THIABENDAZOLE (065)

EXPLANATION

Thiabendazole was evaluated by the JMPR several times in the period 1970-1981 and was reviewed in 1997 under the CCPR Periodic Review Programme.

The 1997 JMPR recommended MRLs for banana (post-harvest), mushroom, potato, witloof chicory (sprouts), cattle milk, meat and edible offal, poultry meat and eggs, and recommended withdrawal of the MRLs for apple, cereal grains, citrus fruits, bulb onion, pear, strawberry, sugar beet, sugar beet leaves and tops, molasses and pulp (dry), tomato, meat and edible offal of cattle, goats, horses, pigs and sheep, and milks.

At the 23rd Session (1999) of the CCPR (ALINORM 99/24A, para. 65) the Committee recommended withdrawal of the CXLs for cereal grains, bulb onion, sugar beet, sugar beet leaves and tops, molasses and pulp (dry), and tomato but retained the CXLs for apple, citrus fruits, pear and strawberry as new data would be available to the 2000 JMPR. The CCPR recommended that the definition of the residue and details of analytical methods should be clarified by the JMPR/JECFA before the proposed draft MRLs for some animal products were advanced further.

After 1997 the interests in thiabendazole were transferred to a different manufacturer who reported data on analytical methods and uses of thiabendazole in several countries, and processing studies on apples, citrus fruits, and ware potatoes to the present Meeting. The results of supervised trials were reported for mandarins, oranges, apples, pears, ware potatoes, avocados, mangoes, melons, papayas and strawberries. The government of Germany provided information on use patterns and the government of The Netherlands on methods of residue analysis, use patterns, monitoring data and national MRLs.

METHODS OF RESIDUE ANALYSIS

Analytical methods

Campbell (2000) validated analytical methods M-027 and M-025.1, for the analysis of animal tissues and eggs respectively, for thiabendazole and its main metabolites 5-hydroxy-thiabendazole and benzimidazole.

Samples were extracted with 6 M HCl (24 h at 90-95ºC) and cleaned up by acid and base partition with ethyl acetate, followed by cation exchange solid-phase extraction (SPE). Extracts were analysed by cation exchange HPLC in compound- and tissue-specific mobile phases with fluorescence detection. The conditions are shown in Table 1.

Table 1. Conditions for HPLC analysis.

Analyte	HPLC mobile phase	Fluorescence detection	
		Excitation (nm)	Emission (nm)
Thiabendazole	25:75 A/W pH=3.0[1] or 3.4[2]	305[1], 265[2]	380
Benzimidazole	25:75 A/W pH=3.4	265	380
5-OH-thiabendazole	10:90 A/W pH=3.0	325	575

A/W = acetonitrile/water (0.05 M KH_2PO_4)
[1] Dairy and poultry meat, cow liver and kidneys
[2] Eggs, poultry skin with attached fat

The LOD of method M-027 was 0.03 mg/kg for each analyte in dairy and poultry meat, poultry skin with attached fat, cow liver and cow kidney. The LOD of method M-025.1 was 0.03 mg/kg for each analyte in eggs. The combined LOD (sum of the three LODs for each analyte) was 0.09 mg/kg. Mean recoveries were >70% and repeatability (RSD_r) was <20% for samples fortified with 0.03 mg/kg thiabendazole, 5-hydroxy-thiabendazole and benzimidazole before extraction (Table 2). Problems were encountered with thiabendazole in cow liver (RSD_r>20%) and benzimidazole in cow kidney (recovery <70%). Control samples of eggs, liver and kidney contained low apparent residues of benzimidazole (0.010-0.018 mg/kg) and control samples of liver of 5-OH-thiabendazole (0.010 mg/kg); recoveries were corrected for these interferences.

Table 2. Mean recoveries and RSD_r for samples fortified with 0.03 mg/kg.

Commodity	Thiabendazole	Benzimidazole	5-OH-thiabendazole
Eggs	99.3 ± 10.1% (n=8)	76.1 ± 8.5% (n=8)	85.1 ± 8.8% (n=8)
Poultry skin with attached fat	81.2 ± 10.3% (n=8)	85.1 ± 9.2% (n=8)	89.1 ± 7.5% (n=8)
Poultry meat	71.4 ± 3.5% (n=4)	73.4 ± 2.0% (n=4)	93.1 ± 5.6% (n=4)
Dairy meat	69.7 ± 5.2% (n=4)	93.3 ± 3.6% (n=4)	71.6 ± 7.2% (n=4)
Cow liver	90.1 ± 22.9% (n=6)	94.2 ± 19.5% (n=7)	69.6 ± 16.9% (n=7)
Cow kidney	75.5 ± 4.6% (n=8)	65.8 ± 13.4% (n=8)	105.3 ± 5.1% (n=8)

RSD_r = repeatability expressed as relative standard deviation

The Ministry of Health, Welfare and Sport of The Netherlands (1996a,b) submitted two enforcement methods for the determination of thiabendazole in non-fatty foods (less than 5% fat). The first (1996a) was a multi-residue method using gas chromatography. The residues in fruits, vegetables and potatoes were extracted with a mixture of acetone, dichloromethane and petroleum ether (1:1:1). The residues in nuts, cereals, pulses, oil and tropical seeds, dried fruits, garlic, herbs and spices were extracted with a mixture of acetone and dichloromethane (1:1). There was no clean-up. Residues were determined by GLC with ITD (ion trap detection) on either DB-1, DB-5 or DB-1701 columns and detection at m/z = 129, 174 and 201-203. The limit of quantification was 0.05 mg/kg. Recoveries and repeatabilities (RSD_r) were 57% ± 22% (n=10) at a fortification level of 0.23 mg/kg and 83% ± 11% (n=10) at 1.16 mg/kg in lettuce.

In the second method (1996b), for the determination of benomyl, carbendazim and thiabendazole in fruits and vegetables, samples were extracted with a mixture of acetone, dichloromethane and petroleum ether (1:1:1), and the extract cleaned up on-line by solid-phase extraction (SPE) on diol-bonded silica cartridges. Determination was by HPLC (Shodex DE-163) with UV (280 nm) and fluorescence detection (excitation 235 nm; emission 280 nm) in tandem. The limit of quantification was 0.05 mg/kg. Recoveries and repeatabilities (RSD_r) were 98.5 ± 3% (n=10; orange) and 103.5 ± 4.5% (n=10; lettuce) at a fortification level of 0.1 mg/kg, and 103.8 ± 1.3% (n=10; orange) and 107.9% ± 2.5% (n=10; lettuce) at 1.0 mg/kg.

USE PATTERN

The major registered or approved uses of thiabendazole on food crops are shown in Table 3 (post-harvest and pre-planting uses), Table 4 (pre-harvest uses) and Table 5 (wound treatment). The information was provided by the manufacturer except where otherwise indicated (* or **). Most of it was reported in summarized form: a hatch (#) indicates that original labels were available and bold that the information on the label differs from that in the summary. In such cases the information on the label is recorded.

Table 3. Registered post-harvest and pre-planting uses of thiabendazole.

Crop	I/F	Country	Form	Application					Waiting time, days
				Method	g ai/t	l/t	g ai/l	No.	
Apple; pear	I	Australia #	DP 900	Dip (30 s)			1.0	1	
	I	Belgium #	SC 450	Dip or drench			1.0	1	
	I	Brazil #	WP 600	Dip or drench (1-3 min)			0.9	1	
	I	France	SC 450	Spray or dip		2	0.45-0.6	1	
	I	France	SL 220	Spray			0.44	1	
	I	Italy #	SC 500	Dip or drench			0.5-1.15	1	30
	I	Italy #	SL 220	Spray			0.33-0.44	1	30
	I	Kenya #	SC 450	30 s dip or drench			0.55-1.1	1	
	I	Mexico #	SC 450	**Pre-harvest**			0.45-0.9	1	
	I	Mexico #	WP 600				**0.12-0.48**	1	
	I	Portugal #	SC 450	20-30 s dip or high volume spray			0.56-0.99	1	
	I	Portugal	SC 500	Dip or high volume spray			0.56-0.99	1	
	I	S. Africa #	SC 450; SC 500	30 s drench or spray (3 min)			1.05	1	
	I	Spain #	SC 225[c]	25-30 s dip or drench			0.9-1.1		
	I	Spain #	SC 330[a]	25-30 s dip or drench			1.0-1.3		
	I	Spain	SC 450; SC 500; SL 220	Dip or drench			1.1	1	
	I	Spain #	WP 600	20-30 s dip or drench			0.9-1.2		
	I	USA #	**SC 492**	Dip, drench or spray (3 min)			0.6	1	
	I	USA	TC 985	Dip or drench			0.5		
	I	Venezuela	SC 450	Drench			0.45-1.1	1	8-13?
Avocado	I	Kenya #	SC 450	Dip or drench			1.1-3.4	1	
	I	S. Africa #	SC 450; SC 500	Dip (20 s)			1.35	1	
	I	S. Africa #	SC 450; SC 500	Wax in water emulsion			0.35 + wax	1	
	I	Venezuela	SC 450	Drench			0.9-2.25	1	8-13?
Banana	I	Australia #	DP 900	Dip (2-4 min)			**0.15-0.42**	1	
	I	Brazil #	**SC 485**	Drench or spray			0.20-0.45	1	
	I	Brazil #	WP 600	Drench			**0.24-0.48**	1	
	I	China	SC 450	Dip or drench			0.22-0.34	1	
	I	France	SL 220	Dip, drench or spray			0.44	1	
	I	France	SC 450				0.45	1	
	I	Israel	SC 450	Dip or spray			0.3	1	
	I	Kenya #	SC 450	Dip or drench			0.20-0.40	1	
	I	Mexico #	SC 450	Drench or spray			0.22-0.45	1	
	I	Mexico #	WP 600				**0.24-0.48**	1	
	I	Portugal #	SC 450	Dip (2-4 min) or high volume spray			0.225	1	
	I	Portugal	SC 500	Dip or high volume spray			0.225	1	
	I	S. Africa #	SC 450; SC 500				0.22	1	
	I	Spain	SC 450; SC 500	Dip or drench			0.45	1	
	I	Spain #	WP 600	25-30 s dip or drench			0.21-0.45	1	
	I	USA	TC 985				0.2		
Banana; plantain	I	Belize #	SL 220	Dip, drench or spray			0.2-0.4	1	
	I	Columbia #	SL 220	Dip, drench or spray			0.2-0.4	1	
	I	Columbia #	SC 450	Drench or spray			0.22-0.45	1	
	I	Costa Rica #	SL 220; SC 450; SC 500	Dip, drench or spray			**0.2-0.4**	1	

Crop	I/F	Country	Form	Application					Waiting time, days
				Method	g ai/t	l/t	g ai/l	No.	
	I	Dominican Republic #	SL 220	Dip, drench or spray			0.2-0.4	1	
	I	Guatemala #	SL 220; SC 450; SC 500	Dip, drench or spray			**0.2-0.4**	1	
	I	Honduras #	SL 220; SC 450	Dip, drench or spray			**0.2-0.4**	1	
	I	Nicaragua #	SC 450	Dip, drench or spray			**0.2-0.4**	1	
	I	Panama #	**SL 220;** SC 450	Dip, drench or spray			**0.2-0.4**	1	
	I	Venezuela	SC 450	Drench			0.23-0.45	1	8-13?
Barley	F	Poland **	FS 10[j]	Seed dressing	0.4	4	0.1		
	F	Poland **	FS 25[l]	Seed dressing	1.2	2	0.625		
	F	Germany	FS 25[m]	Seed dressing before sowing	50			1	
Cabbage (white, red)	F	Germany	SC 443	Atomizing spraying	0.332	0.5		2	10
Citrus fruit	I	Australia #	DP 900				1.0	1	
	I	Brazil #	**SC 485**	Drench, spray			**0.5-5.0**	1	
	I	Brazil #	WP 600	Dip or drench			**0.5-4.8**	1	
	I	China	SC 450	Dip or drench			0.45-1.35	1	
	I	Colombia #	SC 450	Spray or drench			0.45-0.90	1	
	I	Costa Rica #	SC 450	Spray or drench			0.45-0.90	1	
	I	Costa Rica #	SC 500	Spray or drench			2.0-5.0	1	
	I	France	SC 450				2.0	1	
	I	Guatemala #	SC 450	Spray or drench			0.45-0.90	1	
	I	Honduras #	SC 450	Spray or drench			0.45-0.90	1	
	I	Israel	SC 450				1.1	1	
	I	Kenya #	SC 450	Dip or drench			0.90	1	
	I	Mexico #	SC 450	Drench or spray			**0.45-4.5**	1	
	I	Mexico #	WP 600	Drench or spray			0.9-1.1	1	
	I	Nicaragua #	SC 450	Spray or drench			0.45-0.90	1	
	I	Panama #	SC 450	Spray or drench			0.45-0.90	1	
	I	Portugal #	SC 450	Dip (20 s) or high volume spray			**5.0**	1	
	I	Portugal	SC500	Drench or high volume spray			2.0	1	
	I	S. Africa #	SC 450 SC 500	Spray or brush			1.0-2.0	1	
	I	S. Africa #	SC 450; SC 500	Wax emulsion			0.38-1.0 + wax	1	
	I	Spain	EC 5[b]	Spray (2nd application)	5	1	5.0		
	I	Spain #	SC 125[d]	25-30 s drench			0.5	1	
	I	Spain #	SC 225[c]	25-30 dip or drench			0.9-1.1		
	I	Spain #	SC 330[l]	25-30 s dip or drench			1.0-1.3		
	I	Spain	SC 330[e]	1. Drench 2. Spray	3.3-5.0 (2nd)	1 (2nd)	1.0-1.3 (1st); 3.3-5.0 (2nd)	2	
	I	Spain	SC 450	Drench			1.8	1	
	I	Spain	SC 500	1. Drench 2. Spray + wax	7 (2nd) + wax		1.8 (1st)	2	7 (1st); 0 (2nd)
	I	Spain	SC 600	1. Drench 2. Spray + wax	5 (2nd) + wax		1.2-1.8 (1st)	2	
	I	Spain	SL 220	Drench			2.2	1	
	I	Spain #	WP 600	25-30 s dip or drench			1.2-1.8		
	I	USA	Wax 1	Spray in wax	0.8-2.0				
	I	USA	SC 30	Spray			1.0		
	I	USA	TC 985	Spray in wax			2.7		
	I	USA	TC 985	Spray			2.0		
	I	USA	TC 985	Drench			1.0-2.0		
	I	USA	TC 985	Spray in wax	2.9-3.2				

Crop	I/F	Country	Form	Application					Waiting time, days
				Method	g ai/t	l/t	g ai/l	No.	
	I	Venezuela	SC 450	-			0.45-2.0	1	
Grass	I	UK	WS 240[f]	Pre-planting seed treatment	360			1	
Horse beans	F	Germany	WS 240[f]	Pre-planting seed treatment	360	5-10		1	
Mango	I	Guatemala #	SC 500	Dip or drench			1.0-2.5	1	
	I	Kenya #	SC 450	Dip or drench			1.1-3.4	1	
	I	USA	TC 985	Dip or drench			2.0		
	I	Venezuela	SC 450	Drench			0.9-1.8	1	8-13?
Papaya	I	USA	TC 985	Dip or drench			1.0-2.0		
Peas	F	Germany	WS 240[f]	Pre-planting seed treatment	360	5-10		1	
Potato (w)	I	Austria #	SC 450	Spray	45	4	11.25	1	
(w)	I	Austria #	SC 450	Dip (3 min)			2.7	1	
(w)	I	Austria	SC 450	Split application	27(1st) 54(2nd)			2	
(s)	I	Belgium #	SC 450	Seed treatment	30-45	2	15-22	1	
(s)	I	Belgium	SC 500	Seed treatment	30-45	2		1	
(w, s)	I	Belgium	SC 250[g]		30			1	
(w)	I	Brazil #	WP 600	Drench	45	2	22.5	1	
(s)	I	Brazil #	WP 600	Pre-planting dip			1.8	1	
(w)	I	Colombia	SC 450	Spray or dip	45		1.8	1	
(w)	I	Costa Rica	SC 450	Spray or dip	45		1.8	1	
(w)	I	Costa Rica	SC 500	Spray or dip	45		1.8	1	
(w, s)	I	France	SC 450	Drench, spray	60	2	29.9	1	
(w)	I	France	SL 220	Spray			30.8	1	
(s)	I	France	SC 225[c]	Pre-planting seed treatment	45				
(w, s)	I, F	Germany	SC 450; SC 443	Low volume spray;	27	0.06		1	28
(s)	F	Germany	SC 450; SC 443	Spray; pre-planting seed treatment	27-54	0.12			
(w)	I	Guatemala	SC 450	Spray or dip	45		1.8	1	
(w)	I	Honduras	SC 450	Spray or dip	45		1.8	1	
(s, w)	I	Ireland	SL 220	Spray; spinning disk equipment; ultra low volume; 2 weeks after lifting	44	0.2-2			21
(s, w)	I	Ireland	SC 450	Spray	40.5			1	21
(s, w)	I	Ireland	SC 450	Spinning disk		0.09	450	1	21
(s, w)	I	Ireland	SC 450	Ultra low volume		1-2	20.25-40.5	1	21
(s)	I	Ireland	DS 100[h]	Seed treatment; spinning disk; 2 weeks after lifting	40		20-40		42+
(s, w)	I	Italy #	SC 500	Spray	**40**	1-2			30
(s)	I	Italy #	SC 500	3-5 min dip; pre-planting seed treatment			**1.8**	1	
(w, s)	I	Luxembourg	SC 250[g]		30			1	
(w, s)	I	Nether-lands*	SC 450	Spray shortly after harvest	**30**			1	60
(s)	I	Nether-lands*	**EC 250[g]**	Spray shortly after harvest	**30**			1	0
(w)	I	New Zealand	SC 450	Spray	42			1	
(w)	I	Nicaragua	SC 450	Spray or dip	45		1.8	1	
(s)	I	Norway	SC 500	Spray	50			1	
(w)	I	Panama	SC 450	Spray or dip	45		1.8	1	
(w)	I	S. Africa #	SC 450; SC 500	**Spray**		**2-4**	**1.6-3.15**	**1**	

Crop	I/F	Country	Form	Application					Waiting time, days
				Method	g ai/t	l/t	g ai/l	No.	
(s)	I	S. Africa #	SC 450; SC 500	**Spray**		**2-4**	**10.5-21.0**	**1**	
(s)		S. Africa #	SC 450; SC 500	**Pre-planting dip (5 min)**			**4**	**1**	
(s)		S. Africa #	SC 450; SC 500	**Pre-planting; ultra low volume spray**	**67**				
(w, s)	I	S. Africa #	SC 450; SC 500	**(2-4 min) dip**			**2.0**	**1**	
(w, s)	I	S. Africa #	SC 450; SC 500	**Ultra low volume spray**	**45**			**1**	
(w)	I	UK #	SL 220	Spinning disk; within 2 weeks after lifting	**44**	**0.2**		1	21
(w)	I	UK #	SL 220	Ultra low volume spray; within 2 weeks after lifting	**44**	**1-2**		1	21
(w, s)	I	UK	SC 450; SC 500	Spinning disk	40.5	0.09	450	1	21
(w, s)	I	UK	SC 450; SC 500	Ultra low volume spray	40.5	2	20.25	1	21
(w, s)	I	UK #	DS 100[h]	Spinning disk; within 2 weeks after lifting	**40**	**0.4**		1	42
(w, s)	I	UK #	DS 100[h]	Ultra low volume spray; within 2 weeks after lifting	**40**	**1-2**		1	42
(s)	I	UK	SC 300[i]	Pre-planting seed treatment	30				
(w)	I	USA #	SC 492	20 s dip or spray	6.7 (spray)		1.6 (dip)	1-2	
(w)	I	Venezuela	SC 450	Drench			1.35-2.25	1	8-13?
Rape	F	Poland **	WS 35[k]	Seed dressing	49				
Rye	F	Poland **	FS 25[l]	Seed dressing	1.25	2	0.625		
Sweet potato	I	USA #	**SC 492**	1-2 min dip			**4.1**	1	
Triticale	F	Poland **	FS 25[l]	Seed dressing	1.25	2	0.625		
Wheat	F	Poland **	FS 25[l]	Seed dressing	1.25-1.88	2-3	0.625		
Witloof, chicory (endive roots)	I	Belgium #	SC 450	Spray	40	20	2.0	1	
	I	Belgium #	SC 450	Drench (1-2 min)			1.0	1	
	I	France	SC 450	Dip, drench		2	0.84-1.03	1	
	I	France	SC 450	Mist spray	40	8	4.5	1	

I = indoor treatment; F = field treatment; Potato (w) = ware potato; Potato (s) = seed potato
* data submitted by the Plant Protection Service of The Netherlands
** data submitted by the Institute of Plant Protection of Poland
[a] formulation also contains 100 g/l dicloran
[b] formulation also contains 2 g/l imazalil and 180 g/l wax
[c] formulation also contains 75 g/l imazalil
[d] formulation also contains 400 g/l fosetyl-Al
[e] formulation also contains 200 g/l guazatine
[f] formulation also contains 450 g/kg metalaxyl
[g] formulation also contains 125 g/l imazalil
[h] formulation also contains 300 g/l tecnazene
[i] formulation also contains 100 g/l imazalil
[j] formulation also contains 30 g/l flutriafol, 400 g/l ethirimol
[k] formulation also contains 400 g/kg furatiocarb and 25 g/kg metalaxyl
[l] formulation also contains 25 g/l flutriafol
[m] formulation also contains 15 g/l imazalil and 37.5 g/l flutriafol

Table 4. Registered pre-harvest uses of thiabendazole.

Crop	I/F	Country	Application							PHI, days
			Form	Method	Rate, kg ai/ha	Vol., l/ha	Spray, g ai/l	No.	Interval, days	
Apple; pear	F	Mexico # **(2 labels)**	WP 600	Foliar spray; at flowering	**0.3-0.6; 0.4-1.4**			2	10-15	0
Avocado	F	Mexico #	WP 600	Foliar spray; at flowering	**0.3-0.45**		1.1-3.2	2	14-21	15
Banana; plantain	F	Guatemala #	SC 500	Foliar spray	0.036					
Citrus	F	Venezuela	SC 450	Foliar spray		200-800	0.675	1		5
	F	Venezuela	SC 450	Aerial		50-100	0.675	1		5
Mango	F	Mexico #	WP 600	Foliar spray; at flowering	**0.3-0.45**			2	14-21	15
Melon	F	Guatemala#	SC 500	foliar spray			0.6-1.35	1		3
	F	Venezuela	SC 450	foliar spray		200-800	0.675	1		5
	F	Venezuela	SC 450	Aerial		50-100	0.675			5
Mushroom	I	Australia #	DP 900	At casing[1]			230 g ai/t	1		
	I	Kenya #	SC 450	At casing			225 g ai/t			
	I	Kenya #	SC 450	during cropping, between flushes	1.4-14					
	I	S. Africa #	SC 450; SC 500	After casing, drench between breaks	6.3		1.15-1.5			
	I	UK	WP 600	Pre-casing drench or weekly spray during flushes				1-4	7	5
	I	USA #	**SC 492**	Spray at casing, fuzzing, pinning, between breaks	**12.5 (1st); 6.2 (2nd-4th)**			1-4		1
Strawberry	F	Kenya #	SC 450	foliar spray			0.45-0.90	3		14
	F	Venezuela	SC 450	foliar spray		200-800	0.675	1		5
	F	Venezuela	SC 450	Aerial		50-100	0.675			5

I = indoor treatment; F = field application;
[1]Incorporated in water used to wet the peat mass

Table 5. Registered uses of thiabendazole as wound paste. All field uses in Germany. All applications by painting on cleanly cut out wounds.

Crop	Form, g ai/kg
Blackberries	PA 10.1[1]
	PA 10
Blueberries	PA 10.1[1]
	PA 10
Currants (black, white, red)	PA 10.1[1]
	PA 10
Gooseberries	PA 10.1[1]
	PA 10
Hazelnut	PA 10.1[1]
	PA 10
Pome fruit	PA 10.1[1]
	PA 10.1[1]
Raspberries	PA 10.1[1]
	PA 10.1[1]
Stone fruit	PA 10.1[1]
	PA 10.1[1]
Walnut	PA 10.1[1]
	PA 10

[1] Formulation also contains 20 g/kg imazalil and 10 g/kg azaconazole

RESIDUES RESULTING FROM SUPERVISED TRIALS

The results of supervised trials on citrus fruits (oranges and mandarins), pome fruits (apples and pears), strawberries, tropical fruits with inedible peel (avocados, mangoes and papayas), melons and ware potatoes are shown in Tables 6 to 12.

Two or more residues shown for a single location, type of sample, and PHI were in replicate samples from the same pre- or post-harvest treatment. Where reports listed replicate analytical results their means are shown in the Tables. The residues are not corrected for recovery or control values except as indicated. Underlined residues reflect current GAP.

Table 6. Residues from post-harvest applications to mandarins in Spain.

Table 7. Residues from post-harvest applications to oranges in Spain.

Table 8. Residues from post-harvest applications and wound treatments to apples and pears in Spain, France and Germany.

Table 9. Residues from pre-harvest applications to strawberries in Spain.

Table 10. Residues from post-harvest applications to tropical fruits with inedible peel in South Africa, Costa Rica, Brazil and Belize.

Table 11. Residues from pre-harvest applications to melons in Spain.

Table 12. Residues from post-harvest application to ware potatoes in The Netherlands.

Citrus fruits. Details of post-harvest trials according to GLP on citrus fruits in Spain (1998) were reported.

Mandarins and oranges were treated with a post-harvest SC formulation using either (a) a single drench application (2.0 g ai/l) on ripe fruit, (b) a drench on green fruit plus a spray application on degreened fruit two days later (1.8 + 6.0 g ai/l) or (c) a spray on green fruit plus a spray on degreened fruit two days later (3 + 4 g ai/l). Using commercial equipment 35 boxes of citrus fruits (700 kg) were drenched; 12 boxes of which were sprayed automatically simulating conditions in packing houses. The fruits were then waxed with an emulsion of 1 l/t “Teycer”, and stored at 2-5ºC in a normal atmosphere (75-85% humidity, 800-2000 ppm CO_2). Single and duplicate samples (24 mandarins/12 oranges, 1.7-3.5 kg) were collected randomly and stored at or below -18ºC, then separated by hand into pulp and peel. The residue in the whole fruit was calculated from the weights of pulp and peel (51-72% w/w of pulp in mandarins; 51-61% of pulp in oranges). Thiabendazole was determined by a modification of method M-049 (extraction with 0.1 M HCl and HPLC with fluorescence detection). The LOD was 0.01 mg/kg in the pulp, 0.02 mg/kg in the peel and 0.02 mg/kg in the whole fruit. In control samples of pulp thiabendazole was below the LOD, but the peel contained ≤0.08 mg/kg in mandarins and ≤0.13 mg/kg in oranges. The recoveries were 91-108% (n=30) from the pulp and 72-104% (n=26) from peel at fortification levels at the LOD and at 0.05, 0.1, 1.0 and 2.0 mg/kg thiabendazole.

Table 6. Residues of thiabendazole in or on mandarins from post-harvest applications in supervised trials in Spain (1998).

Location	Variety	Application						Sample	DAT	Residues, mg/kg (c=control)	Ref. (Report no.)
		Form	g ai/t	l/t	g ai/l	Interval, days	Type				
Carcer[1,2] (Valencia)	Clemen-villa	SC500			2.0		30 sec drench + wax	peel pulp whole fruit peel pulp whole fruit peel pulp whole fruit	0 0 0 7 7 7 15 15 15	1.7, c=0.03 0.01 <u>0.65</u> 1.6 <0.01 0.64 1.3, c=0.02 0.01 0.51	Kissling, 1999a (2276/98)
Carcer[1,2] (Valencia)	Clemen-tina de Nules	SC 500			2.0		30 sec drench + wax	peel pulp whole fruit peel pulp whole fruit peel pulp whole fruit	0 0 0 7 7 7 15 15 15	1.2 0.01 <u>0.50</u> 1.2 <0.01 0.46 0.87, c=0.02 <0.01 0.37	Kissling, 1999b (2277/98)
Picassent[1,2]	Clemen-villa	SC 500			2.0		150 sec drench + wax	peel pulp whole fruit peel pulp whole fruit peel pulp whole fruit	0 0 0 7 7 7 15 15 15	3.0, c=0.05 0.02 1.1, c=0.02 3.5 0.01 <u>1.4</u> 2.7, c=0.08 0.04 1.0, c=0.04	Kissling, 1999c (2278/98)
Picassent[1,2]	Clemen-tina de Nules	SC 500			2.0		150 sec drench + wax	peel pulp whole fruit peel pulp whole fruit peel pulp whole fruit	0 0 0 7 7 7 15 15 15	3.9, c=0.06 0.01 <u>1.6</u>, c=0.02 3.4 <0.01 1.4 3.9, c=0.04 <0.01 1.6	Kissling, 1999d (2279/98)
Carcer[1,2], Paterna[3]	Clemen-tina de Nules	SC 500	- 6.0	- 1.0	1.8 + 6.0	2	30 sec drench + spray + wax	peel pulp whole fruit controls	0 0 0 0	3.3, 4.6 2.8, 4.4 <0.01, <0.01 0.01, 0.03 1.5, <u>2.2</u>, 1.4, 1.7 c=0.03 (peel) c=0.05 (peel), c=0.03 (fruit)	Kissling, 1999e (2284/98), Kissling, 1999f (2285/98)
Picassent[1,2], Paterna[3]	Clemen-tina de Nules	SC 500	- 6.0	- 1.0	1.8 + 6.0	2	150 sec drench + spray + wax	peel pulp whole fruit controls	0 0 0 0	3.2, 4.4 2.3, 4.3 0.02, 0.01 0.09, 0.04 1.2, <u>2.2</u>, 0.77, 1.4, c=0.04 (peel) c=0.06 (peel) c=0.02 (fruit) c=0.03 (fruit)	Kissling, 1999g (2286/98) Kissling, 1999h (2287/98)

Location	Variety	Application						Sample	DAT	Residues, mg/kg (c=control)	Ref. (Report no.)
		Form	g ai/t	l/t	g ai/l	Interval, days	Type				
Paterna[1,2,3] (Valencia)	Clementina de Nules	SC 500	3.0 + 4.0	1.0 + 1.0	3.0 + 4.0	2	spray + spray + wax	peel pulp whole fruit controls	0 0 0 0	1.6, 1.3 1.1, 1.0 0.07, 0.07 0.03, 0.02 0.49, 0.42, 0.35, 0.32, c=0.02 (peel) c=0.02 (peel)	Kissling, 1999i (2292/98) Kissling, 1999j (2293/98)
Paterna[1,2,3] (Valencia)	Clementina de Nules	SC 500	3.0 + 4.0	1.0 + 1.0	3.0 + 4.0	2	spray + spray + wax	peel pulp whole fruit	0 0 0	0.91, 1.6 1.6, 1.1 <0.01, <0.01 <0.01, <0.01 0.40, 0.78 0.77, 0.51	Kissling, 1999k (2294/98) Kissling, 199l (2295/98)

DAT: days after treatment
[1] field location
[2] first treatment location
[3] second treatment location

Table 7. Residues of thiabendazole in or on oranges from post-harvest applications in supervised trials in Spain (1998).

Location	Variety	Application						Sample	DAT	Residues, mg/kg (c=control)	Ref. (Report no.)
		Form	g ai/t	l/t	g ai/l	Interval, days	Type				
Carcer[1,2] (Valencia)	Orange; Navelina	SC 500			2.0		30 sec drench + wax	peel pulp whole fruit peel pulp whole fruit peel pulp whole fruit	0 0 0 7 7 7 15 15 15	0.94; c=0.03 <0.01 0.40; c=0.02 0.69 <0.01 0.29 0.79; c=0.03 <0.01 0.33; c=0.02	Kissling, 1999m (2280/98)
Carcer[1,2] (Valencia)	Orange; Salustiana	SC 500			2.0		30 sec drench + wax	peel pulp whole fruit peel pulp whole fruit peel pulp whole fruit	0 0 0 7 7 7 15 15 15	1.3; c=0.02 0.01 0.53 1.2 0.01 0.50 0.98; <0.01 0.41	Kissling, 1999n (2281/98)
Picassent[1,2]	Orange; Navelina	SC 500			2.0		150 sec drench + wax	peel pulp whole fruit peel pulp whole fruit peel pulp whole fruit	0 0 0 7 7 7 15 15 15	3.9; c=0.13 <0.01 1.6; c=0.06 3.3 <0.01 1.4 3.8; c=0.10 <0.01 1.5; c=0.04	Kissling, 1999o (2282/98)

Location	Variety	Application						Sample	DAT	Residues, mg/kg (c=control)	Ref. (Report no.)
		Form	g ai/t	l/t	g ai/l	Interval, days	Type				
Picassent[1,2]	Orange; Salustiana	SC 500			2.0		150 sec drench + wax	peel pulp whole fruit peel pulp whole fruit peel pulp whole fruit	0 0 0 7 7 7 15 15 15	3.0; c=0.02 0.01 1.2 2.7 0.01 1.1 2.8; c=0.03 <0.01 1.2	Kissling, 1999p (2283/98)
Carcer[1,2]; Paterna[3]	Orange; Navelina	SC 500	- 6.0	- 1.0	1.8 + 6.0		30 sec drench + spray + wax	peel pulp whole fruit	0 0 0	3.2, 3.9 <0.01, <0.01 1.4, 1.9; c=0.02 (peel)	Kissling, 1999q (2289/98)
Picassent[1,2]; Paterna[3]	Orange; Navelina	SC 500	- 6.0	- 1.0	1.8 + 6.0		150 sec drench + spray + wax	peel pulp whole fruit	0 0 0	2.0, 2.2 <0.01, <0.01 0.89, 1.1; c=0.13 (peel); c=0.06 (fruit)	Kissling, 1999r (2288/98)
Picassent[1,2]; Paterna[3]	Orange; Navelina	SC 500	- 6.0	- 1.0	1.8 + 6.0		150 sec drench + spray + wax	peel pulp whole fruit controls	0 0 0	3.66, 2.68 2.77, 3.32 0.01, 0.01 <0.01, 0.01 1.6, 1.1; 1.2, 1.3; c=0.03 (peel) c=0.05 (peel); c=0.03 (fruit)	Kissling, 1999s (2290/98) Kissling, 1999t (2291/98)
Paterna[1,2,3] (Valencia)	Orange; Navelina	SC 500	3.0 + 4.0	1.0 + 1.0	3.0 + 4.0		spray + spray + wax	peel pulp whole fruit	0 0 0	0.99, 0.85 1.4, 1.1 <0.01, <0.01 <0.01, <0.01 0.41, 0.37 0.52, 0.43; c=0.02 (peel)	Kissling, 1999u (2296/98) Kissling, 1999v (2297/98)
Paterna[1,2,3] (Valencia)	Orange; Navelina	SC 500	3.0 + 4.0	1.0 + 1.0	3.0 + 4.0		spray + spray + wax	peel pulp whole fruit	0 0 0	1.6, 1.6 1.6, 2.0 <0.01, <0.01 <0.01, <0.01 0.65, 0.70 0.68, 0.83	Kissling, 1999w (2298/98) Kissling, 1999x (2299/98)

DAT: days after treatment
[1] field location
[2] first treatment location
[3] second treatment location

Pome fruits. Details of post-harvest trials on pome fruits in France (1998) and Spain (1991) were reported, together with some information on wound treatment trials on apples in Germany (1998).

The GLP trials in France were on post-harvest apples with SC formulations using either a dip simulating local practice (1.1 g ai/l) or a drench with commercial equipment (1.1 g ai/l). Two boxes of 15-20 kg apples were used in the former and three paloxes (stackable wooden containers) each of 300 kg apples in the latter. The apples were stored at 0-2ºC in a normal atmosphere (93-100% relative humidity). Single samples of 1.7-2.7 kg were collected randomly from both sets of samples and stored at or below -18ºC. Thiabendazole was determined by modified method M-049 (HPLC with fluorescence detection). In control samples thiabendazole was <0.02 mg/kg. Recoveries were 99%-105% and 92%-96% at fortification levels of 0.02 and 2.0 mg/kg thiabendazole respectively.

In the trials in Spain (not GLP) apples and pears were drenched post-harvest with SC formulations containing thiabendazole alone or thiabendazole plus ethoxyquin, an anti-scald agent. Samples were stored at -0.8 to +1.0ºC in a normal atmosphere of 90% humidity. In each trial three replicates each of 2-3 kg fruit were analysed in two laboratories. The first presented results near the LOD 0-32 days after treatment, and the second results 100 times higher 32-160 days after treatment. Details of the analyses were not provided, but the first laboratory used GLC with an FPD instead of the usual HPLC. The residues shown in Table 8 are from the second laboratory only. Thiabendazole was not detected (<0.01 mg/kg) in the control samples.

Table 8. Residues of thiabendazole in apples and pears from post-harvest and wound treatment applications in supervised trials in Spain, France and Germany. Whole fruit analysed.

Country; year; treatment location	Fruit and variety	Application					DAT	Residues, mg/kg	Ref.
		Form	g ai/t	l/t	g ai/l	Type			
Spain; 1991; Sudanell	Apple Golden Delicious	Tecto 20S			1.1	drench	32 61 147	1.6, 1.7, 2.2 2.0, 1.8, 2.7 1.8, 2.2, 1.3	Tecnidex 1992;
Spain; 1991; Sudanell	Apple Golden Delicious	Tecto 20S			1.1[a]	drench	32 61 147	2.5, 1.8, 2.0 2.5, 1.5, 1.7 1.6, 1.6, 2.6	Tecnidex 1992
Spain; 1991; Sudanell	Pear Blanquilla	Tecto 20S			1.1	drench	75 160	2.0, 1.8, 1.7 1.6, 1.9, 2.5	Tecnidex 1992
Spain; 1991; Sudanell	Pear Blanquilla	Tecto 20S			1.1[b]	drench	75 160	1.8, 1.6, 1.7 1.8, 2.3, 2.3	Tecnidex 1992
France (North); 1998; Ste-Maure-de Touraine	Apple; Granny Smith	SC 500			1.1	60 sec dip	0 15 30	2.0 1.5 1.7	Kissling, 1999y (2243/98)
France (North); 1998; Ste-Maure-de Touraine	Apple; Rouges Americaines	SC 500			1.1	60 sec dip	0 15 30	1.7 1.5 1.5	Kissling, 1999z (2244/98)
France (North); 1998; Ste-Maure-de Touraine	Apple; Golden Delicious	SC 500			1.1	60 sec dip	0 15 30	1.5 1.4 1.7	Kissling, 1999aa (2245/98)
France (North); 1998; Ste-Maure-de Touraine	Apple; Braeburn	SC 500			1.1	60 sec dip	0 15 30	1.4 1.5 1.5	Kissling, 1999ab (2246/98)
France (North); 1998; Vernantes	Apple Braeburn	SC 500	1200	1100	1.1[c]	45 sec drench	0 14 28	1.6 1.4 1.3	Kissling, 1999ac (2247/98)
France (North); 1998; Vernantes	Apple Granny Smith	SC 500	1200	1100	1.1[c]	45 sec drench	0 14 28	1.6 1.7 1.5	Kissling, 1999ad (2248/98)
France (North); 1998; Lignieres-de-Touraine	Apple Granny Smith	SC 500	1200	1100	1.1	120 sec drench	0 14 29	1.7 1.6 1.6	Kissling, 1999ae (2249/98)
France (North); 1998; Lignieres-de-Touraine	Apple Golden Delicious	SC 500	1200	1100	1.1	120 sec drench	0 14 29	1.8 1.7 1.9	Kissling, 1999af (2250/98)
Germany 1998	Apple Jonathan	PA	25 g formulation per 450 cm^2; about 0.25 g/tree			Wound paste before flowering	125	<0.05	BBA 3688

DAT: days after treatment
[a] also contains 0.72 g/l ethoxyquin
[b] also contains 2.16 g/l ethoxyquin
[c] also contains 0.6% (v/v) diphenylamine (DPA, antioxidant)

Strawberries. Details of residue trials in 1993 on pre-harvest strawberries in Spain were reported, but only summaries for trials in 1989 and 1991. Residues were reported in the 1989 trials as the means of quadruplicate analyses, and in the 1991 trials as two results, each the mean of triplicates. The two

results were assumed to be from duplicate samples from the same plot. The two 1989 trials were evaluated by the 1997 JMPR.

The 1993 trials (not GLP) were in the field or in macro-tunnels with SC formulations sprayed from a motorized backpack at rates of 1.8 kg ai/ha and 90 g ai/hl. Samples of 1-1.5 kg each were taken. Details of storage conditions and analytical methods were not included. Residues of thiabendazole in control samples were 0.01-0.06 mg/kg.

Table 9. Residues of thiabendazole in or on strawberries from pre-harvest open field and macro-tunnel spray applications in supervised trials in Spain. Whole fruit analysed.

Year; Location	Variety	Application					PHI days	Residues, mg/kg	Ref. (Report no.)
		Form	No	kg ai/ha	kg ai/hl	Type			
1989; Moguer; Huelva	Chandler	SC 450	1	1.2	0.07	under plastic	0 3 7 14	1.7 (n=4) 1.6 (n=4) 1.4 (n=4) 1.1 (n=4)	Spain, 1991 (HU 1-89)
1989; Moguer; Huelva	Chandler	SC 450	1	1.2	0.07	open field	0 3 7 14	0.78 (n=4) 0.33 (n=4) 0.43 (n=4) 0.10 (n=4)	Spain, 1991 (HU 2-89)
1991; Lucena del Puerto; Huelva	Chandler	SC 450	1	1.8	0.09	open field	0 3 7	2.5 (n=3), 1.8 (n=3) 1.3 (n=3), 1.3 (n=3) 0.87 (n=3), 0.50 (n=3)	Spain, 1992 (065-91-9011R) Spain, 1992 (065-91-9010R)
1993; Bonares; Huelva	Oso Grande	SC 450	1	1.8	0.09	open field	0 3	4.6, 3.2 (c=0.04, 0.03) 1.6, 1.6	Spain, 1993a (065-93-9007); Spain, 1993b (065-93-9008)
1993; Moguer; Huelva	Chandler	SC 450	1	1.8	0.09	open field	0 3	1.6, 2.7 (c=0.02 , 0.02) 2.3, 1.8	Spain, 1993c (065-93-9011); Spain, 1993d (065-93-9012)
1993; Rociana del condado; Huelva	Oso Grande	SC 450	1	1.8	0.09	open field	0 3	5.2, 5.0 (c=0.04, 0.06) 1.9, 2.7	Spain, 1993e (065-93-9013); Spain, 1993f (065-93-9014)
1993; Lucena del Puerto; Huelva	Chandler	SC 450	1	1.8	0.09	macro-tunnel	0 3	3.4, 3.9 (c=0.03, 0.01) 2.2, 2.6	Spain, 1993g, (065-93-9009; Spain, 1993h; 065-93-9010)

ND: not detected; LOD not stated

Tropical fruits with inedible peel. Detailed reports were available for post-harvest residue trials on avocados in South Africa (1977) and Costa Rica (1996), mangoes in Brazil (1994) and Belize (1996), and papayas in Belize (1996). The trials on avocados and papayas in Costa Rica and on mangoes in Belize were only reported in part (23 pages of 476; appendices missing).

Only limited information on analysis in the South African trials on avocados in 1977 (GLP) was reported. Each fruit was halved, the stone discarded and the skin removed from one half. Composite samples with and without peel were homogenized and analysed in duplicate by GLC with an FID (limit of detection 0.02 mg/kg thiabendazole). Mean recoveries at a fortification level of 2.0 mg/kg were 94% (n=2). Control samples contained 0.05 mg/kg in the pulp and 0.23 mg/kg in the whole fruit.

The 1996 trials on avocados and papayas in Costa Rica and on mangoes in Belize (all GLP) were with SC formulations as a post-harvest dip or spray application to run-off. For dipping, the fruit in a mesh bag was dipped for 30 sec in a freshly-prepared solution. Spraying with a hand-held boom attached to a CO_2-backpack sprayer was directed from above and below the fruit on a suspended wire mesh tray. Duplicate samples each of 24 fruits were treated and stored frozen at temperatures from -6

to -22ºC for 16-34 days. Avocado and mango stones were removed before homogenization, partitioning into ethyl acetate, and clean-up and determination by cation-exchange HPLC with fluorescence detection (Merck method M-067). The recoveries at fortification levels of 0.05, 0.5 and 10.0 mg/kg were 85 ± 13% (n=8) for avocados, 95 ± 14% (n=7) for mangoes and 91 ± 10% (n=11) for papayas. In control samples thiabendazole could not be determined (LOD=0.05 mg/kg)

In the trials on mangoes and avocados residues in the whole fruit could not be calculated because the stones were not weighed. The manufacturer concluded from published sources that the weight of a mango stone is about 20 to 23% of the weight of the whole fruit (Morton, 1987), and from residue trials using another pesticide that an avocado stone weights about 15% of the whole fruit (Bull and Adams, 1987).

Table 10. Residues of thiabendazole in or on tropical fruits with inedible peel (avocados, mangoes, papayas) from single post-harvest applications in supervised trials in Belize, Brazil, Costa Rica and South Africa.

Country; Year; Location[2]	Fruit; variety	Application					Sample	DAT	Residues, mg/kg	Ref. (Report no.)
		Form	g ai/t	l/t	g ai/l	Type				
S. Africa	avocado	-			3.00		stoneless fruit pulp stoneless fruit pulp stoneless fruit pulp	0 0 3 3 7 7	3.8 (n=2) 0.48 (n=2) 2.0 (n=2) 0.34 (n=2) 1.6 (n=2) 0.25 (n=2)	1977 (0311/8833/ P295)
S. Africa	avocado	-			6.00		stoneless fruit pulp; stoneless fruit pulp stoneless fruit pulp	0 0 3 3 7 7	4.7 (n=2) 0.64 (n=2) 3.0 (n=2) 0.33 (n=2) 1.8 (n=2) 0.20 (n=2)	1977 (0311/8833/ P295)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 450			3.25	30 sec dip	stoneless fruit	0	6.2	Rice 1997a (43327)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 450			3.25	30 sec dip	stoneless fruit	0	7.1	Rice 1997a (43327)
Costa Rica; 1996 San Jose[2]	avocado; Haas	SC 450			3.25	30 sec dip	stoneless fruit	0	6.0	Rice 1997a (43327)
Costa Rica; 1996 San Jose[2]	avocado; Haas	SC 450			3.25	30 sec dip	stoneless fruit	0	6.9	Rice 1997a (43327)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 450			3.25	30 sec dip	stoneless fruit	0	4.8	Rice 1997a (43327)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 450			3.25	30 sec dip	stoneless fruit	0	5.6	Rice 1997a (43327)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 483			3.25	30 sec dip	stoneless fruit	0	8.1	Rice 1997a (43327)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 483			3.25	30 sec dip	stoneless fruit	0	6.7	Rice 1997a (43327)
Costa Rica; 1996 San Jose[2]	avocado; Haas	SC 483			3.25	30 sec dip	stoneless fruit	0	7.0	Rice 1997a (43327)
Costa Rica; 1996 San Jose[2]	avocado; Haas	SC 483			3.25	30 sec dip	stoneless fruit	0	7.8	Rice 1997a (43327)

Country; Year; Location[2]	Fruit; variety	Application					Sample	DAT	Residues, mg/kg	Ref. (Report no.)
		Form	g ai/t	l/t	g ai/l	Type				
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 483			3.25	30 sec dip	stoneless fruit	0	5.0	Rice 1997a (43327)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 483			3.25	30 sec dip	stoneless fruit	0	8.0	Rice 1997a (43327)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 450			3.25	spray to run off	stoneless fruit	0	8.1; 8.9; 6.5; 7.0	Rice 1997a (43327)
Costa Rica; 1996 San Jose[2]	avocado; Haas	SC 450			3.25	spray to run off	stoneless fruit	0	11; 10 (n=4)	Rice 1997a (43327)
Costa Rica; 1996 Dulce Nombre[2]	avocado; Haas	SC 483			3.25	spray to run off	stoneless fruit	0	8.5; 8.9; 11; 8.5	Rice 1997a (43327)
Costa Rica; 1996 San Jose[2]	avocado; Haas	SC 483			3.25	spray to run off	stoneless fruit	0	14 (n=2); 8.8	Rice 1997a (43327)
Brazil; 1994; Patos (CE)[1] Ceasa de Cariacica (ES)[2]	mango; Espada	WP 60			1.98	3 min dip	peel pulp	0 0	0.47 <0.03	Garozi 1996a
Brazil; 1994; Patos (CE)[1] Ceasa de Cariacica (ES)[2]	mango; Espada	WP 60			3.96	3 min dip	peel pulp	0 0	0.74 0.12	Garozi 1996a
Brazil; 1994; Patos (CE)[1] Ceasa de Cariacica (ES)[2]	mango; Rosa	WP 60			1.98	3 min dip	peel pulp	0 0	0.56 0.03	Garozi 1996b
Brazil; 1994; Patos (CE)[1] Ceasa de Cariacica (ES)[2]	mango; Rosa	WP 60			3.96	3 min dip	peel pulp	0 0	1.02 0.09	Garozi 1996b
Belize; 1996; Dangria[2]	mango	SC 450			2.5	30 sec dip	stoneless fruit	0	2.6, 1.5 1.7, 1.5	Rice 1997b (43326)
Belize; 1996; Belize city[2]	mango	SC 450			2.5	30 sec dip	stoneless fruit	0	2.6, 2.3 (n=3)	Rice 1997b (43326)
Belize; 1996; Dangria[2]	mango	SC 483			2.5	30 sec dip	stoneless fruit	0	1.9, 1.8 1.3, 1.5	Rice 1997b (43326)
Belize; 1996; Belize city[2]	mango	SC 483			2.5	30 sec dip	stoneless fruit	0	2.1, 2.0	Rice 1997b (43326)
Belize; 1996; Dangria[2]	mango	SC 450			2.5	spray to run off	stoneless fruit	0	3.2, 4.3 3.0, 3.6	Rice 1997b (43326)
Belize; 1996; Belize city[2]	mango	SC 450			2.5	spray to run off	stoneless fruit	0	3.8, 4.6	Rice 1997b (43326)
Belize; 1996; Dangria[2]	mango	SC 483			2.5	spray to run off	stoneless fruit	0	3.1, 2.7 (n=3) 3.0, 2.5	Rice 1997b (43326)
Belize; 1996; Belize city[2]	mango	SC 483			2.5	spray to run off	stoneless fruit	0	3.9, 3.8	Rice 1997b (43326)
Costa Rica; 1996 San Jose[2]	papaya; Havaiana	SC 450			2.0	30 sec dip	whole fruit	0	2.0, 3.5 2.8, 3.8	Rice 1997c (43325)
Costa Rica; 1996 Dulce Nombre[2]	papaya; Havaiana	SC 450			2.0	30 sec dip	whole fruit	0	3.5, 3.2	Rice 1997c (43325)
Costa Rica; 1996 San Jose[2]	papaya; Havaiana	SC 483			2.0	30 sec dip	whole fruit	0	2.6 (n=3), 1.9 3.0, 3.2	Rice 1997c (43325)

Country; Year; Location[2]	Fruit; variety	Application					Sample	DAT	Residues, mg/kg	Ref. (Report no.)
		Form	g ai/t	l/t	g ai/l	Type				
Costa Rica; 1996 Dulce Nombre[2]	papaya; Havaiana	SC 483			2.0	30 sec dip	whole fruit	0	2.8, 3.8 (n=4)	Rice 1997c (43325)
Costa Rica; 1996 San Jose[2]	papaya; Havaiana	SC 450			2.0	spray to run off	whole fruit	0	5.1, 5.0 4.9, 4.3	Rice 1997c (43325)
Costa Rica; 1996 Dulce Nombre[2]	papaya; Havaiana	SC 450			2.0	spray to run off	whole fruit	0	5.1, 4.0	Rice 1997c (43325)
Costa Rica; 1996 San Jose[2]	papaya; Havaiana	SC 483			2.0	spray to run off	whole fruit	0	2.6, 3.3 4.2, 3.9	Rice 1997c (43325)
Costa Rica; 1996 Dulce Nombre[2]	papaya; Havaiana	SC 483			2.0	spray to run off	whole fruit	0	3.1, 3.8	Rice 1997c (43325)

[1] field location
[2] treatment location

Melons. Detailed reports were available for pre-harvest residue trials (not GLP) on melons in Spain (1997). The trials were carried out with SC formulations in a plastic greenhouse using a hydropneumatic backpack sprayer (3 x 0.9 kg ai/ha) with two plots and one control plot per trial. A single sample of five melons was taken from each plot for analysis. Details of storage conditions were not given. Samples were analysed by fluorescent HPLC, but analytical details were in Spanish. Thiabendazole was not detected in control samples (<0.005 mg/kg).

Table 11. Residues of thiabendazole in or on melons from pre-harvest applications in plastic greenhouses in supervised trials in Spain (1997). Whole fruit analysed.

Location	Variety	Application					PHI, days	Residues, mg/kg	Ref. (Report no.)
		Form	No.	Interval, days	kg ai/ha	kg ai/hl			
Yegua Verde (Almeria)	Yupi	SC 480	3	14	0.9	0.2	0 7	0.74; 0.82 0.29; 0.33	Sanchez 1997 (11R)
La Mojonera (Almeria)	Melina	SC 480	3	14	0.9	0.2	0 7	0.35; 0.39 0.57; 0.53	Sanchez 1997 (12R)
La Mojonera (Almeria)	Aitana	SC 480	3	14	0.9	0.2	0 7	0.19; 0.17 0.081; 0.052	Sanchez 1997 (13R)
La Mojonera (Almeria)	Yupi	SC 480	3	14	0.9	0.2	0 7	0.15; 0.12 0.30; 0.31	Sanchez 1997 (14R)
La Mojonera (Almeria)	Melina	SC 480	3	14	0.9	0.2	0 3 7 14	0.34; 0.36 0.26; 0.28 0.23; 0.21 0.33; 0.42	Sanchez 1997 (15R)
La Mojonera (Almeria)	Melina	SC 480	3	14	0.9	0.2	0 3 7 14	0.21; 0.24 0.18; 0.13 0.41; 0.40 0.44; 0.43	Sanchez 1997 (16R)
La Puebla de Vicar (Almeria)	Amarillo canario	SC 480	3	14	0.9	0.2	0 3 7 14	0.67; 0.69 0.14; 0.19 0.13; 0.15 0.13; 0.11	Sanchez 1997 (17R)
La Mojonera (Almeria)	Melina	SC 480	3	14	0.9	0.2	0 3 7 14	0.39; 0.46 0.49; 0.53 0.21; 0.20 0.036; 0.036	Sanchez 1997 (18R)

Ware potatoes. Detailed reports were available for post-harvest residue trials on ware potatoes in The Netherlands (1998). The GLP trials were carried out with single post-harvest spray applications of SC

formulations with commercial Mafex equipment (spinning disk; 4-5 min/t) at a nominal rate of 30 g ai/t and 60 g ai/t. Samples were stored under commercial conditions at 14-15ºC for one week, followed by storage at 9.5ºC for 2-3 weeks, then at 3-5ºC for five months (relative humidity 90%). Single samples of 22-49 potatoes (2.2-5.5 kg) were randomly collected and stored frozen at temperatures below -18ºC for 1-7 months. Homogenized samples were analysed for thiabendazole by modified method M-049 (extraction with 0.1 M HCl and HPLC with fluorescence detection). Low levels of thiabendazole (<0.02-0.05 mg/kg) were found in control samples. Analytical recoveries were 98-105% (n=8), 98% (n=1) and 102-107% (n=4) from fortifications at the LOD, at 0.2 mg/kg and at 2.0 mg/kg thiabendazole respectively.

Table 12. Residues of thiabendazole in or on ware potatoes from single post-harvest spinning-disc spray applications in supervised trials in Bant, The Netherlands (1998). Whole tubers with peel analysed.

Variety	Application					DAT[1]	Residues, mg/kg	Ref. (Report no.)
	Form	g ai/t	l/t	g ai/l	Spin rate			
Agria	SC 500	37.6			spray c 4 min/t	0 20 57 122 178	3.3 (c<0.02) 2.6 3.6 (c<0.02) 4.0 5.6 (c<0.02)	Kissling 1999ag (2235/98)
Santé	SC 500	36.0			spray 4 min/t	0 20 57 122 178	2.4 (c=0.02) 1.7 2.3 (c<0.02) 1.9 1.9 (c<0.02)	Kissling 1999ah (2236/98)
Modesta	SC 500	33.4			spray 5 min/t	0 20 57 122 178	4.2 (c=0.03) 2.8 5.1 (c<0.02) 4.2 5.4 (c=0.02)	Kissling 1999ai (2237/98)
Bintje	SC 500	37.1			spray 5 min/t	0 20 57 122 178	4.6 (c<0.02) 5.5 8.0 (c<0.02) 6.9 6.7 (c=0.05)	Kissling; 1999aj (2238/98)
Agria	SC 500	64.4			spray 5.5 min/t	0 19 56 121 177	4.1 (c<0.02) 5.8 5.1 (c<0.02) 5.9 7.9 (c<0.02)	Kissling; 1999ak (2239/98)
Santé	SC 500	66.9			spray 4 min/t	0 19 56 121 177	2.5 (c=0.02) 2.4 1.9 (c<0.02) 2.1 3.2 (c<0.02)	Kissling; 1999al (2240/98)
Modesta	SC 500	64.3			spray 5 min/t	0 19 56 121 177	11 (c=0.03) 5.2 5.2 (<0.02) 6.5 11 (c=0.02)	Kissling; 1999am (2241/98)
Bintje	SC 500	78			spray 5 min/t	0 19 56 121 177	5.9 (c<0.02) 5.6 6.4 (c<0.02) 9.3 8.2 (c=0.05)	Kissling; 1999am (2242/98)

[1] days after treatment

FATE OF RESIDUES IN STORAGE AND PROCESSING

In processing

Oranges. In two processing trials in Spain (1998) oranges were treated post-harvest with an SC 500 formulation by either (a) a single 30 sec drench application (2.0 g ai/l) on ripe fruit or (b) a 30 sec drench on green fruit plus a spray on degreened fruit two days later (1.8 + 6.0 g ai/l). After the application(s) the oranges were waxed with an emulsion containing 1 l/t "Teycer" and stored at 2-5ºC until sample collection. Samples were collected randomly by hand (200 kg) and stored at ambient temperatures until processing 3 days later. 100 kg oranges were then washed manually for 5 min in vessels containing cold tap water, and separate samples were processed in duplicate into juice and marmalade by simulated industrial processes.

To prepare juice and pomace 25-30 kg washed oranges were cut in half and squeezed in a citrus fruit squeezer. The raw juice was pasteurised for 20-25 min (2 min at 89ºC) in a plate pasteuriser. The pulp and peel were combined and cut in small pieces to produce wet pomace. The wet pomace was dried for 6-7 hours at 63-65ºC in a dry box until the moisture content was 10%, yielding dry pomace.

Marmalade was prepared from 0.5 kg washed fruit with peel cut in a slicing machine. The cut oranges were mixed with glucose syrup, sugar and citric acid, the mixture boiled for 3 min and mixed with a pectin/sugar solution at 75ºC. The marmalade was cooled for two hours and sampled.

Processed samples were stored below -18ºC until analysis. Thiabendazole was determined according to modified method M-049 (extraction with 0.1 M HCl and HPLC with fluorescence detection). Residues in whole fruit were calculated from the weights of pulp and peel (51-61% of pulp). The LOD was 0.01 mg/kg in pulp, juice and marmalade, 0.02 mg/kg in peel, and 0.10 mg/kg in wet and dry pomace. The calculated LOD for whole fruit was 0.02 mg/kg thiabendazole. In pulp control samples thiabendazole was below the LOD, but peel and pomace control samples contained low levels of residue (≤0.31 mg/kg). Analytical recoveries were 72%-111% (n=19) from fortifications at the LOD and at 0.02, 0.05, 0.1, 0.2, 1.0, 2.0 and 10 mg/kg thiabendazole.

Apples. In a processing trial in France (1998) apples were treated post-harvest with a 120 sec drench application of an SC 500 formulation using commercial equipment (1.1 g ai/l). Apples (200 kg) were collected randomly by hand and stored cold at 0-2ºC in a normal atmosphere (93-100% relative humidity) until processing after 14-15 days. The apples were washed manually for 5 min in vessels containing cold tap water, and separate samples were processed in duplicate into juice and sauce by simulated industrial processes.

To prepare juice and pomace 40 kg washed apples were sliced in a slicer and pressed in a juice press (pressure 1-2 MPa), separating the mash into raw juice and wet pomace. The insoluble components of the raw juice were removed in a separator and the juice was pasteurized in a plate pasteuriser (2 min; 85ºC). Wet pomace was dried for 8-9 hours at 63-65ºC in a dry box until the moisture content was 10% to produce dry pomace.

To prepare apple sauce 1.5 kg washed apples were cut in halves and boiled in water (0.5 l water + 1.5 kg fruit) for 15 min at 98-100ºC. The fruit were passed through a sieve and sugar (16.5% of the dry matter), citric acid and ascorbic acid were added (pH 3.0-4.5). The apple sauce was transferred to a 1.5 l tin. After closing, the tin was pasteurized for 20 min at 95ºC in an autoclave.

Processed samples were stored below -18ºC until analysis. Thiabendazole was determined according to modified method M-049 (HPLC with fluorescence detection). The LOD was 0.01 mg/kg in juice, 0.02 mg/kg in fruit, wet pomace and purée, and 0.2 mg/kg in dry pomace. Thiabendazole in control samples was below the LOD. Analytical recoveries were 92-105% (n=14) in fruit, juice, wet

pomace and dry pomace from fortifications at the LOD and at 0.02-0.2-1.0-2.0-6.0 mg/kg thiabendazole. For purée the analytical recoveries were 119% at 0.02 mg/kg and 97% at 2.0 mg/kg.

Ware potatoes. In a processing trial in The Netherlands (1998) ware potatoes were treated with a post-harvest spray application of an SC 500 formulation with commercial Mafex equipment (spinning disc; 5 min/t; 78 g ai/t). Samples were stored under commercial conditions at 14-15ºC for one week, then at 9.5ºC for one week, and finally at 3-5ºC (relative humidity 90%) until processing after 22 or 62 days. The potatoes were washed and divided into four parts for four processes: boiling, microwave boiling, deep frying and crisp production. Each quarter was divided into two or four sub-samples, each of which was individually processed.

Washing. 60 kg unpeeled potatoes were washed manually for 5 min in vessels containing cold tap water.

Boiling. 2 kg washed unpeeled tubers were completely covered with water and boiled at 100ºC (15-20 min until beginning of boiling + 28-30 min boiling).

Microwave boiling. 2 kg washed unpeeled tubers plus 200 ml water were microwave-cooked for 11 min at 800 W and allowed to cool for 2 min.

Deep frying. 5 kg washed unpeeled tubers were peeled with an industrial peeler and cut into potato sticks with a slicing machine. The sticks were blanched for 3 min at 50-82ºC and deep fried for 2 min at 180ºC in pure vegetable oil, then deep-frozen below -18ºC. The deep-frozen chips were finally fried at 180ºC in a deep fat fryer with pure vegetable oil to a golden brown colour (15-19 min).

Crisp production. 5 kg washed unpeeled tubers were peeled with an industrial peeler and sliced into 1 mm discs with a slicing machine. The discs were fried at 180ºC in a deep fat fryer with pure vegetable oil (12-14 min).

Processed samples were stored frozen at temperatures below -18ºC . Homogenized samples were analysed for thiabendazole by modified method M-049. Residues in the whole potato (washed and unwashed) were calculated from the residues in the pulp and peel and the weights of the peel and pulp. The LOD was 0.01 mg/kg in peeled potatoes (fresh, boiled or deep fried), crisps and cooking liquid, and 0.02 mg/kg in peel and whole potatoes (fresh or boiled). Thiabendazole residues in control samples were below the LOD. Analytical recoveries were 92-108% (n=29) from fortifications at the LOD and at 0.02-0.1-1.0-2.0-4.0-5.0-10.0 mg/kg thiabendazole.

Table 13. Residues of thiabendazole in processed fractions of oranges, apples and ware potatoes treated post-harvest (1998).

Crop; variety; Country; Location	Sample	DAT	Residues, mg/kg (c=control)	Processing factor	Ref. (Report no.)
Orange; Navelina Spain; Carcer[1,2] (Valencia)	whole fruit	10	0.37 (c=0.06)	-	Kissling, 1999m (2280/98) treatment a
	peel (unwashed)		0.87	2.4	
	pulp (unwashed)		<0.01	-	
	whole fruit, washed		0.13	0.35	
	peel (washed)		0.32		
	pulp (washed)		<0.01		
	pasteurized juice		0.04; 0.05	0.11; 0.14	
	pomace, wet		0.39 (c=0.02)	1.05	
	pomace, dry		1.8 (c=0.31)	4.84	
	marmalade		0.06; 0.11	0.16; 0.30	

Crop; variety; Country; Location	Sample	DAT	Residues, mg/kg (c=control)	Processing factor	Ref. (Report no.)
Orange; Navelina Spain; Carcer[1,2]; Paterna[3]	whole fruit peel (unwashed) pulp (unwashed) whole fruit, washed peel (washed) pulp (washed) pasteurized juice pomace, wet pomace, dry marmalade	3	1.3 3.4 <0.01 1.1 2.5 <0.01 0.05; 0.04 1.8 8.6 0.42; 0.52	- 2.6 - 0.85 0.04; 0.03 1.36 6.48 0.32; 0.39	Kissling, 1999r (2288/98) treatment b
Apple; Golden Delicious; France (North); Lignieres-de-Touraine[2]	whole fruit washed fruit pasteurized juice pomace, wet pomace, dry apple purée	14	1.93 juice; 1.90 purée 1.50; 1.12 0.80; 0.83; 0.95; 1.04 1.56; 1.93 6.53; 7.67; 8.41; 9.45 0.71; 0.74; 0.89; 0.76	- 0.78; 0.58 0.41; 0.43; 0.49; 0.54 0.81; 1.00 3.38; 3.97; 4.36; 4.90 0.37; 0.39; 0.47; 0.40	Kissling, 1999af (2250/98)
ware potato; Bintje; Netherlands Bant[2]	whole potato potato, peeled potato, peel washed whole potato washed potato, peeled washed potato, peel whole potato, boiled boiled potato, peeled cooking liquid (boiling) whole potato, mw boiled mw boiled potato, peeled cooking liquid (mw) potato, deep fried potato crisps	22	11 0.80 55 2.8; 3.4 0.33; 0.29 14.7; 21.1 1.3; 1.2 0.73; 0.67 4.6; 4.5 2.9; 3.9; 2.8; 3.3 1.8; 1.6; 1.8; 2.1 6.2; 7.0 0.06; 0.17; 0.12; 0.19 0.06; 0.06; 0.09; 0.06	- 0.07 5.0 0.25; 0.31 0.03; 0.03 1.31; 1.88 0.12; 0.10 0.07; 0.06 0.26; 0.35; 0.25; 0.29 0.16; 0.14; 0.17; 0.18 0.005; 0.015; 0.011; 0.017 0.005; 0.005; 0.008; 0.005	Kissling; 1999am (2242/98)
ware potato; Bintje; Netherlands Bant[2]	whole potato potato, peeled potato, peel washed whole potato washed potato, peeled washed potato, peel whole potato, boiled boiled potato, peeled cooking liquid (boiling) whole potato, mw boiled mw boiled potato, peeled cooking liquid (mw) potato, deep fried potato crisps	62	12 0.98 72 2.8; 3.4 0.20; 0.35 16; 17 0.56; 0.93 0.83; 0.92 2.8; 3.8 2.3; 2.8; 4.9; 3.3 1.2; 1.7; 2.2; 1.5 5.4; 7.4 0.04; 0.08; 0.10; 0.12 0.02; 0.06; 0.08; 0.02	- 0.08 6 0.23; 0.28 0.02; 0.03 1.27; 1.38 0.05; 0.08 0.07; 0.07 0.19; 0.23; 0.40; 0.27 0.10; 0.14; 0.18; 0.12 0.003; 0.007; 0.008; 0.010 0.002; 0.005; 0.007; 0.002	Kissling; 1999am (2242/98)

DAT = days after treatment
mw boiled = microwave boiled
[1] field location
[2] first treatment location
[3] second treatment location

RESIDUES IN THE EDIBLE PORTION OF FOOD COMMODITIES

The available information is reported above in ‘Fate of residues in processing’.

RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

Fruit, vegetables and potatoes were analysed in The Netherlands in 1994-1996, 1997 and 1998 for residues of thiabendazole (Anon., 2000). Details of sample collection and analytical methods were not given. Samples in which residues were found are tabulated in Table 14. In 1994-1996 residues were not found in pomelos (n=6), apricots (n=80), peaches (n=252), nectarines (n=221), blackberries (n=244), blue hilberries (n=104), pineapples (n=75), beetroot (n=83), carrots (n=407), small onions (n=97), peppers (n=1525), aubergines (n=148), courgettes (n=206), sweet corn (n=27), brassica vegetables (n=968), leafy vegetables except iceberg lettuce (n=6182), legume vegetables (n=786), fennel (n=52), leeks (441) or rhubarb (n=62).

Table 14. Results of monitoring in The Netherlands of food in commerce (1994-1996, 1997 and 1998).

Group	Commodity	Samples analysed			Samples with residues[1]			Mean residue, mg/kg			Maximum residue, mg/kg		
		'94-'96	'97	'98	'94-'96	'97	'98	'94-'96	'97	'98	'94-'96	'97	'98
Citrus fruit	Grapefruit	301	87	73	129	28	4	0.39	0.40	<0.05	<6.0	<6.0	<6.0
	Lemon	243	51	24	50	2	3	0.22	<0.05	0.07	<6.0	<6.0	<6.0
	Lime	13	10	8	0	1	1		<0.05	<0.05		<6.0	<6.0
	Orange	902	335	124	328	108	29	0.55	0.55	0.31	7.4	?	<6.0
	Tangerine	560	112	70	190	21	16	0.07	0.28	0.30	6.5	<6.0	<6.0
Pome fruit	Apple	1495	398	93	46	4	1	<0.05	<0.05	<0.05	<5.0	<5.0	<5.0
	Pear	366		32	6		2	<0.05		0.12	<5.0		<5.0
Stone fruit	Plum	437			7			<0.05			0.13		
Berries	Grapes	667			7			<0.05			0.15		
	Strawberry	2378	779		6	2		<0.05	<0.05		<5.0	<5.0	
	Raspberry	247			12			<0.05			0.15		
	Currants (red, white, black)	450			2			<0.05			0.06		
Miscella-neous fruit	Avocado	125		25	1		1	<0.05		0.06	0.13		1.8
	Banana	57	38	14	9	10	3	<0.05	0.19	0.16	<3.0	?	<3.0
	Fig	48			2			<0.05			0.07		
	Kiwifruit	223			7			<0.05			0.49		
	Mango	191	63	43	8	2	2	0.12	0.10	0.11	10	2.9	?
	Passion fruit	40			2			<0.05			0.44		
Other fruit and fruit products	-	385	152	51	9	3	1	0.09	0.07	0.18	5.2	?	6.7
Root and tuber vegetables	Radish	1010			1			<0.05			0.06		
Fruiting vegetables	Tomato	1108	1242		14	6		<0.05	<0.05		<2.0	<2.0	
	Cucumber	951	249			1			<0.05			0.12	
	Melon	390	104	51	11	1	2	0.08	<0.05	<0.05	3.3	0.25	?
Brassica vegetables	Broccoli	154		42	0		2			<0.05			<5.0
Leafy vegetables	Iceberg lettuce	471			1			<0.05			0.09		
	Endive	1137		234	0		1			<0.05			1.9
	Other herbs			27			1			<0.05			0.11
Stem vegetables	Celery	233	187		2	2		<0.05	<0.05		0.60	0.74	
Potatoes	Ware potato	325	1437		14	1		<0.05	<0.05		<5.0	<5.0	
Other arable products	-	699	97			2			<0.05			1.6	

[1] Limit of determination 0.05 mg/kg

NATIONAL MAXIMUM RESIDUE LIMITS

National MRLs reported to the Meeting are shown below.

For plant products the residue is defined as thiabendazole. For animal products the residue is defined as the sum of thiabendazole and 5-hydroxy-thiabendazole, expressed as thiabendazole.

Country	Commodity	MRL, mg/kg, expressed as thiabendazole	Residue definition
The Netherlands	Citrus fruit	6	thiabendazole
	Nuts	0.1*	thiabendazole
	Pome fruit	5	thiabendazole
	Strawberry	5	thiabendazole
	Banana	3	thiabendazole
	Onions	0.1	thiabendazole
	Tomato	2	thiabendazole
	Broccoli	5	thiabendazole
	Ware potato	5	thiabendazole
	Tea	0.1*	thiabendazole
	Hops	0.1*	thiabendazole
	Wheat	0.2	thiabendazole
	Rice	0.2	thiabendazole
	Other vegetable products	0.05	thiabendazole
	Muscle, fat, liver, kidney (cow)	0.1	thiabendazole plus 5-OH-thiabendazole
	Milk	0.1	thiabendazole plus 5-OH-thiabendazole
	Other animal products	0.1*	thiabendazole plus 5-OH-thiabendazole
Poland	Citrus fruit	10	thiabendazole
	Banana	3.0	thiabendazole
	Cereal grains	0.05	thiabendazole
	Potato	0.05	thiabendazole
	Eggs	0.1	thiabendazole?

APPRAISAL

Thiabendazole was evaluated by the Joint Meeting in 1997 within the periodic review programme of the CCPR, when it recommended the withdrawal of MRLs for a number of commodities. At its twenty-third session, the CCPR (ALINORM 99/24A, para 65) decided to retain the Codex MRLs for apples, citrus fruits, pears, and strawberries, as new data would become available for review by the Joint Meeting in 2000. Information was made available to the present Meeting on analytical methods for animal products, GAP, and the results of supervised trials on mandarins, oranges, apples, pears, strawberries, avocados, mangoes, papayas, melons, and potatoes.

Thiabendazole is registered in many countries for use as a fungicide before and after harvesting and as a drug in veterinary and human medicine. Its main use in plant protection is after harvesting.

Methods of analysis

Two methods were validated at a LOQ of 0.03 mg/kg for thiabendazole, benzimidazole, and 5-hydroxy-thiabendazole in meat (dairy and poultry), poultry skin with attached fat, eggs, cattle liver,

and cattle kidney. After fortification at 0.03 mg/kg, the mean recovery was 70-99% for thiabendazole, 66-94% for benzimidazole, and 72-105% for 5-hydroxythiabendazole.

Definition of the residue

The 1997 JMPR defined the residue in plant products for compliance with MRLs and for estimation of dietary intake as thiabendazole. For animal products, the residue is defined as the sum of thiabendazole and 5-hydroxythiabendazole for compliance with MRLs, and as the sum of thiabendazole, 5-hydroxythiabendazole, and its sulfate conjugate for estimation of dietary intake.

Results of supervised trials and stability of residues in stored samples

Trials of one or two post-harvest applications were conducted in Spain in 1998 on *orange* and *mandarin*. In eight trials (four on mandarins, four on oranges), the application rate of 2.0 g ai/l corresponded to the Spanish use pattern for single drench applications (0.5-2.2 g ai/l). In five trials (two on mandarins, three on oranges), the rate of 1.8 g ai/l (drench) plus 6.0 g ai/t (spray) were conducted according to the Spanish use pattern for double drench and spray applications (1.0-1.8 g ai/l drench plus 3.3-7 g ai/t spray). Four trials (two on mandarins, two on oranges) of spraying at 3.0 g ai/t plus 4.0 g ai/t were conducted for a new registration and did not correspond to an existing GAP; these data could therefore not be used to estimate maximum residue levels.

The concentrations of residues in mandarins (whole fruit) remained stable or decreased slightly during storage up to 15 days. The concentrations were higher after longer single drench treatment (30 s versus 150 s) and with more treatments (single versus double). With the double treatments, there was no difference between short and long drenching times. The concentrations of residues of thiabendazole in trials that complied with the GAP (median in italics) were 0.50, 0.65, ***1.4***, ***1.6***, and 2.2 (2 trials) mg/kg in the whole fruit and *0.01* (3 trials), *0.03*, 0.04, and 0.09 mg/kg in the pulp.

The concentrations of residues in oranges (whole fruit) remained stable or decreased slightly during storage up to 15 days. The concentrations were higher after longer single drench treatment (30 s versus 150 s) and with more treatments (single versus double). With the double treatments, there was no difference between short and long drenching times. The concentrations of residues of thiabendazole in trials that complied with the GAP were 0.40, 0.53, 1.1, ***1.2***, 1.6 (2 trials), and 1.9 mg/kg in the whole fruit and <*0.01* (4 trials) and 0.01 (3 trials) mg/kg in the pulp.

The Meeting observed that the results for mandarin and orange are comparable. Since this is to be expected from post-harvest treatment, the Meeting decided to combine the data on these two citrus fruits. The concentrations of residues of thiabendazole in trials on mandarin and orange that complied with GAP were 0.40, 0.50, 0.53, 0,65, 1.1, 1.2, ***1.4***, 1.6 (3 trials), 1.9, and 2.2 (2 trials) mg/kg in the whole fruit and <0.01 (4 trials), ***0.01*** (6 trials), 0.03, 0.04, and 0.09 mg/kg in the pulp.

The Meeting estimated a maximum residue level of 3 mg/kg for thiabendazole in unwashed whole citrus fruit arising from double post-harvest application (drench plus spray) to replace the previous recommendation of 10 mg/kg for citrus fruits. The Meeting estimated an STMR value of 0.01 mg/kg and a HR value of 0.09 mg/kg for thiabendazole in the edible part of citrus fruit (pulp).

Post-harvest residue trials were conducted in northern France in 1998 and in Spain in 1991 on *apple* and *pear* treated by a single post-harvest dip or drenching at 1.1 g ai/l. Eight trials carried out in France were evaluated against the Belgian use pattern for apples and pears of 1.0 g ai/l. The concentrations of residues were maintained during storage up to 30 days, and those after dipping or drenching for 45-120 s were similar. Four trials in Spain, two on apples and two on pears, were conducted according to the national use pattern (0.9-1.3 g ai/l) but could not be evaluated because of conflicting analytical results and insufficient detail in the description of the analytical methods used.

The concentrations of thiabendazole residues in the trials in France were 1.5, 1.6, ***1.7*** (4 trials), 1.9, and 2.0 mg/kg**.**

One trial of the use of a paste formulation of thiabendazole for the treatment of wounds was conducted in Germany in 1998 on apple trees before flowering. The trial was according to the national GAP. It confirmed that residues would not be expected in pome fruit after wound treatment (<0.05 mg/kg).

Although all the information available came from trials on apples, the Meeting considered that similar residues would be found in pears treated after harvesting. The Meeting therefore estimated a maximum residue level of 3 mg/kg for thiabendazole in pome fruit (apple and pear) arising from single post-harvest applications. Since no new data were provided on pre-harvest uses on apples and pears, the Meeting confirmed the 1997 decision to recommend the withdrawal of the CXLs of 10 mg/kg for apples and 10 mg/kg for pears for these uses. The Meeting estimated an STMR value of 1.7 mg/kg and a HR value of 2.0 mg/kg for thiabendazole in pome fruit (apple and pear) arising from single post-harvest applications.

Seven trials were conducted in Spain in 1989, 1991, and 1993 on *strawberry* sprayed once before harvesting. The concentrations of residues decreased with longer intervals before harvesting (up to 14 days). The trials in 1991 and 1993 (one in macro-tunnels and four in the open field) at 90 g ai/hl and the trials in 1989 (one under plastic and one in the open field) at 70 g ai/hl were conducted according to the Spanish use pattern (Annex 6, reference 80, p. 795: 0.30-0.90 kg ai/ha, 45-90 g ai/hl; PHI, 3 days). The concentrations of residues were similar in trials conducted indoors and in the open field. The concentrations of thiabendazole in trials that complied with the Spanish GAP were 0.43, 1.3, ***1.6*** (2 trials), 2.3, 2.6, and 2.7 mg/kg.

On the basis of the seven Spanish trials, the Meeting estimated a maximum residue level of 5 mg/kg, an STMR value of 1.6 mg/kg, and a HR value of 2.7 mg/kg for strawberries.

Eighteen trials of post-harvest application were conducted on *avocado* in South Africa in 1977 and Costa Rica in 1996. The concentrations of residues decreased during storage. The trials in South Africa (one at 3.0 g ai/l and one at 6.0 g ai/l) were not conducted according to the national use pattern (0.35-1.36 g ai/l), but the use pattern in Kenya (1.1-3.4 g ai/l) can be used to evaluate the trial conducted at 3.0 g ai/l, which showed a residue concentration on the day of treatment of 3.8 mg/kg in stoneless fruit. The 16 trials in Costa Rica, conducted at 3.25 g ai/l of suspension concentrate formulations applied by dip or spray, were also evaluated against the Kenyan use pattern. Spray application resulted in higher concentrations than a 3-min dip. The concentrations of thiabendazole in trials that complied with the Kenyan GAP were 3.8, 4.8, 5.0, 5.6, 6.0, 6.2, 6.7, 6.9, ***7.0***, 7.1, 7.8, 8.0, 8.1, 8.9, 11 (2 trials), and 14 mg/kg in stoneless fruit. In the two South African trials, residues were measured in both stoneless fruit and flesh 0, 3, and 7 days after treatment, providing ratios of residue in flesh versus stoneless fruit of 0.13 ± 0.02.

According to the Codex classification, the portion of the commodity to which the MRL applies and which is analysed is the whole commodity after removal of the stone but calculated on the basis of the whole fruit. The manufacturer provided a study which indicated that the avocado stone contributes about 15% to the weight of the whole fruit. Therefore, the concentrations of residues were multiplied by a factor of 1/1.15 = 0.87, resulting in concentrations of 3.3, 4.2, 4.4, 4.9, 5.2, 5.4, 5.8, 6.0, ***6.1***, 6.2, 6.8, 7.0 (2 trials), 7.7, 9.6 (2 trials), and 12 mg/kg in the whole fruit.

In order to obtain the values for the edible portion of avocado, the concentrations in stoneless fruit were multiplied by the ratio of 0.13 for concentrations in flesh versus stoneless fruit obtained in the South African trials. This yielded concentrations in avocado flesh of 0.5, 0.6, 0.7 (2 trials), 0.8 (2 trials), ***0.9*** (4 trials), 1.0 (2 trials), 1.1, 1.2, 1.4 (2 trials), and 1.8 mg/kg.

The Meeting estimated a maximum residue level of 15 mg/kg for thiabendazole in avocado (whole fruit) arising from a single post-harvest application. The Meeting estimated an STMR value of 0.9 mg/kg and a HR value of 1.8 mg/kg for thiabendazole in the edible portion of avocado.

Twelve trials on *mango* treated by dip or spray after harvesting were conducted in Brazil in 1994 and Belize in 1996. For the trials in Brazil (two at 1.98 g ai/l and two at 3.96 g ai/l by dipping in a wettable powder formulation), no national use pattern was available, but that in Venezuela (drenching; 0.9-1.8 g ai/l) can be used to evaluate the two trials at 1.98 g ai/l. The concentrations of residues on the day of treatment were <0.03 and 0.03 mg/kg for pulp; those in whole fruit were not reported. For the eight trials in Belize (at 2.5 g ai/l by dipping or spraying with suspension concentrate formulations), no national use pattern was available, but that of Guatemala (1.0-2.5 g ai/l) can be used. The concentrations of residues in stoneless fruit (with peel) were 1.9, 2.1, and *2.6* mg/kg after dipping and ***3.1***, 3.9, 4.3, and 4.6 mg/kg after spraying. The Meeting noted that, contrary to what might be expected, spray application resulted in marginally higher concentrations of residues. It nevertheless decided to combine the data sets.

According to the Codex classification, the portion of the commodity to which the MRL applies and which is analysed is the whole commodity after removal of the stone but calculated on the basis of the whole fruit. The manufacturer provided a study which indicated that the mango stone contributes 20-23% to the weight of the whole fruit. Therefore, the concentrations of residues were multiplied by a factor of 1/1.20 = 0.83, yielding values of 1.6, 1.7, ***2.2*** (2 trials), ***2.6***, 3.2, 3.6, and 3.8 mg/kg in the whole fruit.

The Meeting estimated a maximum residue level of 5 mg/kg for thiabendazole in whole mangoes arising from a single post-harvest application. The Meeting estimated an STMR value of 2.85 mg/kg and a HR value of 4.6 mg/kg for thiabendazole in stoneless mangoes, since insufficient information on the residue in the edible portion was available.

Eight trials were conducted in Costa Rica in 1996 on *papaya* treated after harvesting at 2.0 g ai/l by dipping or spraying with suspension concentrate formulations. They were evaluated in comparison with the GAP in the USA (1.0-2.0 g ai/l). The concentrations of thiabendazole were 3.2, 3.5, ***3.8*** (3 trials), 4.2, and 5.1 (2 trials) mg/kg.

The Meeting estimated a maximum residue level of 10 mg/kg for thiabendazole in whole papayas arising from a single post-harvest application. The Meeting estimated an STMR value of 3.8 mg/kg and a HR value of 5.1 mg/kg in whole papayas, as information was not available on the residue in the edible portion.

Trials were conducted in Spain in 1997 on *melon* in plastic greenhouses sprayed three times before harvesting. Eight trials at three applications of 0.9 kg ai/ha (200 g ai/hl) were conducted according to the Spanish use pattern (Annex 6, reference 80, p. 795: 0.45-0.90 kg ai/ha; 68-90 g ai/hl; PHI, 3 days). In four of the trials, residues were measured only 0 and 7 days after treatment. Data from day 0 in these trials and from day 3 in the other four trials were used, except when the values obtained after the longer PHI were higher. The concentrations in whole fruit were 0.19 (2 trials), 0.31, ***0.42***, ***0.44***, 0.53, 0.57, and 0.82 mg/kg.

The Meeting estimated a maximum residue level of 1 mg/kg for thiabendazole in whole melons arising from pre-harvest application. The Meeting estimated an STMR value of 0.43 mg/kg and a HR value of 0.82 mg/kg for thiabendazole in whole melon, as information on the residue in the edible portion was not available.

Eight trials of a single post-harvest application of suspension concentrate formulations by spinning-disc spray were conducted on *potato* in The Netherlands in 1998. Four trials at 30 g ai/t were conducted according to the Dutch use pattern for this formulation (30 g ai/t; PHI, 60 days). For the remaining four trials (at 60 g ai/t), no Dutch use pattern was available, and the French use pattern (60

g ai/t; spray; no PHI specified) was used. The concentrations of residue in unpeeled tubers remained unchanged during storage up to 178 days. As the values in the trials at 30 and 60 g ai/t were not significantly different, the residues were treated as one group. The highest concentrations of residues in whole potato tubers were 2.4, 3.2, 5.4, ***5.6***, ***7.9***, 8.0, 9.3, and 11 mg/kg.

In trials of post-harvest treatment of potatoes from the United Kingdom and the USA evaluated by the Meeting in 1997, the concentrations of residues of thiabendazole on unwashed potatoes were 1.9, 2.0, 2.2, 2.4, ***2.6***, ***4.2***, 5.4, 5.5, 7.3, and 11 mg/kg.

Since the data sets evaluated in 1997 and by the present Meeting represent the same population, the Meeting decided to combine the two. The concentrations were 1.9, 2.0, 2.2, 2.4 (2 trials), 2.6, 3.2, 4.2, 5.4 (2 trials), 5.5, 5.6, 7.3, 7.9, 8.0, 9.3, and 11 (2 trials) mg/kg. The Meeting confirmed the maximum residue level of 15 mg/kg for thiabendazole in whole potatoes proposed by the 1997 JMPR. The present Meeting established an STMR value of 5.4 mg/kg to replace the previous STMR value of 3.4 mg/kg and a HR value of 11 mg/kg.

Fate of residues during processing

Information was provided to the Meeting on the fate of thiabendazole during the processing of oranges, apples, and potatoes.

Washing removed 19-65% of the residue from *oranges*, and the remainder was concentrated in wet and dry pomace. The calculated mean processing factors in two trials of industrial processing of oranges were 0.6 for washing, 0.08 for pasteurized juice, 0.3 for marmalade, *1.2* for wet pomace, and *5.7* for dry pomace.

The processing factors derived by the 1997 JMPR related to washed fruit, except those for marmalade made in a preserving pan (0.32) and in a microwave oven (0.37), which agree with that calculated by the present Meeting.

The median residue concentrations in processed commodities (STMR-P) calculated from the processing factors and the STMR value for unwashed whole citrus fruit (1.4 mg/kg) in supervised trials were 0.08 x 1.4 = 0.11 mg/kg for pasteurized orange juice; 0.3 x 1.4 = 0.42 mg/kg for marmalade; 1.2 x 1.4 = 1.7 mg/kg for wet orange pomace; and 5.7 x 1.4 = 8.0 mg/kg for dry orange pomace.

Washing removed 20-42% of the residue from *apples*, and the residue was concentrated in dry pomace. The calculated industrial processing factors for *apples* were *0.68* for washing, 0.47 for pasteurized juice, 0.41 for apple sauce, 0.92 for wet pomace, and 4.2 for dry pomace.

The median residue concentrations in processed commodities (STMR-P) calculated from the processing factors and the STMR value for whole apples (1.7 mg/kg) were 0.47 x 1.7 = 0.8 mg/kg for pasteurized apple juice; 0.41 x 1.7 = 0.7 mg/kg for apple sauce (purée); 0.92 x 1.7 = 1.6 mg/kg for wet apple pomace; and 4.2 x 1.7 = 7.1 mg/kg for dry apple pomace.

The Joint Meeting in 1997 discussed processing studies on potatoes extensively and noted that residues are transferred from the peel to the potatoes during peeling, as the average concentration was 1.54 mg/kg in potatoes peeled before washing and 0.08 mg/kg in those peeled after washing. Potatoes are always washed before peeling during industrial processing and either before or after peeling or both in the kitchen. In 1997, the Meeting therefore concluded that it was more appropriate to estimate the effect of peeling washed potatoes. By multiplying the STMR value derived in 1997 by the processing factors for both washing and peeling, the 1997 Meeting estimated an STMR-P value for washed peeled potatoes of 0.02 mg/kg and an STMR-P value of 0.44 mg/kg for washed potatoes.

The effects of frying, microwave and oven cooking, washing, boiling, baking, and crisping of potatoes treated with thiabendazole were also evaluated in 1997. That Meeting concluded that baking and frying did not change the residue content substantially. Furthermore, noting that baked potatoes may be consumed with or without the peel and fried potatoes may be prepared in a variety of ways, the 1997 Meeting recommended the use of STMR-P values for washed potatoes (0.44 mg/kg) and for washed peeled potatoes (0.02 mg/kg) for estimating dietary intake.

The present Meeting received the results of a new trial of the effects of washing, boiling, and frying of potatoes and the preparation of potato crisps. The calculated mean processing factors for unwashed potatoes were 0.08 for peeling, 0.27 for washing, 0.03 for peeling and washing, 0.09 for boiling, 0.07 for peeling after boiling, 0.29 for microwave boiling, 0.15 for peeling after microwave boiling, 0.01 for deep frying, and 0.00 for crisp processing. The mean of the processing factors for washing derived in 1997 and by the present Meeting was 0.2.

The Meeting agreed with the decision of the 1997 Meeting to use only the STMR-P values for washed and washed and peeled potatoes for estimating dietary intake. The median residue concentrations in processed commodities (STMR-P) calculated from the processing factors and the STMR value for unwashed whole potatoes (5.4 mg/kg) were 1.08 mg/kg (0.2 x 5.4) for washed potatoes and 0.16 mg/kg (0.03 x 5.4) for washed peeled potatoes. These STMR-P values replace the previous recommendations. Furthermore, an STMR-P value for wet potato peel of 30 mg/kg (5.5 x 5.4) is recommended for estimating animal dietary intake.

Residues in animal and poultry commodities

The Meeting estimated the dietary burden of thiabendazole residues in farm animals on the basis of the diets listed in Appendix IX of the *FAO Manual* (FAO, 1997). Calculation from MRLs (or HR values) provides concentrations in feed suitable for estimating MRLs for animal commodities, while calculation from STMR values for feed is suitable for estimating STMR values for animal commodities.

Commodity	HR, mg/kg	Group	% dry matter	HR/ dry matter	% of diet			Concentration of residue, mg/kg		
					Beef cattle	Dairy cows	Poultry	Beef cattle	Dairy cows	Poultry
Wet apple pomace	1.8 (0.92 x 2.0)	AB	40	4.5	-	-	-	-	-	-
Dry citrus pulp	12.5 (5.7 x 2.2)	AB	91	13.7	20	20	-	2.74	2.74	-
Wet potato peel	60 (5.5 x 11)	SM	15	400	75	40	-	300	160	-
Total								303	163	-

Commodity	STMR, mg/kg	Group	% dry matter	STMR/ dry matter	% of diet			Concentration of residue, mg/kg		
					Beef cattle	Dairy cows	Poultry	Beef cattle	Dairy cows	Poultry
Wet apple pomace	1.6 (0.92 x 1.7)	AB	40	4.0	-	-	-	-	-	-
Dry citrus pulp	8.0 (5.7 x 1.4)	AB	91	8.8	20	20	-	1.76	1.76	-
Wet potato peel	30 (5.5 x 5.4)	SM?	15	200	75	40	-	150	80	-
Total								152	82	-

The dietary burdens of thiabendazole used for estimating MRLs and STMR values (residue concentrations in animal feeds expressed as dry weight) are 303 and 152 ppm for beef cattle and 163 and 82 ppm for dairy cows. Poultry are not exposed to thiabendazole residues. In the 28-day study evaluated by the 1997 JMPR in which dairy cows were fed diets containing 25, 75, or 250 ppm thiabendazole, the mean concentrations of thiabendazole and 5-hydroxythiabendazole residues on day 29 were 0.02 mg/kg in fat, 0.60 mg/kg in kidney, 0.21 mg/kg in liver, and 0.02 mg/kg in muscle at

250 ppm; and 0.03 mg/kg in fat, 0.27 mg/kg in kidney, 0.13 mg/kg in liver, and 0.02 mg/kg in muscle at 75 ppm. The highest concentration of thiabendazole plus 5-hydroxythiabendazole in milk reached on day 28 was 0.15 mg/kg at 250 ppm and 0.12 mg/kg at 75 ppm. The results with the lower dose indicated that a plateau had already been reached by day 28.

The residue definition for dietary intake of animal products is the sum of thiabendazole, 5-hydroxy-thiabendazole, and its sulfate conjugate. The sulfate conjugate is included since it is the main residue in milk. In the analytical method used for milk (Annex 6, reference 80, p. 791), the sulfate conjugate is presumed to be hydrolysed to 5-hydroxythiabendazole. The Meeting therefore estimated STMR values for cattle kidney, liver, meat, and milk on the basis of the feeding study evaluated by the 1997 Meeting.

The Meeting thus recommended withdrawal of the existing proposed MRLs and STMR values for cattle milk, meat, and edible offal. It estimated maximum residue levels of 1 mg/kg in cattle kidney, 0.3 mg/kg in cattle liver, 0.1 mg/kg in cattle meat, and 0.2 mg/kg in cows' milk, and STMR values of 0.5 mg/kg in cattle kidney, 0.2 mg/kg in cattle liver, 0.02 mg/kg in cattle meat, and 0.12 mg/kg in cows' milk.

At its thirty-second session, the CCPR requested (ALINORM 01/24, paragraph 104) the Joint Meeting to review the MRL for edible offal of cattle. It noted that the residue definition includes the sum of thiabendazole and 5-hydroxythiabendazole and considered that the MRL of 0.1 mg/kg might be too low.

The 1997 JMPR reviewed a study of transfer in ruminants within the periodic review of thiabendazole and recommended MRLs for cattle meat, milk, and offal. A MRL of 0.1 mg/kg was recommended for offal. At the recommended feeding level at that time of 25 ppm, the maximum concentrations of thiabendazole residues were 0.020 mg/kg in kidney and 0.049 mg/kg in liver. The LOQ of the analytical methods was reported to be 0.1 mg/kg for each analyte. Thus, the appropriate MRL would necessarily be 0.1 mg/kg plus 0.1 mg/kg or 0.2 mg/kg.

The manufacturer has now indicated that the LOQ of two methods for thiabendazole, benzimidazole, and 5-hydroxythiabendazole has been validated at 0.03 mg/kg. The combined LOQ would be 0.06 mg/kg, that is, 0.03 plus 0.03 mg/kg, on the basis of the Codex residue definition. The average recoveries of thiabendazole, benzimidazole, and 5-hydroxythiabendazole from cattle liver fortified at 0.03 mg/kg with each analyte were 90, 69, and 94%, respectively, and those from cattle kidney similarly fortified were 75, 105, and 65%, respectively (n = 6-8). The standard deviation for liver was excessive (17-23%).

The Meeting concluded that the proposed MRL of 0.1 mg/kg for the combined residue of thiabendazole and 5-hydroxythiabendazole, expressed as thiabendazole, in offal is appropriate, given the recent validations of the analytical method at 0.03 mg/kg for each analyte. However, in the light of the new data evaluated by the present Meeting (see above), the proposal is withdrawn and replaced by a recommendation for a maximum residue level of 1 mg/kg in cattle kidney and 0.3 mg/kg in cattle liver.

RECOMMENDATIONS

The Meeting estimated the maximum residue levels and STMRs shown below. The maximum residue levels are recommended for use as MRLs.

Definition of the residue for compliance with MRLs and estimation of dietary intake for plant commodities: thiabendazole. For compliance with MRLs for animal commodities: sum of thiabendazole and 5-hydroxythiabendazole. For estimation of dietary intake for animal commodities: sum of thiabendazole, 5-hydroxythiabendazole and its sulfate conjugate.

Commodity		MRL, mg/kg		STMR, mg/kg	HR, mg/kg
CCN	Name	New	Previous		
FP 0226	Apple	W[1]	W[2]		
JF 0226	Apple juice			0.8	
AB 0226	Apple pomace, dry			7.1	
	Apple pomace, wet			1.6	
	Apple purée			0.7	
FI 0326	Avocado	15 Po	-	0.9	1.8
MM 0812	Cattle meat	0.1	0.05	0.02	0.02
ML 0812	Cattle milk	0.2	0.05	0.12	0.15
MO 0812	Cattle, Edible offal of	W	0.1		
M0 1280	Cattle, kidney	1		0.5	0.6
MO 1281	Cattle, liver	0.3		0.2	0.21
FC 0001	Citrus fruits	3 Po	W[2]	0.01	0.09
FI 0345	Mango	5 Po	-	2.85	4.6
VC 0046	Melons, except Watermelon	1	-	0.43	0.82
JF 0004	Orange juice			0.11	
	Orange pomace, dry			8	
	Orange pomace, wet			1.7	
FI 0350	Papaya	10 Po	-	3.8	5.1
FP 0230	Pear	W[1]	W[2]		
FP 0009	Pome fruits	3 Po	-	1.7	2.0
VR 0589	Potato	15 Po	15	5.4	
	Potato peel, wet			30	
	Potato, washed			1.08	
	Potato, washed and peeled			0.16	11
FB 0275	Strawberry	5	W	1.6	2.7

[1] Now included in recommendation for Pome fruits
[2] Recommendation of the 1997 JMPR

Dietary risk assessment

Chronic intake

STMR values have been estimated for 13 commodities, and the 1997 JMPR estimated STMR values for five additional commodities: bananas, mushrooms, poultry meat and eggs, and witloof chicory (sprouts).

The international estimated daily intakes from the five GEMS/Food regional diets, based on estimated STMR values, represented 1-9% of the ADI of 0-0.1 mg/kg bw. The Meeting concluded that long-term intake of residues of thiabendazole resulting from uses that have been considered by the JMPR is unlikely to present a public health concern.

Short-term intake

The toxicological profile of thiabendazole includes effects of concern that would indicate a need for an acute RfD. The Meeting recommended that this task be referred to JECFA, which conducted the most recent toxicological assessment of this chemical.

The IESTI for thiabendazole was calculated as described in Section 3 for the commodities for which maximum residue levels and STMR values were estimated and for which data on consumption were available. The results are shown in Annex 3. The IESTI varied from 0 to 0.287 mg/kg bw for the

general population and from 0 to 0.939 mg/kg bw for children. As no acute RfD has been established yet, the risk assessment for thiabendazole was not finalized.

REFERENCES

Anon. 1977. Report on thiabendazole residues in avocado pears. South Africa. 0311/8833/P295, Merck & Co. Inc. USA. Unpublished.

Anon. 1998. Residues data summary from supervised trials. Thiabendazole, apples. Federal Biological Research Centre for Agriculture and Forestry (BBA), Germany. Study Nr. 004956, BBA No. 3688. Unpublished.

Anon. 2000. Information of The Netherlands to be considered by the JMPR 2000, for the compound thiabendazole. Ministry of Health, Welfare and Sport, Public Health Department, Den Haag, The Netherlands, May 25, 2000. Unpublished.

Bull, M.S. and Adams, S. 1987. Residues of methidathion on avocados following multiple applications with Supracide. Technical Memorandum No. M87/4/1115. Ciba-Geigy Australia. Unpublished.

Garozi M.J. and Piffer R. 1996a. Avaliaçao de residuos de thiabendazole na casca e polpa de manga (Mangifera indica) apos a apliccaçao em pos-colheita com o fungicida tecto 600 PM. Merck Sharp & Dohme. Sao Paulo. Brazil. Unpublished. (Translated by P. Dieterle, Novartis, on request: Evaluation of residues of thiabendazole on peel and pulp of mangoes (Mangifera indica) after post-harvest application of the fungicide Tecto 60 WP)

Garozi M.J. and Piffer R. 1996b. Avaliaçao de residuos de thiabendazole na casca e polpa de manga (Mangifera indica) apos a apliccaçao em pos-colheita com o fungicida tecto 600 PM. Merck Sharp & Dohme. Sao Paulo. Brazil. Unpublished. (Translated by P. Dieterle, Novartis, on request: Evaluation of residues of thiabendazole on peel and pulp of mangoes (Mangifera indica) after post-harvest application of the fungicide Tecto 60 WP)

Kissling, M. 1999a. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2276/98. Novartis Crop Protection AG, Switzerland. Unpublished

Kissling, M. 1999b. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2277/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999c. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2278/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999d. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2279/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999e. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2284/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999f. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2285/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999g. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2286/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999h. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2287/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999i. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2292/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999j. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2293/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999k. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2294/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999l. Residue study with Thiabendazole (MK 360) in or on mandarins in Spain. Rep. No. 2295/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999m. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2280/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999n. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2281/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999o. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2282/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999p. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2283/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999q. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2289/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999r. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2288/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999s. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2290/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999t. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2291/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999u. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2296/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999v. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2297/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999w. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2298/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999x. Residue study with Thiabendazole (MK 360) in or on oranges in Spain. Rep. No. 2299/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999y. Residue study with Thiabendazole (MK 360) in or on apples in France (North). Rep. No. 2243/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999z. Residue study with Thiabendazole (MK 360) in or on apples in France (North). Rep. No. 2244/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999aa. Residue study with Thiabendazole (MK 360) in or on apples in France (North). Rep. No. 2245/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999ab. Residue study with Thiabendazole (MK 360) in or on apples in France (North). Rep. No. 2246/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999ac. Residue study with Thiabendazole (MK 360) in or on apples in France (North). Rep. No. 2247/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999ad. Residue study with Thiabendazole (MK 360) in or on apples in France (North). Rep. No. 2248/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999ae. Residue study with Thiabendazole (MK 360) in or on apples in France (North). Rep. No. 2249/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999af. Residue study with Thiabendazole (MK 360) in or on apples in France (North). Rep. No. 2250/98. Novartis Crop Protection AG, Switzerland. Unpublished.

Kissling, M. 1999ag. Residue Study with Thiabendazole (MK 360) in or on Potatoes in Netherlands. Rep. No. 2235/98. Novartis Crop Protection AG, Switzerland. Unpublished

Kissling, M. 1999ah. Residue Study with Thiabendazole (MK 360) in or on Potatoes in Netherlands. Rep. No. 2236/98. Novartis Crop Protection AG, Switzerland. Unpublished

Kissling, M. 1999ai. Residue Study with Thiabendazole (MK 360) in or on Potatoes in Netherlands. Rep. No. 2237/98. Novartis Crop Protection AG, Switzerland. Unpublished

Kissling, M. 1999aj. Residue Study with Thiabendazole (MK 360) in or on Potatoes in Netherlands. Rep. No. 2238/98. Novartis Crop Protection AG, Switzerland. Unpublished

Kissling, M. 1999ak. Residue Study with Thiabendazole (MK 360) in or on Potatoes in Netherlands. Rep. No. 2239/98. Novartis Crop Protection AG, Switzerland. Unpublished

Kissling, M. 1999al. Residue Study with Thiabendazole (MK 360) in or on Potatoes in Netherlands. Rep. No. 2240/98. Novartis Crop Protection AG, Switzerland. Unpublished

Kissling, M. 1999am. Residue Study with Thiabendazole (MK 360) in or on Potatoes in Netherlands. Rep. No. 2241/98. Novartis Crop Protection AG, Switzerland. Unpublished

Ministry of Health, Welfare and Sport. 1996a. Multi-residue Methods, Part I, Multi-residue method I, Pesticides amenable to gas chromatography. p. 1-5 and p. 17-22, Annex A p. 8, Annex B p. 7, Annex C p. 7, Annex D p. 10. In: Analytical Methods for Pesticide Residues in Foodstuffs, 6th ed, SDU Publishers. The Hague. The Netherlands.

Ministry of Health, Welfare and Sport. 1996b, The Netherlands. Special Methods, Part II, Benomyl/carbendazim/thiabendazole. In: Analytical Methods for Pesticide Residues in Foodstuffs, 6th ed, SDU Publishers. The Hague. The Netherlands.

Morton, J.F. 1987. In: Fruits of warm climates, Mango p221-239. Miami, Fl.

Rice, F. and Fieser, J.A. 1997a. Magnitude of the residue of thiabendazole in or on the raw agricultural commodity avocado. ABC Laboratories Rep. No. 43327. Merck & Co, New Jersey, USA. Unpublished.

Rice, F. and Fieser, J.A. 1997b. Magnitude of the residue of thiabendazole in or on the raw agricultural commodity mango. ABC Laboratories Rep. No. 43326. Merck & Co, New Jersey, USA. Unpublished.

Rice, F. and Fieser, J.A. 1997c. Magnitude of the residue of thiabendazole in or on the raw agricultural commodity papaya. ABC Laboratories Rep. No. 43325. Merck & Co, New Jersey, USA. Unpublished.

Sanchez, J. 1997. Thiabendazole residues in melons after foliar application with 480 SC formulation in Spain. Laboratoria Quimico Microbiologico SA. Murcia. Spain. Rep. No. PNT-EST-13. Unpublished.

Spain. 1991. Residue levels of thiabendazole in strawberry; Summary of trial nr. HU 1-89 and HU 2-89. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1992. Residue levels of thiabendazole in strawberry; Summary of trial nr. 065-91-9010R and 065-91-9011R. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1993a. Study on the degradation of thiabendazole in strawberry crops. Rep. No. 065-93-9007. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1993b. Study on the degradation of thiabendazole in strawberry crops. Rep. No. 065-93-9008. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1993c. Study on the degradation of thiabendazole in strawberry crops. Rep. No. 065-93-9011. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1993d. Study on the degradation of thiabendazole in strawberry crops. Rep. No. 065-93-9012. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1993e. Study on the degradation of thiabendazole in strawberry crops. Rep. No. 065-93-9013. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1993f. Study on the degradation of thiabendazole in strawberry crops. Rep. No. 065-93-9014. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1993g. Study on the degradation of thiabendazole in strawberry crops. Rep. No. 065-93-9009. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Spain. 1993h. Study on the degradation of thiabendazole in strawberry crops. Rep. No. 065-93-9010. Merck Sharp & Dohme SA. Madrid. Spain. Unpublished.

Tecnidex. 1992. Report on the pre-registration trial of the post-harvest use of the fungicidal formulation TECTO 20S (ARBOTECT) in pomes. Tecnidex, S.A., Spain. Unpublished.