photometric detection).

Milk samples were extracted with a mixture of ethanol, diethyl ether and petroleum ether in the presence of sodium oxalate. The dried concentrated extract was cleaned up on GPC column. The dichlorvos residues were determined with GC-FPD.

Animal tissue samples were extracted with dichloromethane, cleaned up on GPC and analysed by GC-FPD.

The validated LOQ was 0.01 in all matrices, and the recoveries ranged between 70–120%.

Some of the studies published in scientific papers employed colorimetric method based on enzyme inhibition and spectrophotometric detection. The LOQ of the methods for plant materials was 0.1 mg/kg. The recovery varied but was in the acceptable range of 70–110%.

Dichlorvos residues may also be quantitatively determined with several multi residue methods used currently by regulatory laboratories.

Stability of residues in stored analytical samples

Peanut samples were obtained from a facility which was treated for 9 months at the daily rate of 18 g ai/1000 m^3) air space. The samples stored at -20 ºC were analysed on days 0, 39, 74, and 136 days after storage. The remaining residues were ≥ 70% in all samples demonstrating that residues of dichlorvos in peanuts are stable up to 136 days under frozen conditions. The maximum period of storage prior to analysis of all the bulk peanut samples in the facility was 134 days.

Winter wheat of about 12% moisture content was treated at a 15 mg/kg calculated deposit rate. Samples were stored for 8 weeks at -18 °C. The residues remaining in wheat grain varied in the range of 57% and 144% with an average of 90%.

Wheat grains of 9, 11, 13 and 14% moisture content were treated with dichlorvos at 50 mg/kg and stored for 11 months at -15 °C. At the end of the storage period, the samples contained 49, 43, 34 and 34 mg/kg of dichlorvos residues, respectively, corresponding to losses of 2%, 14%, 32 and 32% of initial dichlorvos.

It is apparent from the results that the disappearance of dichlorvos on wheat is dependent on both moisture content and temperature, which are affecting the stability of the residues. The stability of residues in commodities for which residue levels could be estimated was supported by the reported storage stability tests.

Definition of the residue

Biotransformation studies indicated that dichlorvos is rapidly absorbed by all routes of exposure and rapidly metabolised.

In lactating goats treated dermally the following TRR levels (mg/kg) were found in various tissues of occluded and non-occluded goat, respectively: distal and proximal muscle 2.30–2.56, 0.65–0.55; liver 36.1; 9.13; kidney 13.5; 3.23 distal and proximal fat 0.69–0.64, 0.13–0.43. The aggregated TRR found in the tissues accounted for 6.7% and 1.3% of the administered dose, for the occluded and non-occluded goats, respectively. The phosphorous moiety was mainly excreted as phosphates via urine.

Neither dichlorvos nor desmethyl dichlorvos, 2,2-dichloroacetic acid, 2,2 dichloroacetaldehyde and 2,2-dichloroethanol were present in tissues and milk. The dechlorinated vinyl portion of dichlorvos was incorporated into natural products such as glycerol, lactose and amino acids.

In dermally dosed laying hens TRR levels found in egg yolks ranged from < 0.014 to 0.863 mg/kg, and in egg whites ranged from 0.015 to 0.876 mg/kg., The parent dichlorvos (0.004 mg/kg, 1.1% of TRR) and des-methyl dichlorvos (0.039 mg/kg, 7.8% of TRR) were only present in breast muscle and fat following dermal treatment with grossly exaggerated dose (18.7 mg/kg bw) Consequently, these compounds would not be detectable under practical use conditions.

Animal transfer studies with exaggerated oral dose resulted in non-detectable residues in meat, liver, kidney and fat of cows, similarly no residue was detectable in poultry meat, fat, liver, kidney and eggs.

Dichlorvos concentration in/on treated plants declined rapidly partly by evaporation due to its high vapour pressure. The parent compound was the predominant residue immediately after application and degraded rapidly via (i) hydrolysis to form the major metabolite dimethyl phosphate and dichloroacetaldehyde; (ii) demethylation of dimethyl phosphate to monomethyl phosphate and inorganic phosphates; (iii) conversion of dichloroacetaldehyde to 2,2-dichloroethanol. The metabolites are conjugated and/or incorporated into naturally occurring plant components such as phosphorylated protein derivatives. The dimethyl phosphate is a common metabolite of several other pesticides.

Analytical methods are available for determining dichlorvos residues in plant and animal tissues, milk and eggs. In supervised trials on plant commodities the parent dichlorvos was the only residue component measured.

Dichlorvos residues are present in muscle at about 4 times higher concentration than in fat and are about equally distributed between egg yolk and egg white, Further, the parent dichlorvos has high water solubility (245 g/L) and log P_{ow} value of 2.

Based on the metabolism studies on plants and animals and availability of analytical methods, the Meeting recommended the following residue definition for dichlorvos.

Definition of the residue for compliance with the MRL and for estimation of dietary intake for plant and animal commodities*: dichlorvos.*

The residue is not fat soluble.

Residues deriving from post-harvest use of dichlorvos

Treatment of bagged, packed or covered commodities according to US GAP

The US GAP specifies a minimum of 7 day intervals between applications at 15–70 g ai/1000m^3 except on cocoa beans and whole peanuts where daily applications should not exceed 18 g ai/1000 m^3 of head space. Bulk unpacked food and feed should be removed or covered before the treatment begins. The US GAP does not specify a withholding period. Therefore, the residues measured in bagged, packed and covered commodities can only be considered for estimating maximum residue levels when the trial conditions are compared to US GAP. The residues deriving from dichlorvos application according to US GAP are summarized below.

Following multiple treatments the residue levels generally increased with the number of dichlorvos applications and they were typically the highest in the samples taken from top boxes followed by those from the side and interior of the piles. Consequently, for estimating maximum residue levels only the highest residue was considered from each trial which included sequential sampling or sampling from different positions of the treated commodities.

Study 1: In a simulated warehouse experiment in USA four applications were made at one week intervals at the nominal maximum GAP rate of 70 g ai/1000 m^3 for each application. Thirteen commodities (breakfast cereal, cocoa beans, coffee beans, cookies, crackers, dried beans, field corn, flour, oats, peanuts, soya beans, sugar and walnuts) were selected for evaluation to provide data on typical residues to be expected following storage in the facility.

The commodities were kept in their commercial packing and were placed on pallets in three to five tiers with four to five bags per tier. Two replicate samples were taken from the top tier, opposite sides of the pallet and from the interior of the pallets about 6 hours after the pesticide application.

The highest average residues detected in bagged commodities after sequential treatments 1–4 were: breakfast cereals: 0.02 mg/kg; cocoa beans: < 0.01 mg/kg; coffee beans: 0.43 mg/kg; cookies: 0.06 mg/kg; crackers: 0.29 mg/kg; dried beans: 0.12 mg/kg; field corn: 0.66 mg/kg; flour: 0.45 mg/kg; oat: 0.65 mg/kg; peanut: 3.49 mg/kg; peanut nutmeat: 0.28 mg/kg; soya beans: 0.13 mg/kg; sugar: 0.04 mg/kg; walnut meat: < 0.01 mg/kg.

No residue was detectable in pre-treatment samples.

Study 2: Dichlorvos was applied weekly in USA for 21 weeks at a rate of about 53 g/1000 m^3 (0.76 × max GAP). Samples were collected before applications 2, 8 and 16 (1 week after last application) and 6 hours after applications 1, 3, 5, 9, 13, 17 and 21. The residues were determined with an enzyme inhibition method (LOQ 0.1 mg/kg). Though the surface of the bags contained relatively high dichlorvos residues, no residue (< 0.1 mg/kg) was determined in any samples of beans, flour, noodles, raisins, rice and sugar.

Detectable residues were present in wheat flour (0.1 mg/kg) and in peanut (1.6 mg/kg).

Study 3: Bulk commodities including cocoa beans, coffee beans, dried beans, field corn, flour, oats, soya beans, sugar, tree nuts (walnuts) and wheat were treated without cover in a simulated warehouse experiment at the maximum US GAP rate of 70 g ai/1000 m^3. Some of the commodities were covered with plastic sheet. Post-application samples were collected within a day of application.

The average residues measured in duplicate samples taken from tote bins covered with plastic sheets were: cocoa beans: < 0.01 mg/kg; coffee beans: 0.02 mg/kg; field corn: < 0.01 mg/kg; flour: 0.02 mg/kg; soya beans: < 0.01 mg/kg and sugar: < 0.01 mg/kg.

The samples taken before dichlorvos treatment did not contain detectable residues.

Studies conducted according to Australian GAP

In Australia, dichlorvos can be used as surface spray or fumigant for protection of stored grains, applying EC formulation at 6 g ai /t grain or 12 g ai/t grain with withholding periods of 7 and 28 days respectively. It can also be applied as fog at 70 g ai/1000 m^3 or 3.5 g ai/50 m^2.

Study 4: In laboratory scale experiments wheat (*ca.* 1 kg samples) was treated with dichlorvos at rates equivalent to 6 and 12 g ai/t and then the stored at 20 °C or 30 °C for up to 8 weeks in closed screw cap jars. The residues in stored wheat were 0.7 mg/kg, 2.8 mg/kg and 4.1 mg/kg 7 days after treatment at 6 g ai/t. The residues were 2.2 and 1.4 mg/kg four weeks after treatment at 12 g ai/t rate.

Study 5: Residues on stored paddy rice was studied at commercial rice storage facilities and laboratory scale experiments in Australia. Dichlorvos was applied to paddy rice at 6 or 12 g ai/t rate then paddy rice was stored for up to 28 days after application. Seven days after treatment at 6 g ai/t rate the residue was 2.9 mg/kg in paddy rice, while following 12 g ai/t treatment the residues were 1.9, 2.8 and 5.2 mg/kg 28 days after application.

Study 6: Dichlorvos was applied as a direct spray application with diluted EC formulation at 5, 10 and 15 g/t paddy rice in a jar and small bin tests. 30 days after the treatment with dichlorvos at 15 mg/kg rate, the paddy rice contained 0.87 mg/kg residue.

In summary, residues in commodities treated according to US GAP were

	Covered	Packed or bagged
Cocoa beans:	< 0.01 mg/kg	< 0.01 mg/kg
Coffee beans:	0.02 mg/kg	0.43 mg/kg
Dried beans:		0.12 mg/kg
Peanut		3.5 mg/kg 1.6 mg/kg
Soya beans:	< 0.01 mg/kg	0.13 mg/kg
Oats:		0.65 mg/kg
Field corn:	< 0.01 mg/kg	0.66 mg/kg
Walnuts:	< 0.01 mg/kg	< 0.01 mg/kg
Flour:	0.02 mg/kg	0.45 mg/kg
Sugar:	< 0.01 mg/kg	0.04 mg/kg

Because only one or two independent residue data are available for each commodity treated according to US GAP, the database is considered insufficient for the estimation of maximum residue levels.

The Meeting considered that the residues in wheat 7 and 28 days after treatments with 6 g ai/t and 12 g ai/t, respectively, were not different and could be combined.

In wheat treated according to Australian GAP the residues were: 0.7, 1.4, 2.2, 2.8 and 4.1 mg/kg.

The residues in paddy rice following treatments according to Australian use pattern were: 0.87, 1.9, 2.8, 2.9 and 5.2 mg/kg.

The residues in other cereal commodities can be expected to be in the same range because the decline of dichlorvos is mainly influenced by the moisture content of the grains and the temperature

of storage. Therefore, the residues in wheat should cover the expected residues in other cereal products except rice.

However, the Meeting noted that including cereal grains excluding rice would result in long-term intake of 220% of maximum ADI of 0.004 mg/kg. Therefore the Meeting recommends maximum residue levels, STMR and HR values wheat only and for rice and resulting processed products.

The Meeting estimated a maximum residue level of 7 mg/kg, HR of 4.1 and STMR of 2.2 mg/kg for wheat.

The Meeting estimated a maximum residue level of 7 mg/kg, HR of 5.2 and STMR of 2.8 mg/kg for rice.

The Meeting withdraws its previous recommendations for maximum residue levels of 5 mg/kg for cereal grains.

Fate of residues during processing

The effect of processing was studied on peanut, corn, wheat, rice, cotton seed and soya bean following treatment with dichlorvos at recommended or exaggerated rates.

Study P1: As part of the study on residues in bulk peanut an exaggerated 40× rate was used (843 g ai/1000 m^3). The whole peanut samples were processed into fractions of meal, crude oil, refined oil, and soapstock.

Study P2: Field corn, wheat, rice, cotton seed, and soya beans were treated with dichlorvos at an exaggerated 12× rate of 842 g ai/1000 m^3 in a simulated warehouse. The treated commodities were processed in a pilot scale facility applying methods representing the industrial practice as close as possible.

Study P3: Residues in various wheat grain and milled products were determined in pilot scale trials (2 tonnes of grain treated at each rate). Wheat was treated with dichlorvos at rates of 6, 12 and 20 g ai/t. From the milled products noodles and breads were prepared.

Study P4: Winter wheat was treated at a 15 g ai/t calculated deposit rate. Samples were collected after 0, 0.5, 1, 2, 3, 4, 5, 6, 8, 12, and 16 weeks of storage. The dichlorvos residues were determined in the milling fractions and in bread made from the patent flour fraction.

Study P5: Rice was treated at 12 g ai/t in 2 commercial scale trials and 6 or 12 g ai/t in laboratory scale trials. Dichlorvos residues were determined in paddy rice, brown rice, white rice, hulls and bran by GC.

*Study P6***:** Soya beans were treated with water emulsion of dichlorvos at an intended rate of 20 g ai/t. After 7 days the treated beans were milled and the meal extracted for oil with large-scale laboratory equipment representing the industrial process.

Study 7: Potatoes were sprayed with a mixed solution containing dichlorvos. Initial residues in unwashed potatoes were 0.92 mg/kg. Washing for 1 minute in water removed > 96% of residues. No dichlorvos residues (< 0.001 mg/kg) were detected in wet or dry starch.

The processing factors (P_f) calculated from the studies are summarized in the following table. Factors are indicated with a "<" (less than) sign when the residue in the processed commodity is below the LOQ of the analytical method. The calculation is then made with the LOQ of the analytical method and the residue concentration of the RAC (raw agricultural commodity).

Treated commodity (RAC)	Processed commodity	P_f Median or best estimate	RAC STMR/HR	STMR-P/HR-P	
Whole wheat (Study P3)	Bran	1.73	2.2, 4.1	3.81	7.09
	Germ	1.02		2.24	4.18
	Flour	0.10		0.22	0.41

	Whole meal flour	0.40		0.88	1.64
Whole wheat (Study P4)	Bran	1.78	2.2, 4.1	3.92	7.30
	Flour low grade	0.10		0.23	0.42
	Patent flour	0.09		0.20	0.38
	Bread	1.00		0.88	1.64
White flour (Study 3)	White bread	0.33	2.2 4.1	0.073	0.14
	White noodles	0.6		0.132	0.25
Whole meal flour	Whole meal bread	0.14		0.123	0.23
	Flat bread	2.25		1.98	3.69
Whole rice (Study 2 and Study 5)	Polished rice	0.005	2.8, 5.2	0.014	0.03
	Brown rice	0.16		0.448	0.83
	Hulls	5.47		15.3	28.4
	Bran	1.05		2.94	5.46

Based on the residues measured in cereal grains and taking into account the best estimates for the processing factors, the Meeting estimated maximum residue levels for: rice polished 0.15 mg/kg, rice husked: 1.5 mg/kg and rice bran: 15 mg/kg.

The Meeting withdraws its previous recommendations for maximum residue levels of 1 mg/kg for wheat flour, 10 mg/kg for wheat germ and 2 mg/kg for wheat wholemeal.

Residues in animal commodities

Farm animal dietary burden

The Meeting estimated the dietary burden of dichlorvos in livestock on the basis of the diets listed in OECD Feed Table 2009 (available from the FAO website: http//www.fao.org/agriculture/crops/core-themes/theme/pests/pm/jmpr/jmpr-docs/en/). Calculation from highest residue, STMR and STMP-P values provides the levels in feed suitable for estimating MRLs, while calculation from STMR and STMR-P values for feed is suitable for estimating STMR values for animal commodities.

Estimated maximum and mean dietary burdens of farm animals

Dietary burden calculations for beef cattle, dairy cattle, broilers and layer are provided in Annex 6 of the 2012 JMPR Report and summarized below.

	Animal dietary burden, dichlorvos, ppm of dry matter diet							
	US-Canada		EU		Australia		Japan	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Beef cattle	2.40	2.40	2.31	2.31	4.16[a]	4.16[b]	3.04	3.04
Dairy cattle	1.96	1.96	2.31	2.31	3.66[c]	3.66	1.98	2.23
Poultry - broiler	3.58[d]	3.58	2.61	2.61	2.96	2.96	0.22	0.47
Poultry - layer	3.58	3.58[e]	2.61	2.61	2.59	2.59	1.32	1.32

[a] Highest maximum beef or dairy cattle dietary burden suitable for MRL estimates for mammalian meat and mammalian milk.

[b] Highest mean beef or dairy cattle dietary burden suitable for STMR estimates for mammalian meat and mammalian milk.

[c] Highest mean beef or dairy cattle dietary burden suitable for STMR estimates for mammalian milk.

[d] Highest maximum poultry dietary burden suitable for MRL estimates for poultry meat and eggs.

[e] Highest mean poultry dietary burden suitable for STMR estimates for poultry meat and eggs.

Farm animal feeding studies

Dairy cows

Nine Holstein cows were orally dosed with encapsulated test material for 28 days at 2, 6, and 20 ppm levels based on dry matters.

Milk samples were collected in the morning and in the evening daily for 28 days. Equal portions of morning and evening milk were composited and then analysed.

Within 15 hours after administering the last dose, all cows were sacrificed muscle, perirenal and omental fat, liver, and kidneys samples were collected.

The LOQ of the method was 0.01 mg/kg for all matrices. No detectable dichlorvos residue was present in any of the samples.

Laying hens

Thirty two white leghorn laying hens were orally dosed with encapsulated dichlorvos for 42 days at nominal dose rates of 0, 2.0, 6.0 and 20 ppm for 42 days. Each capsule contained half a dose and each hen received two capsules per day, one in the morning and one in the evening. Nominal dose concentrations were 0.0 ppm (controls), 2.0 ppm, 6.0 ppm and 20.0 ppm.

Eggs were sampled from 1 to 42 days. Whole eggs (yolks and albumin) were collected as one sample and egg shells were discarded. Eggs within each group were pooled to form one composite sample and weighed.

All hens were sacrificed on day 43, and muscle (breast and thigh), liver, peritoneal fat, and kidneys. tissues were collected from each hen.

None of the egg or tissue samples contained detectable residues. The LOQ of the methods was 0.01 mg/kg.

Animal commodity maximum residue levels

Animal feeding studies indicated that there was no detectable residue in milk, meat, eggs and edible offal even at exaggerated continuous dose of 20 ppm in feed on dry weight basis, which was about 5 times higher than the calculated maximum animal burden. The Meeting noted that the metabolism study following dermal application at extreme dose rate revealed that dichlorvos residues may occur at trace levels in poultry tissues. However, it was concluded that dichlorvos residues would not be present under practical conditions.

The Meeting estimated maximum residue level of 0.01* mg/kg for meet, fat and edible offal of mammals and poultry, and mammalian milks and eggs. The estimated HR and STMR values for animal commodities are 0 mg/kg.

RECOMMENDATIONS

On the basis of the data from supervised trials, the Meeting concluded that the residue concentrations listed below are suitable for establishing MRLs and for assessing IEDIs and IESTIs.

Definition of the residue (for compliance with the MRL and for estimation of dietary intake) for plant and animal commodities: dichlorvos.

The residue is not fat soluble.

CCN	Commodity	MRL, mg/kg		STMR or STMR-P	HR or HR-P
		New	Previous		
GC 0080	Cereal grains	W	5		
MO 0105	Edible offal (Mammalian)	0.01*		0	0
PE 0112	Eggs	0.01*		0	0
MF 0100	Mammalian fats	0.01*		0	0
MM0095	Meat (from mammals other than marine mammals)	0.01*		0	0
ML 0106	Milks	0.01*		0	0
PF 0111	Poultry fat	0.01*		0	0
PM 0110	Poultry meat	0.01*		0	0
PO 0111	Poultry, edible offal of	0.01*		0	0
CG0649	Rice	7		2.8	5.2
CM 1206	Rice bran	15 PoP		2.94	5.46
CM 0649	Rice husked	1.5 PoP		0.45	0.83

CCN	Commodity	MRL, mg/kg		STMR or STMR-P	HR or HR-P
		New	Previous		
CM 1205	Rice polished	0.15 PoP		0.014	0.03
GC 0654	Wheat	7 Po		2.2	4.1
CM 0654	Wheat bran, unprocessed	15 PoP	10	4.33	
CF 1211	Wheat flour	0.7 Pop	1	0.22	
CF 1210	Wheat germ	W	10		
CF 1212	Wheat wholemeal	3 Pop	2	0.88	

DIETARY RISK ASSESSMENT

Long-term intake

The evaluation of dichlorvos resulted in recommendations for MRLs and STMR values for raw and processed commodities. The residue data were used to calculate dietary intake. The results are shown in Annex 3 of the 2012 JMPR Report.

The International Estimated Daily Intakes (IEDIs) of dichlorvos, based on the STMRs estimated, were 5–30% of the maximum ADI of 0.004 mg/kg bw for the thirteen GEMS/Food cluster diets. The Meeting concluded that the long-term intake of residues of dichlorvos resulting from its uses that have been considered by JMPR unlikely to present a public health concern.

Short-term intake

The IESTI of dichlorvos calculated on the basis of the recommendations made by the JMPR was from 80% of the ARfD (0.1 mg/kg bw) for children and 60% of the general population.

The Meeting concluded that the short-term intake of residues of dichlorvos resulting from its uses that have been considered by JMPR unlikely to present a public health concern.

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