FENPROPIMORPH (188)

EXPLANATION

Fenpropimorph was first evaluated for residues by the 1995 JMPR. That Meeting estimated maximum residue levels which were recommended for use as MRLs for cereals (barley, oats, rye and wheat), cereal straw and fodder (dry), sugar beet, and fodder beet leaves or tops. Further work or information was desirable, among other items, on livestock and poultry feeding studies with determination of fenpropimorph and the major metabolites identified in the metabolism studies (e.g. BF 421-1, BF 421-2 and BF 421-3), and validated analytical regulatory methods (including representative chromatograms) for the determination of fenpropimorph and its major metabolites in animal products.

The 1997 CCPR noted that animal transfer studies were being developed (ALINORM 97/24A, para 77). The 1998 CCPR noted such studies would be available to the 1999 JMPR and that the draft MRL for sugar beet should be 0.05 mg/kg (*). The Committee postponed discussions and scheduled the residue evaluation of fenpropimorph for the 1999 JMPR (ALINORM 99/24, para 80 and Appendix II).

Information on GAP, a dairy cattle feeding study, an analytical method for animal products, and a metabolism study and residue trials on bananas were reported to the present Meeting by the manufacturers (Burkey, 1997). Information on national MRLs and GAP was provided by Poland and The Netherlands, and on GAP by Germany and the UK.

METABOLISM AND ENVIRONMENTAL FATE

Plant metabolism

Hamm (1997) treated banana plants four times at the twofold application rate of 0.9 kg ai/ha with [*morpholine*-2,6-^{14}C] and [U-*phenyl*-^{14}C]fenpropimorph. Because in commercial practice growing bunches are protected against insects by a plastic bag which can be destroyed leaving the fruit unprotected, trials were on bagged and unbagged bananas. The intervals between the four applications were 14, 51 and 12 days. All samples were taken one day after the last application.

Table 1. Total radioactive residues in bananas, mg/kg as fenpropimorph (Hamm, 1997).

Sample	Unripe unbagged		Ripe unbagged		Unripe bagged		Ripe bagged	
	morpholine label	phenyl label	morpholine label	phenyl label	Morpholine Label	phenyl label	morpholine label	phenyl label
Peel	0.42	0.22	0.41	0.19	0.18	0.038	0.22	0.04
Pulp	0.79	0.042	0.73	0.025	0.43	0.018	0.38	0.017
Whole fruit	0.67	0.105	0.61	0.094	0.35	0.025	0.32	0.026

On a whole fruit basis, the maximum TRR from the morpholine label was about 0.67 mg/kg in unripe, unbagged and 0.61 mg/kg in ripe, unbagged bananas. The corresponding residues in bagged bananas were 0.35 and 0.32 mg/kg. Phenyl-labelled bananas contained significantly lower TRRs: 0.11 mg/kg (unripe, unbagged) and 0.09 mg/kg (ripe, unbagged), with corresponding residues in bagged bananas of 0.025 and 0.026 mg/kg (Table 1).

About 73–88% of the TRR in whole ripe fruit and 27% to 72% of that in unripe fruit was extractable with methanol (Table 2).

Table 2. Methanol-extractability of ^{14}C in whole bananas (Hamm, 1997).

	^{14}C fenpropimorph , mg/kg and (% of TRR)							
	Unbagged ripe fruit		Unbagged unripe fruit		Bagged unripe fruit		Bagged unripe fruit	
	morpholine label	phenyl label	morpholine label	phenyl label	morpholine label	phenyl label	morpholine label	phenyl label
TRR	0.61 (100)	0.094(100)	0.67 (100)	0.11 (100)	0.32 (100)	0.026(100)	0.35 (100)	0.025 (100)
MeOH extract	0.51 (83)	0.078 (88)	0.14 (27)	0.082 (72)	0.23 (73)	0.021 (84)	0.07 (27)	0.014 (49)
Residue	0.097 (17)	0.014 (14)	0.5 (68)	0.023 (29)	0.01 (31)	0.005 (17)	0.26 (69)	0.011 (55)

The TRR is higher in fruit treated with morpholine-labelled than phenyl-labelled fenpropimorph because the morpholine ring can be opened and the resulting ^{14}C fragments incorporated during assimilation processes in leaves and growing and ripening fruits. The assimilation products are translocated from leaves, and to some extent from fruits, by the phloem to the storage parenchyma of the bananas and transformed to starch which is enzymatically hydrolysed to mono- and disaccharides during ripening. The highest content of ^{14}C-labelled sugars (76% of the TRR) was found in unbagged ripe fruit. No ^{14}C can be incorporated from the phenyl label, so the TRR is low.

The methanol extract of morpholine labelled samples showed two major HPLC peaks, one non-polar identified by MS as fenpropimorph, and the other polar identified by acetylation and HPLC as a mixture of the natural assimilation products glucose, fructose and saccharose. Phenyl-labelled samples showed only one prominent HPLC peak which was identified as fenpropimorph. Table 3 shows the residues of the unchanged parent.

Table 3. [^{14}C]fenpropimorph found in banana metabolism study (Hamm, 1997).

Banana sample	Fenpropimorph, mg/kg, and % of TRR			
	Morpholine label		Phenyl label	
	mg/kg	% TRR	mg/kg	% TRR
Unbagged, unripe	0.07	15.5	0.064	60.5
Unbagged, ripe	0.017	3.2	0.038	34.9
Bagged, unripe	0.022	10.7	0.008	34.7
Bagged, ripe	0.012	4.4	0.005	13.7

METHODS OF RESIDUE ANALYSIS

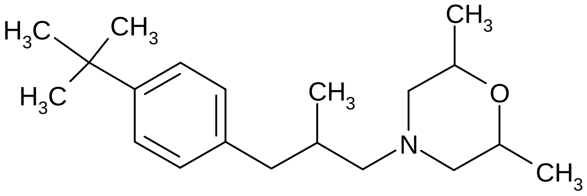
Analytical methods

Analytical methods for fenpropimorph in bananas and the metabolite BF 421-2 in animal products were reported. The structures and chemical names of the two compounds are shown in Figure 1.

Bananas. BASF method 241/1 (JMPR 1995) was modified to determine residues of fenpropimorph in bananas (Tilting, 1993; Zehr, 1997). Fenpropimorph is distilled from the fruit after mixing with aqueous sodium bicarbonate solution in Bleidner apparatus and the distillate is collected in dichloromethane. After clean-up by liquid/liquid partition and a cation-exchange column, the residues are quantified by GLC with an NPD. The LOD for whole fruit and pulp is 0.05 mg/kg (Table 4).

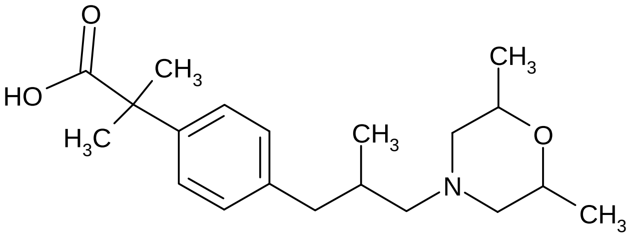
Figure 1: Structures and chemical names

fenpropimorph



Chemical name: (±)cis-4-[3-(4-*tert*-butyl phenyl)-2-methyl propyl]-2,6-dimethyl morpholine

BF 421-2



Chemical name: 2-methyl-2-{4-[2-methyl-3-(*cis*-2,6-dimethylmorpholin-4-yl)propyl]phenyl}propionic acid

Table 4. Validation of analytical method 241/1 for bananas (Tilting, 1993).

Sample	Fortification levels, mg/kg	Average recovery of fenpropimorph, % ± SD (n = 4)
Banana pulp	0.05 5	96 ± 6 91 ± 15
Banana peel	0.05 5	92 ± 2 87 ± 15
Whole banana	0.05 5	97 ± 6 96 ± 3

The method was validated by an independent laboratory (Arzt and Malinsky, 1997). Shaffer (1997a) used GC-MS to test specificity. Fenpropimorph has been tested through the Pesticide Analytical Manual Volume I multiresidue methods by Fomenko (1996).

Multiresidue method. The official method of analysis in The Netherlands (Olthof, 1999) describes the determination of fenpropimorph residues in fatty and non-fatty foods by GLC with an ion trap detector. The LOD is 0.05 mg/kg.

Animal products. The method (Tribolet, 1995) determines fenpropimorph acid (BF 421-2), which is the major metabolite of fenpropimorph in animal tissues, eggs and milk. The limits of determination are 0.01 mg/kg for animal tissues and eggs, and 0.002 mg/l for milk.

Milk and eggs are extracted with acetonitrile and pH 9 buffer. After filtration the acetonitrile is evaporated and the residue is redissolved in methanol, diluted with water and pH 9 buffer, and purified by partitioning with hexane. The analyte, which remains in the aqueous phase, is cleaned up on a C-18 bonded silica gel column. Determination is by HPLC with UV detection. Tissues are extracted directly with methanol and pH 9 buffer and the analysis is completed as above.

Validation showed mean recoveries from the individual substrates and an overall mean recovery within the range of 70-110%. All standard deviations were <20%. The repeatability and reproducibility were tested with meat and milk. For the repeatability the difference between the minimum and maximum individual recovery value in one laboratory was 19% and 13% for meat and milk, respectively. For the reproducibility the difference between the minimum and maximum individual recovery value of two laboratories was 33% and 45% for meat and milk, respectively (see Tables 5 and 6).

Table 5: Recoveries of BF 421-2 from animal products (Tribolet, 1995).

Sample	Fortification, mg/kg	Control, mg/kg	Recovery, %	Mean, %	SD_{abs}	SD, %	n
Meat Laboratory 1	0.01 0.1	<0.01	100, 103, 108, 105, 105, 97, 105, 116 94, 98, 96, 95, 98, 101, 95, 97	105 97	5.6 2.3	5.4 2.3	8 8
Meat Laboratory 2	0.01	<0.01	83, 100, 84				3
Milk Laboratory 1	0.002 mg/l 0.02 mg/l	<0.002	94, 94, 94, 99, 105, 107, 105, 105 85, 91, 89, 86, 75, 84, 87, 89	100 86	5.8 4.9	5.7 5.7	8 8
Milk Laboratory 2	0.002 mg/l	<0.002	63, 65, 62				3
Liver Laboratory 1	0.01 0.1	<0.01	81, 98, 92 103, 101, 106	97	9.1	9.4	6
Kidney Laboratory 1	0.01 0.1	<0.01	94, 89, 89 98, 96, 96	94	3.8	4.1	6
Eggs Laboratory 1	0.01 0.1	<0.01	70, 66, 80 78, 77, 74	74	5.3	7.2	6

Table 6: Overall recoveries of BF 421-2 in animal products (Tribolet, 1995).

Sample	n	Recovery, % (from Table 5)			Mean recovery, %	SD, %
		minimum	maximum	difference		
Meat	19	83	116	33	99	7.7
Milk	19	62	107	45	88	16
Liver	6	81	106	25	97	9.4
Kidney	6	89	98	9	94	4.1
Egg	6	66	80	14	74	7.2

Stability of residues in stored analytical samples

Bananas. In the supervised trials on bananas the longest period that samples were stored frozen before analysis was 7.5 months. The storage stability of fenpropimorph in whole bananas was determined during this period (Shaffer, 1997b). Control samples of whole bananas were fortified with fenpropimorph at 1 mg/kg and re-analysed after 1, 2, 3 and 7.5 months (Table 7).

Table 7. Storage stability of fenpropimorph in bananas (Shaffer, 1997).

Storage period, months	% remaining	Procedural recovery, %	Mean corrected % remaining
1	67, 75	87	82
2	76, 76	78	97
3	86, 78	85	96
7.5	68, 69	72	95

Animal products. Samples_fortified with known amounts of BF 421-2 were stored at -18°C for similar periods to those in the cattle feeding trials. The results are shown in Table 8.

The average percentage of the added BF 421-2 remaining after storage was found to be 66% for muscle, 81% for milk, 92% for liver, 95% for kidney, 74% for fat and 76% for blood. The freshly fortified samples were not analysed.

Table 8: Storage stability of BF 421-2 in animal products (Tribolet, 1999).

Sample	Sample size	Fortification level	Storage period	BF 421-2, mg/kg or mg/l	Average, %[1]
Muscle	5 g	0.1 mg/kg	26 Mar-01 Dec.	0.058 / 0.064, 0.054 / 0.059 0.082 / 0.077[2]	66
Liver	5 g	0.1 mg/kg	26 Mar-01 Dec.	0.092, 0.092, 0.092	92
Kidney	5 g	0.1 mg/kg	26 Mar-01 Dec.	0.094, 0.095, 0.097	95
Fat	5 g	0.1 mg/kg	26 Mar-04 Jan. 1999	0.076, 0.073, 0.073	74
Milk	10 ml	0.02 mg/l	19 Mar-27 Oct.	0.018, 0.016, 0.015, 0.016, 0.016	81
Blood	1 ml	0.04 mg/l	26 Mar-30 Nov.	0.030, 0.034, 0.030, 0.030, 0.028	76

[1] Average remaining expressed as percentage of nominal value. The results are not corrected for individual procedural recoveries which were muscle 113, 97, 103, 108%; kidney 105, 108%; liver 103, 107%; fat 95, 88%; blood 78, 82%; milk 81, 70%.

[2] The three samples were analysed twice.

Definition of the residue

The 1995 JMPR concluded that for regulatory purposes the residue in plants should be defined as fenpropimorph. For risk assessment purposes, the data suggested that the total residues of fenpropimorph plus its major plant metabolites will almost certainly be no more than 3 times the level of fenpropimorph alone, but probably less than twice that level. No definition was proposed for animal products.

The current Meeting agreed that the definition of the residue for compliance with MRLs for plant commodities should be fenpropimorph *per se*. On the evidence of the metabolism in bananas, the same definition would be acceptable for the estimation of dietary intake in bananas.

In goats, no parent compound was found and the metabolite 2-methyl-2-{4-[2-methyl-3-(*cis*-2,6-dimethylmorpholin-4-yl)propyl]phenyl}propionic acid (BF 421-2) was the major component of the residue. The metabolite 421-1 is present only in the fat, and BF 421-3 at lower concentrations in the kidneys, milk whey and fat. Conjugates of BF 421-2 were found in goat liver (1995 JMPR evaluations, Table 3, p.192).

In hens, although 3-10 unidentified metabolites were detected and measured as fenpropimorph equivalents in the organosoluble or water-soluble fractions of excreta, eggs, muscle, fat, skin and gizzard, compounds were identified and determined only in the plasma, liver and kidneys. The parent compound was detected only in the kidneys. No conjugates were found in hens (1995 JMPR, evaluations, Table 6 p.195).

On the basis of the metabolism studies on lactating goats reviewed by the 1995 JMPR, the current Meeting agreed that the definition of the residue for compliance with MRLs for animal products should be BF 421-2, expressed as fenpropimorph, and that the same definition was suitable for the estimation of dietary intake.

The Meeting agreed to recommend the following residue definitions.

Commodities of plant origin for both compliance with MRLs and the estimation of dietary intake: *fenpropimorph.*

Commodities of animal origin for compliance with MRLs and the estimation of dietary intake: *2-methyl-2-{4-[2-methyl-3-(cis-2,6-dimethylmorpholin-4-yl)propyl]phenyl}propionic acid, expressed as fenpropimorph.*

USE PATTERN

Fenpropimorph is used in combination with other fungicides mainly in cereals. Tables 9 and 10 show the new information on GAP submitted by the manufacturers and governments to the present Meeting. Other uses are listed in the 1995 JMPR residue evaluation. Variations in PHIs are based on the GAP for the other fungicides in the registered formulations.

Formulations listed in Table 9

250EC 250 g/l fenpropimorph + 133 g/l bromuconazole
250EC 250 g/l fenpropimorph + 167 g/l bromuconazole
250EC 250 g/l fenpropimorph + 84 g/l epoxiconazole
270EC 270 g/l fenpropimorph + 480 g/l fenpropidin
275EC 275 g/l fenpropimorph + 160 g/l flusilazole + 100 g/l tridemorph
300EC 300 g/l fenpropimorph + 200 g/l tebuconazole
300EC 300 g/l fenpropimorph + 125 g/l propiconazole
300EC 300 g/l fenpropimorph + 300 g/l prochloraz
375EC 375 g/l fenpropimorph + 125 g/l propiconazole
375EC 375 g/l fenpropimorph + 160 g/l flusilazole
750EC 750 g/l fenpropimorph
250EW 250 g/l fenpropimorph + 67 g/l quinoxyfen
150SE 150 g/l fenpropimorph + 125 g/l epoxiconazole + 125 g/l kresoxim-methyl
187SE 187 g/l fenpropimorph + 250 g/l chlorothalonil
233SE 233 g/l fenpropimorph + 65 g/l quinoxyfen
250SE 250 g/l fenpropimorph + 84 g/l epoxiconazole
280SE 280 g/l fenpropimorph + 100 g/l azoxystrobin
300SE 300 g/l fenpropimorph + 150 g/l kresoxim-methyl

Table 9. Registered uses of fenpropimorph on cereals, grasses and oilseeds (foliar spray unless indicated as seed treatment).

Crop	Country	Form.	Application				PHI, days
			Time, growth stage	Rate, kg ai/ha	Spray conc., kg ai/hl	No.	
Barley	Germany	300 EC	Spring, beginning of infection	0.3	0.075	2	35
		300 SE		0.21	0.053-0.11	2	35
		250 SE		0.38	0.094-0.19	2	35
		150 SE		0.15	0.038	2	35
		233 SE	Spring, up to stage 49 beginning of infection	0.35	0.087-0.18	2	49
	Poland	250 SC	From end of tillering to beginning of earing	0.25	0.06-0.12	1-2	35
		750 EC		0.75	0.19-0.37	1-2	35
Barley, spring	Netherlands	750 EC 250 EC	At infestation, between tillering and emergence of ears	0.75 0.38	0.13-0.38 0.063-0.19	1-2	42
		300 SE	At infestation, Feekes 4-5	0.21	0.035-0.11	1-2	35
	Poland	300 SE	From end of tillering to beginning of earing	0.15-0.21	0.04-0.1	1-2	35
		300 EC		0.3	0.08-0.15	1-2	35
	UK	250 EW	Before first spikelet of inflorescence visible	0.38		2	60
		270 EC	Before start of anthesis	0.27		2	50
		275 EC	Before early milk stage	0.28		2	40
		300 EC		0.3		2	35
		150 SE	Up to and including ear emergence just complete	0.15		2	50
		250 SE		0.38		2	50
		280 SE		0.56		2	35
		300 SE		0.21		2	50
Barley, winter	Netherlands	250 EC	At infestation, between tillering and emergence of ears	0.38	0.063-0.19	1-2	42
		300 SE	At infestation, Feekes 4-5	0.21	0.035-0.11	1-2	35
	Poland	300 SE	From end of tillering to beginning of earing	0.15-0.21	0.04-0.1	1-2	35
		300 EC		0.3	0.08-0.15	1-2	35
	UK	750 EC	Maximum of 2 treatments in year of harvest Maximum of 3 treatments in year of harvest	0.75 or 0.56		3 or 4	35
		250 EC	Before third node and/or before grain watery ripe stage	0.48 0.38		1 1	70 40
		270 EC	Before start of anthesis	0.27		2	50
		275 EC	Before early milk stage	0.28		2	40
		300 EC[1]		0.45		2	42
		300 EC[2]	Up to and including ear emergence complete	0.38		2	50
		150 SE		0.15		2	50
		250 SE		0.38		2	50
		300 SE		0.21		2	50
		300 EC[3]		0.3		3	35
		375 EC[4]	Before early milk stage	0.38		2	40
		375 EC[1,3]		0.38		3	35
		250 EW	Before first spikelet of inflorescence visible	0.38		2	60
		280 SE		0.56		2	35
Dandelion	Germany	750 EC	Spring, beginning of infection	0.75	0.13	2	35
Grasses	Netherlands	750 EC		0.75	0.38	1-2	28[5]
Linseed	UK	43 SC	Seed treatment		0.095	1	150
Oats	Netherlands	750 EC	As soon as mildew is visible on third upper leaf	0.75	0.13-0.38	1	42
Oats, spring	UK	300 EC		0.3		2	35
		250 EW	Before first spikelet of inflorescence visible	0.38		2	60

Crop	Country	Form.	Application: Time, growth stage	Rate, kg ai/ha	Spray conc., kg ai/hl	No.	PHI, days
Oats, winter	UK	750 EC	Maximum of 2 treatments in year of harvest Maximum of 3 treatments in year of harvest	0.75 or 0.56		3 or 4	35
		300 EC		0.3		3	35
		250 EW	Before first spikelet of inflorescence visible	0.38		2	70
Rape	UK	43 SC	Seed treatment		0.095	1	135
Rye	Germany	300 EC	Spring, beginning of infection	0.3	0.075	2	35
		300 SE		0.21	0.053-0.11	2	35
		150 SE		0.15	0.038	2	35
		250 SE		0.38	0.094-0.19	2	35
	Netherlands	750 EC	At infestation, from emergence of last leaf until beginning of blossoming	0.75	0.13-0.38	1	42
	Poland	300 SE	From beginning of shooting to beginning of earing	0.15-0.21	0.04-0.1	1-2	35
		250 SC		0.25	0.06-0.12	1-2	35
		300 EC		0.3	0.08-0.15	1-2	35
		750 EC		0.75	0.19-0.37	1-2	35
	UK	250 EW	Before first spikelet of inflorescence visible	0.38		2	60
Rye, winter	Netherlands	250 EC	At infestation	0.38	0.063-0.19	1-2	42
	UK	750 EC	Maximum of 2 applic. in year of harvest Maximum of 3 applic. in year of harvest	0.75 or 0.56		3 or 4	35
Triticale	Germany	250 SE	Spring, beginning of infection	0.38	0.094-0.19	2	35
		150 SE		0.15	0.038	2	35
	UK	250 EW	Before first spikelet of inflorescence visible	0.38		2	70
Triticale, winter	UK	750 EC	Maximum of 2 applic. in year of harvest Maximum of 3 applic. in year of harvest	0.75 or 0.56		3 or 4	35
Wheat	Germany	750 EC	Spring, beginning of infection	0.75	0.13	2	35
		300 EC		0.3	0.075	2	35
		150 SE		0.15	0.038	3	35
		250 SE		0.38	0.094-0.19	2	35
		300 SE		0.21	0.053-0.11	2	35
		233 SE	Spring, up to stage 49 beginning of infection	0.35	0.087-0.18	2	49
	Poland	750 EC	From beginning of shooting to end of earing	0.75	0.19-0.37	1-2	35
		250 SC		0.25	0.06-0.12	1-2	35
Wheat, durum	UK	250 EW	Before first spikelet of inflorescence visible	0.38		2	70
Wheat, spring	Netherlands	250 EC	At infestation, from emergence of last leaf until blossoming	0.38	0.063-0.19	1	42
		375 SC	At infestation, from ear emergence until beginning of blossoming	0.38	0.063-0.19	1	42
		300 SE	At infestation, Feekes scale 4-5	0.21	0.035-0.11	1-2	35
	Poland	300 SE	From beginning of shooting to end of earing	0.15-0.21	0.04-0.1	1-2	35
		300 EC		0.30	0.08-0.15	1-2	35
	UK	750 EC		0.75		2	35
		250 EC	Before third node detectable and/or before grain watery ripe stage	0.48 0.38		1 1	80 40
		300 EC[2]	Before grain milky ripe stage	0.38		2	40
		300 EC[3]		0.3		2	35

Crop	Country	Form.	Application				PHI, days
			Time, growth stage	Rate, kg ai/ha	Spray conc., kg ai/hl	No.	
		250 EW	Before first spikelet of inflorescence visible	0.38		2	70
		280 SE		0.56		2	35
Wheat, winter	Netherlands	250 EC	At infestation, from emergence of last leaf until blossoming	0.38	0.063-0.19	1	42
		375 SC	At infestation, from ear emergence until beginning of blossoming	0.38	0.063-0.19	1	42
		300 SE	At infestation, Feekes scale 4-5	0.21	0.035-0.11	1-2	35
	Poland	300 SE	From beginning of shooting to end of earing	0.15-0.21	0.04-0.1	1-2	35
		300 EC		0.3	0.08-0.15	1-2	35
	UK	250 EC	Before third node detectable and/or before grain watery ripe stage	0.48 0.38		1 1	90 40
		270 EC	Before start of anthesis	0.27		2	60
		275 EC	Before early milk stage	0.28		3	40
		300 EC[1]		0.45		2	42
		300 EC[2]	Before grain milky ripe stage	0.38		2	40
		300 EC[2]		0.3		3	35
		375 EC[4]	Before early milk stage	0.38		2	40
		375 EC[1,3]		0.38		3	35
		250 EW	Before first spikelet of inflorescence visible	0.38		2	70
		150 SE	Up to and including ear emergence just complete	0.15		2	50
		187 SE	Max. total dose per crop 1.1 kg ai/ha. Latest application before flowering	0.75			60
		250 SE	Up to and including flowering just complete	0.38		2	50
		300 SE		0.21		2	50
		280 SE		0.56		2	35

[1] Fenpropimorph + prochloraz
[2] Fenpropimorph + tebuconazole
[3] Fenpropimorph + propiconazole
[4] Fenpropimorph + flusilazole
[5] 28: for mown grass as feed or for grazing by cattle

Table 10. Registered uses of fenpropimorph on fruits and vegetables (outdoor).

Crop	Country	Form.	Application				PHI, days
			Method	Rate, kg ai/ha	Spray conc,, kg ai/hl	No.	
Banana	Cameroon[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
	Central America[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
	Cuba	88 OL	Foliar spray	0.44	2.2	4-12	0
	Ivory Coast[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
	Lesser Antilles[1]	88 OL	Foliar spray	0.44	2.2	2-5	0
	Philippines[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
	South America[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
Beetroot	UK	750 EC	Foliar spray	0.75		2	21
Bilberry	UK	750 EC	Foliar spray	0.75		3	10
Brussels sprouts	UK	750 EC	Foliar spray	0.75		3-5	14
Cranberry	UK	750 EC	Foliar spray	0.75		3	10
Currant, Black, Red, White	UK	750 EC	Foliar spray	0.75		3	10

Crop	Country	Form.	Application				PHI, days
			Method	Rate, kg ai/ha	Spray conc,, kg ai/hl	No.	
Dewberries (incl.boysen- and loganberry)	UK	750 EC	Foliar spray	0.75		3	10
Gooseberry	UK	750 EC	Foliar spray	0.75		3	10
Hops	UK	750 EC	Foliar spray		0.0375	6	10
Horseradish	UK	750 EC	Foliar spray	0.75		3	28
Leek	Netherlands	750 EC	Foliar spray	0.75	0.14-0.19	2-3	21
Parsley, root	UK	750 EC	Foliar spray	0.75		3	28
Parsnip	UK	750 EC	Foliar spray	0.75		3	28
Plantain	Cameroon[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
	Central America[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
	Cuba	88 OL	Foliar spray	0.44	2.2	4-12	0
	Ivory Coast[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
	Lesser Antilles[1]	88 OL	Foliar spray	0.44	2.2	2-5	0
	Philippines[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
	South America[1]	88 OL	Foliar spray	0.44	2.2	4-12	0
Raspberries, Red, Black	UK	750 EC	Foliar spray	0.75		3	10
Salsify	UK	750 EC	Foliar spray	0.75		3	28
Strawberry	UK	750 EC	Foliar spray	0.75		3	10

[1] GAP pending

RESIDUES RESULTING FROM SUPERVISED TRIALS

In plants

Bananas (Table 11). Fenpropimorph is a fungicide of the morpholine group with a high level of activity against Black Sigatoka *(Mycospaerella fijiensis)* and Yellow Sigatoka *(Mycospaerella musicola)* in bananas. The compound is systemic. Registration is already approved in Cuba and is pending, with similar conditions, in several other countries. The formulated product to be used on banana crops is an oil liquid containing 880 g/l fenpropimorph.

Bananas were treated with about 0.5 kg ai/ha in 20 l/ha oil-water emulsion. The intervals between the applications were 15-20 days for the control of Black Sigatoka and 16-42 days for Yellow Sigatoka depending on the weather conditions and disease pressure. In view of the recommendation that no more than two consecutive treatments should be applied to control each of the insects involved (fungicide resistance management strategy for morpholine products) four applications have been considered to be the maximum number during the growth of individual banana bunches.

In eight supervised trials in 1994 in Martinique, a 750 g/l EC formulation was applied to bagged bananas from the ground with motorised knapsack mistblower sprayers (Tilting and Mackenrogh, 1995). The spray nozzle was directed vertically upwards between the banana plants so that the spray rose above them and was able to fall onto the upper leaves of the plant. In this way the spray application simulated aerial application.

Further trials in1996 in Costa Rica (4), Ecuador (4), Columbia (3), Honduras (2), Guatemala (1) and Mexico (1), were with the 880 g/l OL (Wofford and Artz, 1997). Each trial was with a control plot and a treated plot. Before the first application, bananas on half the trees in each plot were bagged. The fungicide was applied with motorised backpack mist blower sprayers at twelve sites. Applications at three sites were made by air with either a helicopter or fixed-wing aircraft at a target rate for each of the four applications of 0.545 kg ai/ha. The applications were 68, 56, 12 and 0 days before harvest.

Where residues were not detected, they are recorded in Table 11 as below the limit of determination (LOD). Residues, application rates and spray concentrations have generally been rounded to 2 significant figures or, for residues near the LOD, to 1 significant figure. Although all trials included control plots, no control results are recorded in the Table as none of the residues in control samples exceeded the LOD. The residues were not corrected for recovery.

Table 11. Residues of fenpropimorph in or on bananas.

Report No., Location, Country, Year	Form.	Type of application	Application rate			No. of treat-ments	Sample	PHI, days	Residues, mg/kg
			kg ai/ha	Water, l/ha	kg ai/hl				
RNC 95153 Pueblo Nuevo, Costa Rica, 1996	88 OL	Ground	0.44	20	2.2	4	Whole fruit (unbagged)	0	1.2
			0.62	20	3.1			5	0.72
			0.49	20	2.5		Pulp (unbagged)	0	0.30
			0.55	20	2.8			5	0.17
							Whole fruit (bagged)	0	0.13
								5	0.16
							Pulp (bagged)	0	0.08
								5	<0.05
RNC 95154 Santa Maria, Costa Rica, 1996	88 OL	Ground	0.61	20	3.1	4	Whole fruit (unbagged)	0	0.75
			0.56	20	2.8			5	0.38
			0.51	20	2.6			10	0.50
			0.55	20	2.8			15	0.32
								25	<0.05
							Pulp (unbagged)	0	0.22
								5	0.18
								10	0.29
								15	0.13
								25	<0.05
							Whole fruit (bagged)	0	0.37
								5	0.38
								10	0.40
								15	0.31
								25	<0.05
							Pulp (bagged)	0	0.20
								5	0.19
								10	0.19
								15	0.11
								25	<0.05
RNC 95155 Santa Maria, Costa Rica, 1996	88 OL	Ground	0.58	20	2.9	4	Whole fruit (unbagged)	0	1.4
			0.52	20	2.6			5	0.66
			0.59	20	3		Pulp (unbagged)	0	0.29
			0.56	20	2.8			5	0.43
							Whole fruit (bagged)	0	0.13
								5	0.33
							Pulp (bagged)	0	<0.05
								5	0.07
RNC 95156 Boliche, Ecuador, 1996 1996	88 OL	Ground	0.53	20	2.7	4	Whole fruit (unbagged)	0	0.26
			0.57	20	2.9			5	0.20
			0.62	20	3.1		Pulp (unbagged)	0	0.06
			0.56	20	2.8			5	0.06
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	<0.05

Report No., Location, Country, Year	Form.	Type of application	Application rate kg ai/ha	Water, l/ha	kg ai/hl	No. of treat-ments	Sample	PHI, days	Residues, mg/kg
								5	<0.05
RNC 95157	88 OL	Ground	0.59	20	2.9	4	Whole fruit (unbagged)	0	0.21
Milagros,			0.56	20	2.8			5	0.36
Ecuador,			0.64	20	3.2		Pulp (unbagged)	0	<0.05
1996			0.56	20	2.8			5	<0.05
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	<0.05
								5	<0.05
RNC 95158	88 OL	Ground	0.51	20	2.6	4	Whole fruit (unbagged)	0	0.1
Marcelino,			0.52	20	2.6			5	0.06
Ecuador,			0.60	20	3.0		Pulp (unbagged)	0	<0.05
1996			0.52	20	2.6			5	<0.05
							Whole fruit (bagged)	0	0.17
								5	0.17
							Pulp (bagged)	0	0.07
								5	0.06
RNC 95159	88 OL	Ground	0.52	20	2.6	4	Whole fruit (unbagged)	0	0.16
Cienaga,			0.52	20	2.6			5	0.08
Colombia,			0.54	20	2.7			10	0.09
1996			0.51	20	2.5			15	0.11
								25	0.07
							Pulp (unbagged)	0	<0.05
								5	<0.05
								10	<0.05
								15	<0.05
								25	<0.05
							Whole fruit (bagged)	0	<0.05
								5	<0.05
								10	<0.05
								15	0.13
								25	<0.05
							Pulp (bagged)	0	<0.05
								5	<0.05
								10	<0.05
								15	<0.05
								25	<0.05
RNC 95160	88 OL	Ground	0.56	20	2.8	4	Whole fruit (unbagged)	0	0.12
La Aguja,			0.52	20	2.6			5	0.07
Colombia,			0.57	20	2.9		Pulp (unbagged)	0	<0.05
1996			0.53	20	2.7			5	<0.05
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	<0.05
								5	<0.05
RNC 95161	88 OL	Ground	0.53	20	2.65	4	Whole fruit (unbagged)	0	0.47
Batan,			0.50	20	2.5			5	0.65
Honduras,			0.50	20	2.5		Pulp (unbagged)	0	0.19
1996			0.54	20	2.7			5	0.28
							Whole fruit (bagged)	0	<0.05
								5	<0.05

Report No., Location, Country, Year	Form.	Type of application	Application rate			No. of treat-ments	Sample	PHI, days	Residues, mg/kg
			kg ai/ha	Water, l/ha	kg ai/hl				
							Pulp (bagged)	0	<0.05
								5	<0.05
RNC 95162 Cortes, Honduras, 1996	88 OL	Ground	0.54	20	2.7	4	Whole fruit (unbagged)	0	0.30
			0.52	20	2.6			5	0.43
			0.54	20	2.7		Pulp (unbagged)	0	0.14
			0.48	20	2.4			5	0.12
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	<0.05
								5	<0.05
RNC 95163 San Marcos, Guatemala, 1996	88 OL	Ground	0.62	20	3.1	4	Whole fruit (unbagged)	0	0.70
			0.53	20	2.7			5	0.45
			0.57	20	2.9		Pulp (unbagged)	0	0.18
			0.56	20	2.8			5	0.12
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	<0.05
								5	<0.05
RNC 95164 Chiapas, Mexico, 1996	88 OL	Ground	0.58	20	2.9	4	Whole fruit (unbagged)	0	0.32
			0.57	20	2.9			5	0.18
			0.52	20	2.6		Pulp (unbagged)	0	0.07
			0.49	20	2.5			5	0.08
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	NA[1]
								5	<0.05
RNC 95168 Pueblo Nuevo, Costa Rica, 1996	88 OL	Aerial	0.61	20	3.1	4	Whole fruit (unbagged)	0	0.11
			0.57	20	2.9			5	0.09
			0.57	20	2.9		Pulp (unbagged)	0	<0.05
			0.52	20	2.6			5	<0.05
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	NA
								5	<0.05
RNC 95169 Boliche, Ecuador, 1996	88 OL	Aerial	0.52	20	2.6	4	Whole fruit (unbagged)	0	<0.05
			0.54	20	2.7			5	<0.05
			0.54	20	2.7		Pulp (unbagged)	0	NA
			0.60	20	3.0			5	NA
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	NA
								5	NA
RNC 95170 Cienaga, Colombia, 1996	88 OL	Aerial	0.55	20	2.75	4	Whole fruit (unbagged)	0	<0.05
			0.56	20	2.8			5	<0.05
			0.58	20	2.9		Pulp (unbagged)	0	<0.05
			0.54	20	2.7			5	<0.05
							Whole fruit (bagged)	0	<0.05
								5	<0.05
							Pulp (bagged)	0	<0.05
								5	NA
95/10747, trial 1	75 EC	Simulated	0.53	20	2.6	4	Whole fruit	0	<0.05

Report No., Location, Country, Year	Form.	Type of application	Application rate			No. of treat-ments	Sample	PHI, days	Residues, mg/kg
			kg ai/ha	Water, l/ha	kg ai/hl				
Lareinty, Martinique, Lesser Antilles, 1994		aerial treatment				(dry season)	(bagged)	3	<0.05
								7	<0.05
								14	<0.05
95/10747, trial 2 Petit Morne, Martinique, Lesser Antilles, 1994	75 EC	Simulated aerial treatment	0.53	20	2.6	4 (dry season)	Whole fruit (bagged)	0	0.07
								3	<0.05
								7	<0.05
								14	<0.05
95/10747, trial 3 Rivière Lézarde, Martinique, Lesser Antilles, 1994	75 EC	Simulated aerial treatment	0.53	20	2.6	4 (dry season)	Whole fruit (bagged)	0	<0.05
								3	<0.05
								7	<0.05
								14	<0.05
95/10747, trial 4 Rivière Lézarde, Martinique, Lesser Antilles, 1994	75 EC	Simulated aerial treatment	0.53	20	2.6	4 (dry season)	Whole fruit (bagged)	0	<0.05
								3	<0.05
								7	<0.05
								14	<0.05
95/10747, trial 5 Rivière Lézarde, Martinique, Lesser Antilles, 1994	75 EC	Simulated aerial treatment	0.53	20	2.6	4 (wet season)	Whole fruit (bagged)	0	<0.05
								3	<0.05
								7	<0.05
								14	<0.05
95/10747, trial 6 Rivière Lézarde, Martinique, Lesser Antilles, 1994	75 EC	Simulated aerial treatment	0.53	20	2.6	4 (wet season)	Whole fruit (bagged)	0	0.13
								3	<0.05
								7	<0.05
								14	<0.05
95/10747, trial 7 Bochet, Martinique, Lesser Antilles, 1994	75 EC	Simulated aerial treatment	0.53	20	2.6	4 (wet season)	Whole fruit (bagged)	0	<0.05
								3	<0.05
								7	<0.05
								14	<0.05
95/10747, trial 8 Bochet, Martinique, Lesser Antilles, 1994	75 EC	Simulated aerial treatment	0.53	20	2.6	4 (wet season)	Whole fruit (bagged)	0	<0.05
								3	<0.05
								7	<0.05
								14	<0.05

[1] NA: not analysed

In animals

Cattle (Tribolet, 1999). Eleven lactating Simmental x Red Holstein crossbreed cows (9 treated and 2 controls) were selected from 15 animals 10 days before the first treatment on the basis of milk production, general health and body weight.

The nominal doses were 150, 450 and 1500 mg fenpropimorph/animal/day. The cows were fed with 26 kg of maize silage daily and the measured dose rates were 136, 408 and 1363 mg/animal/day giving levels of 5.2, 15.7 and 52.4 ppm of fenpropimorph in the daily feed. The calculated daily dose rates per kg body weight based on an average body weight of 600 kg were 0.23, 0.68 and 2.3 mg fenpropimorph. The cows were dosed daily for at least 28 days.

Samples of tissues, fat and blood were analysed for fenpropimorph acid (BF 421-2) only. The results are given in Table 12. The results are not corrected for recoveries: the controls were all below the LODs (0.01 mg/kg for muscle, fat and kidney, 0.1 mg/kg for liver and 0.05 mg/l for blood). The average residues of BF 421-2 found in muscle (tenderloin, round steak and diaphragm) of the low, middle and high dose groups were 0.03, 0.03 and 0.19 mg/kg. The corresponding residues in the other samples were 0.09, 0.10 and 0.73 mg/kg in kidneys, 0.75, 0.57 and 5.6 mg/kg in liver, 0.02, 0.02 and 0.15 mg/kg in fat (omental and perirenal, and 0.13, 0.15 and 1.1 mg/kg in blood. There was no significant difference between the mean residues of BF 421-2 in the muscle, liver, kidney, fat and blood from the two lower dose groups. The residues from the highest dose group were between about 6 and 8 times those from the lowest, so slightly less than proportional to the dose.

Table 12. Residues of BF 421-2 in tissues, fat and blood (Tribolet, 1999).

Dose, ppm	Cow no.	Residues, mg/kg							mg/l
		Tenderloin muscle	Round steak	Diaphragm muscle	Liver	Kidney	Perirenal fat	Omental fat	Blood
0	229	<0.01	<0.01	<0.01	<0.1	<0.01	<0.01	<0.01	<0.05
5	220	0.03	<0.01	0.03	0.56	0.08	0.02	0.02	0.12
	222	0.02	0.03	0.04	0.75	0.11	0.02	0.02	0.15
	227	0.04	0.01	0.04	0.94	0.08	0.02	0.02	0.13
	Mean	0.03[2]			0.75	0.09	0.02[3]		0.13
15	221	0.02	0.03	0.03	0.45	0.10	0.02	0.02	0.14
	224	0.02	0.02	0.02	0.51	0.08	0.02	0.01	0.16
	234	0.04	0.02	0.03	0.74	0.12	0.03	0.03	0.16
	Mean	0.03[2]			0.57	0.10	0.02[3]		0.15
50	223	0.21/0.19[1]	0.22/0.19	0.25/0.25	8.6/7.0	0.92	0.18	0.12	0.94
	225	0.09/0.10	0.09/0.08	0.10/0.09	4.1/3.0	0.34	0.08	0.07	0.61
	230	0.31/0.31	0.24/0.26	0.26/0.26	6.2/4.8	0.92	0.22	0.22	1.72
	Mean	0.19[2]			5.6	0.73	0.15[3]		1.09

[1]The two values for each cow are the results of analyses with and without a further clean-up step respectively.
[2]Average of all results for tenderloin, round steak and diaphragm
[3]Average of all residues in perirenal and omental fat

Milk was analysed for BF 421-2 with the results shown in Table 13. The results were not corrected for recoveries, and all the residues in the control samples were below the LOD of 0.002 mg/l.

In the two lower dose groups the residues of BF 421-2 in individual animals reached a plateau in about 7 days. The range of the group mean residues from day 7 to day 28 was 0.01-0.013 and 0.015-0.019 mg/l in the 5 ppm and 15 ppm dose groups respectively. In the 50 ppm group the residues reached a plateau after 14 days. The range of the group means from day 14 to day 28 was 0.051 (day 21)- 0.11 (day 14) mg/l. The individual results show substantial variation between animals of the same dose group as well as between sampling dates when the plateau has been reached. There is only a slight difference between the 5 and 15 ppm dose groups. The results for animals 227 and 220 in the 5 ppm dose group are about the same as for the cows in the 15 ppm group until day 17, but lower thereafter.

Table 13. Residues of BF 421-2 in milk (Tribolet, 1999).

Day	BF 421-2, µg/l, individual cows and group means[1,2]									
	Control	5 ppm group			15 ppm group			50 ppm group		
	229	220	222	227	221	234	224	223	225	230
-4	<2/<2	<2/<2	<2/<2	<2/<2	<2/<2	<2/<2	<2/NA[3]	<2/<2	<2/<2	<2/NA
		Mean <2			Mean <2			Mean <2		
-3	<2/<2	<2/<2	<2/<2	<2/<2	<2/<2	<2/<2	<2/NA	<2/<2	<2/<2	<2/NA
		Mean <2			Mean <2			Mean <2		
1	<2/<2	<2/<2	<2/<2	<2/<2	2.0/<2	3.3/2.7	<2/NA	12/17	6.9/6.6	NA/29
		Mean <2			Mean 2			Mean 17		
4	<2/<2	9.2/13	3.9/4.3	5.0/5.0	13/13	11/12	2.7/NA	58/78	32/36	NA/86
		Mean 7			Mean 9			Mean 63		
7	<2/NA	17/22	3.6/4.1	6.0/5.6	20/16	17/18	8.1/NA	50/63	24/32	NA/71
		Mean 10			Mean 15			Mean 52		
9	<2/<2	12/15	4.1/4.6	15/16	12/12	15/18	16/NA	75/75	32/33	NA/66
		Mean 11			Mean 15			Mean 58		
14	<2/<2	19/15	5.3/5.2	15/17	18/15	16/18	24/NA	94/121	41/46	NA/173
		Mean 13			Mean 19			Mean 110		
17	NA/<2	17/NA	6.0/7.2	15/18	12/13	16/20	16/NA	86/100	54/54	NA/129
		Mean 13			Mean 16			Mean 92		
21	<2/<2	8.4/NA	4.9/6.6	16/17	15/18	19/20	17/NA	35,47,50 /67	NA/37	NA/66
		Mean 10			Mean 18			Mean 51		
23	<2/NA	6.1/4.8	4.2/5.2	20/23	16/22	17/18	7.2/NA	101/104	33/43	NA/71
		Mean 11			Mean 15			Mean 71		
28	<2/NA	9.5/8.9	10/13	13/18	9/18	28/29	14/NA	67,68,47 /95	27/46	NA/89
		Mean 12			Mean 19			Mean 65		

[1] Mixture of morning and evening milk analysed
[2] The two values for each cow are the results of analyses with and without a further clean-up step respectively.
The mean of each pair was taken to calculate the group means
[3] NA: not analysed

FATE OF RESIDUES IN STORAGE AND PROCESSING

No new information.

Residues in the edible portion of food commodities

Fenpropimorph residues in banana pulp from bagged and unbagged bananas were <0.05 (7), 0.07, 0.07, 0.08 and 0.2 mg/kg, and <0.05 (4), 0.06, 0.08, 0.14, 0.18, 0.28, 0.29, 0.3 and 0.43 mg/kg, respectively (see Table 11).

RESIDUES IN FOOD IN COMMERCE OR AT CONSUMPTION

No information.

NATIONAL MAXIMUM RESIDUE LIMITS

The Meeting was informed that the national MRL for cereal grains in Poland is 0.5 mg/kg (residue defined as fenpropimorph *per se*).

APPRAISAL

Fenpropimorph was first evaluated for residues by the 1995 JMPR. That Meeting estimated maximum residue levels which were recommended for use as MRLs for cereals (barley, oats, rye, wheat), cereal straw and fodder (dry), sugar beet and fodder beet leaves and tops.

Conventional livestock and poultry feeding studies with determination of fenpropimorph and the main metabolites identified in metabolism studies, and validated analytical regulatory methods (including representative chromatograms) for the determination of fenpropimorph and its main metabolites in animal products were listed as desirable.

A dairy cattle feeding study and an analytical method for animal products as well as information on GAP, a metabolism study and residue data on bananas have been reported to the present Meeting.

Plant metabolism

Banana plants were treated four times at the twofold application rate of 0.9 kg ai/ha with morpholine-2,6-^{14}C- and phenyl-U-^{14}C-labelled fenpropimorph.

On a whole fruit basis, bananas treated with morpholine-labelled fenpropimorph had a maximum TRR as fenpropimorph of about 0.67 mg/kg in unripe, and 0.61 mg/kg in ripe, unbagged fruit. The corresponding values for bagged fruit were 0.35 and 0.32 mg/kg. Bananas treated with the phenyl-labelled compound had significantly lower TRR levels: 0.11 mg/kg (unripe, unbagged) and 0.09 mg/kg (ripe, unbagged). The corresponding values for bagged bananas were 0.025 and 0.026 mg/kg.

Most of the total ^{14}C was extractable with methanol: 83 to 88% from ripe fruit and 27% to 72% from unripe fruit. The extract of bananas treated with the morpholine-labelled compound showed two main HPLC peaks. One was non-polar and identified by MS as unchanged fenpropimorph. The other peak was polar and was identified by HPLC after acetylation as a mixture of natural assimilation products (glucose, fructose, saccharose). Bananas treated with phenyl-labelled fenpropimorph showed only one prominent HPLC peak which was identified as fenpropimorph.

In contrast to the metabolism in cereals (1995 JMPR), the metabolites 4-{3-[4-(2-hydroxy-1,1-dimethyl)ethylphenyl]-2-methylpropyl}-*cis*-2,6-dimethylmorpholine (BF 421-1), 2-methyl-2-{4-[2-methyl-3-(*cis*-2,6-dimethylmorpholin-4-yl)propyl]phenyl}propionic acid (BF 421-2), methyl 2-methyl-2-{4-[2-methyl-3-(*cis*-2,6-dimethylmorpholin-4-yl)propyl]phenyl}propionate (BF 421-2-Me), [3-(4-*tert*-butylphenyl)-2-methylpropyl](2-hydroxypropyl)amine (BF 421-7), *cis*-2,6-dimethylmorpholine (BF 421-

10), 4-[3-(4-*tert*-butylphenyl)-2-methyl-1-oxopropyl]-*cis*-2,6-dimethylmorpholine (BF 421-13) and 4-[3-(4-*tert*-butylphenyl)-2-methyl propyl]-*cis*-2,6-dimethylmorpholin-3-one (BF 421-15) were not reported.

Farm animal metabolism

In goats fenpropimorph acid, BF 421-2, is the main component of the residue. BF 421-2 would not be expected to concentrate in lipid-rich tissues and products, but it can occur at detectable levels. In liver, the data suggested that the residues of BF 421-2 plus its conjugates would almost certainly be no more than twice the level of BF 421-2 alone. In hens BF 421-2 is probably also the main metabolite but, since residues were only characterized in plasma, liver and kidneys, there was no information on the nature of the residue in poultry meat, fat or eggs (1995 JMPR).

Methods of residue analysis

BASF method 241/1 was developed to determine residues of fenpropimorph in bananas. Fenpropimorph was distilled from the fruit using a Bleidner apparatus after mixing with aqueous sodium bicarbonate solution and the distillate was collected in dichloromethane. After clean-up by liquid/liquid partition and a cation-exchange column, the final residues were quantified by GLC with an NPD. The LOD for whole fruit and pulp was 0.05 mg/kg.

The official multi-residue method of analysis in The Netherlands describes the determination of fenpropimorph residues in fatty and non-fatty foods by GLC with an ion trap detector. The LOD is 0.05 mg/kg.

BF 421-2, the main metabolite of fenpropimorph in animal products, is extracted from fat with hexane, from meat liver and kidney by maceration with methanol/aqueous pH 9 buffer, and from milk and eggs with acetonitrile/aqueous pH 9 buffer. After liquid-liquid partition and further clean-up on a C-18 bonded silica gel column, the BF 421-2 is determined by HPLC with a UV detector. LODs are 0.01 mg/kg for animal tissues and eggs, and 0.002 mg/l for milk. No conjugates of BF 421-2, other metabolites or the parent compound are determined by the method.

Under frozen storage, fenpropimorph residues are stable for at least 7.5 months in bananas. Recoveries of BF 421-2 when stored frozen for 7-8 months were muscle 66%, fat 74%, blood 76%, milk 81%, liver 92% and kidney 95%.

Definition of the residue

The 1995 JMPR concluded that for enforcement and dietary intake purposes the residue in plants should be defined as fenpropimorph. No residue definition was proposed for animal products.

The present Meeting agreed that the definition of the residue for compliance with MRLs for plant commodities should be fenpropimorph *per se*. On the basis of the metabolism in bananas, the same definition should be acceptable for the estimation of the dietary intake in bananas.

On the basis of the metabolism studies on rats and lactating goats reviewed by the 1995 JMPR, the Meeting agreed that BF 421-2 can be used as a marker compound for enforcement purposes. The definition of the residue for compliance with MRLs for animal products should therefore be 2-methyl-2-{4-[2-methyl-3-(*cis*-2,6-dimethylmorpholin-4-yl)propyl]phenyl}propionic acid (BF 421-2), expressed as fenpropimorph. The same definition should be used for animal products to estimate the dietary intake.

In view of the residues found in animals in the tissues and organs in the metabolism and feeding studies, the Meeting concluded that BF 421-2 should not be categorised as fat-soluble.

The Meeting concluded that the following residue definitions are appropriate.

Commodities of plant origin for compliance with MRLs and for the estimation of dietary intake: fenpropimorph

Commodities of animal origin for compliance with MRLs and for the estimation of dietary intake 2-methyl-2-{4-[2-methyl-3-(*cis*-2,6-dimethylmorpholin-4-yl)propyl]phenyl}propionic acid expressed as fenpropimorph.

Residues resulting from supervised trials

Bananas. Fenpropimorph is registered in Cuba for 4–12 applications of 0.44 kg ai/ha and 2.2 kg ai/hl. In view of the fungicide resistance management strategy for morpholine products, the four applications used in the supervised trials have been considered to be the maximum number of treatments.

Eight supervised trials were conducted in 1994 in Martinique: 4 x 0.53 kg ai/ha (20 l water/ha, 2.6 kg ai/hl) were applied to bagged bananas as a simulated aerial treatment. On day 0, the residues in the whole fruit were <0.05 (6), 0.07 and 0.13 mg/kg.

A further 15 trials were conducted in 1996 in Costa Rica (4), Ecuador (4), Columbia (3), Honduras (2), Guatemala (1) and Mexico (1), all with 4 applications at the nominal application rate of 0.545 kg ai/ha (20 l water/ha, 2.7 kg ai/hl). In each plot 50% of the trees were bagged. Twelve trials were with ground and three with aerial applications. Residues in the ground-sprayed trials on the day of treatment were as follows.

Unbagged bananas, whole fruit: 0.1, 0.12, 0.16, 0.26, 0.32, 0.36, 0.43, 0.65, 0.7, 0.75, 1.2, 1.4 mg/kg
Unbagged bananas, pulp: <0.05 (4), 0.06, 0.08, 0.14, 0.18, 0.28, 0.29, 0.3, 0.43 mg/kg
Bagged bananas, whole fruit: <0.05 (7), 0.13, 0.16, 0.17, 0.33, 0.4 mg/kg
Bagged bananas, pulp: <0.05 (7), 0.07, 0.07, 0.08, 0.2 mg/kg

The residues from aerial application were significantly lower. One sample of unbagged whole fruit contained 0.11 mg/kg. Residues in all the other samples were below the LOD.

The Meeting estimated a maximum residue level of 2 mg/kg based on the residues in ground-sprayed unbagged whole fruit and an STMR of 0.11 mg/kg from the corresponding residues in the pulp.

Animal products. Assuming worst-case feeding situations, the maximum theoretical fenpropimorph levels in animal feed were estimated by the 1995 JMPR to be 1.3 ppm for beef cattle, 1.7 ppm for dairy cattle and 0.35 ppm for poultry.

Groups of 3 cows were fed for 28 days with 26 kg maize silage containing 5.2 ppm, 15.7 ppm or 52.4 ppm fenpropimorph. For an average body weight of 600 kg the calculated daily dose rates were 0.23, 0.68 and 2.3 mg fenpropimorph per kg body weight. Milk samples were collected from all cows on days 1, 4, 7, 9, 14, 17, 21, 23 and 28. At the end of the test period the animals were slaughtered and their tissues and milk analysed for residues of the metabolite BF 421-2.

There was hardly any difference in the residues of BF 421-2 in the milk or tissues between the two lower dose groups. No clear explanation for this was suggested. As the ratios of the high/mean residues in the 52.4 to 5.2 ppm dose group in milk were 8.8/8.3, in liver 9.1/7.5, in kidney 8.4/8.3, in muscle 7.8/6.3 and in fat 11/7.8, indicating near linearity, further calculations assuming a more realistic dietary burden of 1.7 ppm were based on the residues in these groups only. The following

Table shows the highest and the mean measured and extrapolated residues. Since the residues reached a plateau in the milk slowly (in 2 weeks), maximum residue levels were estimated from the highest extrapolated residues. STMRs were estimated from the mean extrapolated residues.

Dose group ppm	BF 421-2 residues, calculated as fenpropimorph, mg/kg									
	Milk, day 14		Liver		Kidney		Muscle		Fat	
	high	mean	high	mean	high	mean	high	mean	high	mean
1 x rate, 5.2 (1.7) [1]	0.017 (0.006)	0.012 (0.004)	0.86 (0.28)	0.68 (0.22)	0.1 (0.033)	0.08 (0.026)	0.036 (0.012)	0.027 (0.009)	0.018 (0.006)	0.018 (0.006)
3 x rate, 15.7 (1.7)	0.022 (0.0024)	0.017 (0.0018)	0.67 (0.073)	0.52 (0.056)	0.11 (0.012)	0.091 (0.01)	0.036 (0.004)	0.027 (0.003)	0.027 (0.003)	0.018 (0.002)
10 x rate, 52.4 (1.7)	0.16 (0.005)	0.1 (0.003)	7.8 (0.25)	5.1 (0.17)	0.84 (0.027)	0.66 (0.021)	0.28 (0.009)	0.17 (0.006)	0.2 (0.006)	0.14 (0.005)

[1]Values in parenthesis: calculated, assuming 1.7 ppm intake

The Meeting estimated maximum residue levels of 0.01 mg/kg for milk, 0.3 mg/kg for liver, 0.05 mg/kg for kidney, 0.02 mg/kg for meat and 0.01 mg/kg for fat and STMR levels of 0.004 mg/kg for milk, 0.22 mg/kg for liver, 0.026 mg/kg for kidney, 0.009 mg/kg for meat and 0.006 mg/kg for fat.

As the metabolism is similar in rats and cows, these levels are estimated for cattle, goats, sheep and pigs.

The Meeting noted that the nature of the residue in poultry meat, fat and eggs is unknown and no feeding study was carried out. Nevertheless, taking into account the results of the poultry metabolism study reviewed by the 1995 JMPR, with doses of 51.5 ppm in the diet with the phenyl label and 39.3 ppm with the morpholine label compared with the low estimated maximum dietary burden of 0.35 ppm, the Meeting concluded that no residues are to be expected in poultry products.

RECOMMENDATIONS

The Meeting estimated the following maximum residue levels which are recommended for use as MRLs.

Definition of the residue for compliance with MRLs and estimation of dietary intake for plant commodities: fenpropimorph.

For compliance with MRLs and estimation of dietary intake for animal commodities: 2-methyl-2-{4-[2-methyl-3-(*cis*-2,6-dimethylmorpholin-4-yl)propyl]phenyl}propionic acid expressed as fenpropimorph.

Commodity		Recommendation		
		MRL, mg/kg		STMR, mg/kg
CCN	Name	New	Previous	
FI 0327	Banana	2		0.11
PE 0112	Eggs	0.01*		0
MO 0098	Kidney of cattle, goats, pigs and sheep	0.05		0.026

Commodity		Recommendation		
		MRL, mg/kg		STMR, mg/kg
CCN	Name	New	Previous	
MO 0099	Liver of cattle, goats, pigs and sheep	0.3		0.22
MF 0100	Mammalian fats (except milk fats)	0.01		0.006
MM 0095	Meat (from mammals other than marine mammals)	0.02		0.009
ML 0106	Milks	0.01		0.004
PF 0111	Poultry fats	0.01*		0
PM 0111	Poultry meat	0.01*		0
PO 0111	Poultry, Edible offal of	0.01*		0

DIETARY RISK ASSESSMENT

Chronic intake

STMRs have been estimated by the current Meeting for bananas and animal products. Where consumption data were available these STMRs were used in the estimates of dietary intake together with the draft MRLs for 5 other food commodities.

The estimated dietary intakes for the five GEMS/Food regional diets, based on these MRLs and STMRs, were in the range of 10-90% of the ADI. The Meeting concluded that the intake of residues of fenpropimorph resulting from its uses that have been considered by the JMPR is unlikely to present a public heath concern.

Acute intake

The international estimate of short-term intake (IESTI) for fenpropimorph was calculated for the only commodity for which an MRL and STMR were established and for which consumption data (large portion consumption and unit weight) were available. The results are shown in Annex IV. The IESTIs were 0.0045 mg/kg bw for the general population and 0.018 mg/kg bw for children. As no acute reference dose has been established, the acute risk assessment for fenpropimorph was not finalized.

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