



Residue Findings of QuPPE-Compounds in Samples of Plant Origin from the German Market in 2021

Reported by: EURL-SRM
Version 1 (last update: 01.04.2022)

The aim of this compilation is to give an overview as to which highly polar (QuPPE-) compounds are currently encountered in food products of plant origin. This should help other institutions when it comes to taking decisions on how to expand the scope of analytes, on how to plan the sampling and on which QuPPE compounds to target in certain types of samples.

At CVUA Stuttgart, 44 QuPPE-compounds were routinely monitored in 2021 (see Table 1). Some of these compounds are not legally relevant, as they are not part of the legal residue definition.

Despite not being a QuPPE compound, a brief overview of the residue findings of 2-chloroethanol (formed from the reaction of the fumigant ethylene oxide with chloride) in 2021 is given at the end of this document. This is to acknowledge the high incidences of 2-CE findings in 2021, which caused severe turbulences in the EU-food market in 2021.

Table 1: Scope of QuPPE-compounds that were routinely monitored by the CVUA Stuttgart in 2021

Compound	Notes on legal limits	General notes
Ammelide	Non-regulated metabolite and contaminant	Ammelide can originate from various sources, similar to Ammeline. Ammelide (and ammeline) are formed as intermediates during the gradual transformation of Melamine (a compound with multiple sources, see below) to cyanuric acid. Ammelide is reported as a metabolite of various triazine pesticides incl.: cyromazine (insecticide), anilazine (fungicide) and the herbicides terbuthylazine, prometryn, simazine, atrazine, ametrin, cyanazine. Among those pesticides, only terbuthylazine is currently approved within the EU.
Ammeline	Non-regulated metabolite and contaminant	Intermediate in the conversion of melamine to cyanuric acid. For more info, see Ammelide
Amitrole	MRLs are set at the LOQ in all products	Non-approved herbicide, the most important of the very few triazole pesticides with herbicidal properties. Approval expired in mid-2016.
Bromide	MRLs refer to bromide ion. Background levels are generally considered in MRLs for food of plant origin, but rather not considered in MRLs for food of animal origin. Collection of data on background levels in the latter would be useful.	Reaction product of fumigant methylbromide. Also originating from irrigation water and soil. Counter ion of certain quarternary ammonium compounds e.g. benzalkonium, Didecyl Dimethyl Ammonium (DDA-), diquat and paraquat
Chlorate	New MRLs set in 2020	Formerly used as herbicide, but nowadays mainly originating from chlorinated water that is often used to irrigate fields or for washing harvested products or the equipment that is used for processing or storage of agricultural products.
Chloridazon-desphenyl	Regulated metabolite	Metabolite of chloridazon (which approval expired on 31/12/2018). Chloridazon-desphenyl is quite persistent in the environment, thus residues in succeeding crops, and in water, are encountered.
Chlormequat	MRLs refer to chlormequat chloride	EU-Approved growth regulator with a wide range of applications.
Cyanuric acid	Non-regulated metabolite	Compound originating from multiple sources, e.g.: Triazine pesticides (incl. the herbicides terbuthylazine, atrazine, cyanazine, the fungicide; anilazine and the insecticide cyromazine). From the above only terbuthylazine is currently in use within the EU. Cyromazine has lost approval in Dec. 2019. Cyanamide-based fertilizers. Cyanamide contained in fertilizers may convert to melamine through trimerization, which can further hydrolyze to cyanuric acid. Urea-based fertilizers or feed: especially at high temperatures urea loses ammonia converting to isocyanic acid (HNCO), which trimerizes to cyanuric acid. Mono-, Di- and Trichloroisocyanurates: Used as disinfectants, algacides and bactericides. They are used in sanitation liquids and bleaching agents as well as in swimming pools (pool-tabs) to retard the loss of chlorine in chlorinated water. In water, they gradually convert to cyanuric acid. Natural formation of cyanuric acid has also been reported (e.g. in humus).

Compound	Notes on legal limits	General notes
Cyromazine	MRLs in food of plant origin are set at the LOQ with multiple exceptions (e.g. fruiting vegetables, lettuces, celery, fresh herbs, and sheep products).	Non-approved fungicide (EU-approval expired in Dec. 2019). Also used as an ectoparasiticide (e.g. on sheep, but not on lactating sheep) and as a biocide on manure against fly larvae
Daminozide	MRLs are set at the LOQ in all products	Approved growth regulator
Difenzoquat	No specific MRLs established (0.01 mg/kg applies)	Non-approved herbicide
Dimethoate-O-desmethyl	Non-regulated metabolite	Also known as Metabolite X
Diquat	Specific MRLs set for several commodities where siccation takes place prior to harvest (such as potatoes, pulses and oily seeds) and for some other products, (such as citrus fruits, stone fruit, tree nuts, oats, strawberries, eggs)	Non-approved herbicide, formerly used for siccation in potatoes (EU-approval expired in Dec. 2019)
Diquat dipyridone	Non-regulated metabolite	Metabolite of diquat
Diquat monopiryridone	Non-regulated metabolite	Metabolite of diquat
Diquat Met. TOPPS	Non-regulated metabolite	Metabolite of diquat
Ethephon		Approved growth regulator with multiple applications
HEPA	Non-regulated metabolite	Metabolite of ethephon. Natural formation by bacteria under anaerobic conditions was reported. Detected by the EURL-SRM in all analyzed samples of bovine liver (levels around 0.5 mg/kg). These levels are considered natural artefacts.
ETU	Non-regulated degradant	Degradant of ethylen-bis-dithiocarbamates. Also impurity in formulations based on EBTCs. Also formed during food processing. Marker for EBTC-application history. Note: Most EB-DTCs lost approval within the EU (Mancozeb expired on Jan 2021 with the period of grace ending in Jan 2022; Maneb expired in Jan 2017, Zineb and Nabam did not receive EU-approval). Metiram is still approved (current approval period ends in Jan 23).
Fosetyl		Approved fungicide (converts to phosphonic acid, which is the active component)
Phosphonic acid	Regulated with parent fosetyl	Approved fungicide, used as such and also formed as a metabolite of fosetyl
Glufosinate	Specific MRLs apply for many crops	Non-approved herbicide, also used in the cultivation of glufosinate-resistant transgenic crops. EU-approval expired in mid-2018 and not renewed
MPP (MPPA)	Included in residue definition of glufosinate	Metabolite of glufosinate
N-Acetyl Glufosinate	Included in residue definition of glufosinate	Metabolite of glufosinate
Glyphosate	Specific MRLs apply for many crops	Approved herbicide, also used in the cultivation of glyphosate-resistant transgenic crops. Current approval periods end in Dec 2022.
AMPA	Non-regulated metabolite.	Metabolite of glyphosate. Planned inclusion in RD of glyphosate.
N-Acetyl-Glyphosate	Non-regulated metabolite.	Metabolite of glyphosate. Planned inclusion in RD of glyphosate.
Maleic hydrazide	Plant product MRLs set at 0.2* / 0.5* except for Potatoes, Carrots, Parsnips, Onions, Garlic, Shallots, Chicory	Approved sprouting inhibitor.
Matrine	MRL of 0.01 mg/kg applies (listed in EU-pesticide database)	Natural quinolizidine alkaloid that is considered (together with oxymatrine) as the active ingredient of biopesticides based on extracts of certain plants of the <i>Sophora</i> family. Not approved within the EU as PPP, neither in conventional nor in organic production. Registered in various countries in Asia, Africa and South America. There were cases of illegal addition of <i>Sophora</i> root extracts in fertilizers in Italy. Together with oxymatrine, often found in so-called "acacia honey" from China, which is often collected from flowers of plants of the <i>Sophora</i> family. <i>Sophora</i> extracts also used in traditional Asian medicine and cosmetics.
Oxymatrine	MRL of 0.01 mg/kg applies (listed in EU-pesticide database)	Quinolizidine alkaloid present in <i>Sophora</i> extracts, remarks on matrine apply
Melamine	Regulated by Reg. 1881/2006/EC as a contaminant	Metabolite of cyromazine (pesticide and vet. drug). May also originate from cyanamide fertilizers (trimerization of cyanamide). It may also originate from urea, where it is formed through trimerisation to triuret and subsequent elimination of ammonia and carbon dioxide (Note: biuret and triuret are related non-cyclic products formed from the di- and trimerisation of urea respectively). Melamine hydrolyzes to cyanuric acid via ammeline and ammelide. Melamine is widely used for the synthesis of melamine-formaldehyde resins that are employed in synthetic surfaces of furniture, textiles, kitchenware as well as in moulding and packaging materials. Also used as a fire-retardant.
Mepiquat	MRLs refer to mepiquat chloride	Approved growth regulator

Compound	Notes on legal limits	General notes
Mepiquat, 4-Hydroxy	Non-regulated metabolite	Metabolite of mepiquat, mainly relevant for food of animal origin
Morpholine	Not regulated as a pesticide	Additive of waxes (typically added in a 1:1 mixture with oleic acid) to assist emulsification in water and improve handling.
Nereistoxin	Non-regulated metabolite	Transformation product of various members of the nereistoxin pesticides family, such as bensultap, sultap, cartap and thioacydam
Nicotine	Specific MRLs set for rose hips, herbs, edible flowers, wild fungi, teas, herbal infusions and spices. MRLs will be revised when information on origin of background levels become available.	Non-approved insecticide, contaminant from tobacco through air, soil and human contact.
Paraquat	MRL at LOQ 0.02 to 0.05 mg/kg	Non-approved herbicide, EU-approval expired in Dec. 2007
Perchlorate	Regulated as a contaminant, see Reg. (EC) 1881/2006/EC	Persistent and ubiquitous environmental contaminant. Mainly originating from fertilizers, may be also formed as a byproduct of disinfection of drinking water. Temporarily inhibits the intake of iodine in the thyroid gland.
Propamocarb		Approved fungicide, mainly relevant for vegetables, e.g. root, bulb, fruiting, leafy vegetables
Propamocarb N-desmethyl	Non regulated metabolite	Metabolite of propamocarb
Propamocarb-N-oxide	Non regulated metabolite	Metabolite of propamocarb
PTU	Regulated in infant- and baby food Reg. EC 125/2006 and 141/2006	Degradant of propylen-bis-dithiocarbamates (essentially propineb). Also impurity in formulations based on propineb. Also formed during food processing. Useful marker for propineb-application history. Note: Propineb is not any more approved within the EU (approval expired in March 2018)
Thiocyanate	No specific MRLs set. Formally, the default MRL of 0.01 mg/kg applies. Collection of data on background levels would help introduce reasonable MRLs that take into account the background levels.	Non-approved fungicide. Also naturally formed in various cultivated plants of the brassica and allium family. Temporarily inhibits the intake of iodine in the thyroid gland. Eggs and milk may contain higher levels if fed with brassica crops. Also naturally formed in animals (e.g. in saliva).
Trimesium	MRLs of dry commodities do not always take into account the amounts formed during the drying process.	Counter-ion of glyphosate, also naturally formed as an artefact during the drying process of food

Residue Findings:

In 2021, a total of 2445 samples, mainly fruit and vegetables, but also cereals, pulses, processed goods, tea and others, were analyzed for QuPPE-amenable compounds at the CVUA Stuttgart. 1863 samples (76 %) contained quantifiable residues of one or more of the tested QuPPE compounds.

Table 2 sorts the compounds based on the frequency of finding above the reporting limit. Table 3 shows a compilation of all the results concerning the above-listed highly polar compounds.

Table 2: Residue findings of QuPPE-compounds (CVUA Stuttgart 2021)

Frequency of findings > respective RL	Compounds (pesticides and legally relevant metabolites shown in bold)
> 10 % of samples.	<i>Cyanuric acid, Phosphonic acid, Perchlorate, Chlorate and 2-Chloroethanol*</i>
1 - 10 % of samples.	<i>Melamine, Thiocyanate, Propamocarb, Propamocarb-N-oxide, Bromide, Trimethylsulfonium cation, Nicotine, <i>Ethephon metabolite HEPA, Propamocarb-N-desmethyl, Chlormequat-chloride, sum, Ethephon and Ammelide</i></i>
0.1 -1% of samples	<i>Chloridazon-desphenyl, Diquat, Maleic hydrazide, Dimethoate-O-desmethyl, Glufosinate met. MPPA, Mepiquat-chloride, Cyromazine, Fosetyl, ETU, Glyphosate, Nereistoxin, Morpholine, Mepiquat- 4-hydroxy, Amitrole and Daminozide</i>
Not detected above LOQ	<i>Ammeline, Difenzoquat, Diquat-dipyridone, Diquat met. TOPPS, Diquat-monopyridone, Ethylene oxide*, Glufosinate, Glyphosate met. N-Acetylgliphosate, Matrine, N-Acetyl-glufosinate, Oxymatrine, Paraquat (very few analyses) and PTU (two times below LOQ)</i>
* technically not QuPPE compounds but still shown here (see towards the end of this document)	

Table 3: Residue findings of QuPPE-compounds (CVUA Stuttgart 2021)

Compound	# samples	# pos.	% pos.	Max (mg/kg)	Mean ¹⁾ (mg/kg)	Median ¹⁾ (mg/kg)	# >MRL ²⁾	% >MRL	RL ³⁾
Cyanuric acid	2445	941	38	6.5	0.059	0.013	0	0	0.005
Phosphonic acid	2449	589	24	192	3.8	0.97	15	0.6	0.05
Perchlorate	2446	463	19	2.6	0.062	0.014	1	0.04	0.005
Chlorate	2446	384	16	8.7	0.13	0.015	10	0.4	0.005
Melamine	2445	255	10	3.3	0.13	0.04	0	0	0.005
Thiocyanate	2446	208	8.5	214	8.4	4.0	0	0	0.1
Propamocarb	2445	88	3.6	9.5	0.20	0.023	3	0.1	0.005
Propamocarb-N-oxide	2445	73	3	0.46	0.042	0.019	0	0	0.005
Bromide	2446	70	2.9	392	39.8	18.0	5	0.2	5
Trimesium	2445	68	2.8	1.2	0.098	0.032	15	0.6	0.005
Nicotine	2445	56	2.3	0.36	0.071	0.041	22	0.9	0.005
Ethephon metabolite HEPA	2445	47	1.9	2.5	0.19	0.050	0	0	0.005
Propamocarb-N-desmethyl	2445	47	1.9	0.4	0.022	0.009	0	0	0.005
Chlormequat chloride	2445	43	1.8	0.68	0.095	0.044	11	0.4	0.005
Ethephon	2445	36	1.5	5.6	0.30	0.089	3	0.1	0.02
Ammelide	2445	30	1.2	1.6	0.21	0.11	0	0	0.005
Chloridazon-desphenyl	2445	22	0.9	0.18	0.032	0.007	0	0	0.01
Diquat	217	2	0.9	0.02	0.013	0.013	0	0	0.01
Maleic hydrazide	2445	20	0.8	18.6	4.3	1.45	0	0	0.01
Dimethoate-O-desmethyl	2445	18	0.7	0.58	0.053	0.016	0	0	0.005
Glufosinate met. MPPA	2445	15	0.6	0.14	0.042	0.028	0	0	0.01
Mepiquat chloride	2445	15	0.6	0.14	0.025	0.011	0	0	0.005
Cyromazine	2445	12	0.5	0.84	0.14	0.026	1	0.04	0.01
Fosetyl	2446	13	0.5	0.35	0.12	0.066	0	0	0.01
ETU	2445	10	0.4	0.39	0.15	0.11	0	0	0.02
Glyphosate	2445	8	0.3	0.87	0.20	0.10	2	0.08	0.02
Nereistoxin	2445	4	0.2	0.053	0.031	0.032	0	0	0.005
Morpholine	2447	3	0.1	0.67	0.25	0.041	0	0	0.02
Mepiquat, 4-hydroxy	2445	2	0.08	0.026	0.017	0.017	0	0	0.005
Amitrole	2445	1	0.04	0.006	0.006	-	0	0	0.005
Daminozide	2445	1	0.04	0.007	0.007	-	0	0	0.02

¹⁾ Mean and median of positives

²⁾ Numerical MRL-exceedances

³⁾ RL= Reporting Limit (exemplary for fruits and vegetables)

MRL exceedances

In 107 samples MRLs for different compounds were exceeded. Table 4 gives an overview of these exceedances.

Table 4: Samples with residues of QuPPE-compounds exceeding existing MRLs* (CVUA Stuttgart 2021)

Compound	Commodity	Country of Origin	Conc. (mg/kg)	>2x MRL**	Note
Bromide	Algae (dried)	Poland	392	X	organic
	Algae (dried)	South Korea	56		
	Algae (dried)	unknown	297	X	organic
	Hop	Germany	32		
	Spinach	France	54		
Chlorate <i>(herbicide, but chlorinated water used in irrigation or sanitation mostly responsible for levels found in food)</i>	Bell pepper (frozen)	Portugal	0.31		
	Chives (frozen)	Germany	0.79		
	Cucumber	Spain	0.60	X	
	Okra (frozen)	Egypt	0.20		
	Okra (frozen)	Egypt	4.8	X	
	Romaine lettuce	Spain	1.9	X	
	Sesame	unknown	0.055		organic
	Paprika (spice)	Poland	8.7	X	
	Strawberry	Spain	0.31	X	
	Vegetable products, chlorella	Germany	0.64		organic
Chlormequat chloride	Asparagus (frozen)	unknown	0.015		
	Bell peppers	Spain	0.012		
	Cucumber	Turkey	0.64	X	
	Garlic (dried)	unknown	0.059		
	Peanut, roasted	Turkey	0.039	X	
	Paprika (spice)	Spain	0.25	X	

Compound	Commodity	Country of Origin	Conc. (mg/kg)	>2x MRL**	Note
	Paprika (spice)	unknown	0.13		
	Paprika (spice)	unknown	0.14		
	Dill (dried)	unknown	0.68	X	
	Strawberry	Germany	0.021		
	Strawberry (frozen)	unknown	0.023	X	
Cyromazine	Pomegranate	Turkey	0.062		
Ethephon	Medlar	Spain	0.051		
	Bell peppers	Turkey	5.6	X	
	Melon	Turkey	0.28	X	
Fosetyl, sum <i>(phosphonic acid was the only detected compound in most cases)</i>	Asparagus	Germany	3.2		
	Asparagus	Germany	6.0	X	
	Asparagus	Germany	6.7	X	
	Asparagus	Germany	8.3	X	
	Asparagus	Germany	9.3	X	
	Broad beans with pod	Turkey	14.0	X	
	Cherry	Turkey	2.7		
	Cherry	Turkey	7.4	X	
	Ginger	China	2.4		
	Green beans	Egypt	3.4		
	Green beans	Morocco	3.5		
	Green beans	Morocco	7.7	X	
	Papaya	Brazil	4.2	X	
	Passion fruit	Colombia	2.8		
	Peanut	Egypt	6.3	X	
	Plum	Germany	8.5	X	
	Pomegranate	Turkey	2.1		
	Pomegranate	Turkey	2.1		
	Pomegranate	Turkey	5.0	X	
	Pomegranate	Turkey	5.1	X	
	Pomegranate	Turkey	6.4	X	
	Pomegranate	Turkey	6.8	X	
	Pomegranate	Turkey	8.7	X	
Glyphosate	Plum	Republic of Moldova	0.11		
	Pomegranate	Turkey	0.18		
Nicotine <i>(insecticide, but tobacco-related contamination mostly responsible for levels found in food)</i>	Algae, dried	Norway	0.16		organic
	Algae, dried	unknown	0.14		
	Borecole	Germany	0.012		
	Borecole	Germany	0.055	X	
	Borecole	unknown	0.017		
	Fruiting vegetables (dried)	unknown	0.079		
	Oyster mushroom	Poland	0.026	X	
	Oyster mushroom	unknown	0.011		
	Passion fruit	South Africa	0.014		
	Pear	The Netherlands	0.013		
	Plum	Germany	0.011		organic
	Rucola	Germany	0.012		
	Rucola	Germany	0.013		
	Rucola	Italy	0.013		
	Spices	Spain	0.12		organic
	Spices	Hungary	0.25	X	
	Spinach	Germany	0.027	X	
	Spinach	Germany	0.03	X	
	White button mushroom	Poland	0.011		
	Wine leaves (in brine)	Turkey	0.019		
Wine leaves (in brine)	Turkey	0.029	X		
Wine leaves (in brine)	Turkey	0.048	X		
Perchlorate <i>(contaminant in fertilizers)</i>	Potato	Egypt	0.055		
Propamocarb	Celery, prepared	Spain	0.021		
	Vegetable powder	Kenya	0.10		organic
	Wine leaves (in brine)	Egypt	0.017		
Trimesium <i>(Counter ion of glyphosate but also natural formation during drying process of crops)</i>	Black tea	India	0.10		
	Black tea	Sri Lanka	0.08		
	Black tea	Sri Lanka	0.16	X	
	Black tea	Sri Lanka	0.20	X	
	Black tea	Sri Lanka	0.27	X	

Compound	Commodity	Country of Origin	Conc. (mg/kg)	>2x MRL**	Note
	Food supplement	Germany	0.21	X	organic
	Green tea	China	0.055		organic
	Green tea	China	0.16	X	organic
	Green tea	China	0.29	X	organic
	Green tea	China	0.055		
	Jasmine tea	Taiwan	0.47	X	
	Dill (dried)	unknown	0.40		
	Dill (dried)	unknown	1.2	X	
	Vegetable powder	Kenya	0.10		organic
	Vegetable powder	unknown	0.55		organic

* >1xMLR

** >2xMRL means that the sample exceeded MRL even after deducting measurement uncertainty of 50%

Table 5: Top 15 residue levels of most frequently found QuPpe-compounds (with > 50 findings in total)

Compound	Commodity	Country of origin	Residue level (mg/kg)
Cyanuric acid <i>(non-regulated pesticide metabolite and contaminant in fertilizers)</i>	Vegetable products, chlorella	Germany	6.5
	Asparagus	Mexico	3.3
	Juices, orange juice	Unknown	1.7
	Juices, orange juice	Unknown	1.5
	Juices, orange juice	Unknown	1.5
	Strawberry (frozen)	Unknown	1.5
	Shiitake (dried)	China	1.2
	Avocado	Israel	1.1
	Spices, paprika	Spain	0.83
	Pineapple	Costa Rica	0.81
	Pineapple	Costa Rica	0.64
	Cultivated mushroom (dried)	China	0.51
	Dill (dried)	Unknown	0.51
	Juices, pineapple juice	Unknown	0.50
Pineapple	Costa Rica	0.50	
Phosphonic acid <i>(Metabolite of Fosetyl but also used as such. Shows high persistence in plants, and residues in crops of perennial plants may originate from previous seasons)</i>	Almond	Unknown	192
	Beer ingredients, hop	Germany	96
	Batavia lettuce	Germany	57
	Rucola	Italy	52
	Strawberry	Germany	49
	Pear	Italy	48
	Rucola	Italy	47
	Dill (dried)	Unknown	47
	Almond	Unknown	39
	Avocado	South Africa	32
	Wine grapes	Germany	27
	Pear	Italy	23
	Chives	Ethiopia	23
	Almond	USA	22
Sultana	South Africa	22	
Perchlorate <i>(Regulated as contaminant)</i>	Algae (dried)	Germany	2.6
	Algae (dried)	Norway	2.4
	Dill (dried)	Unknown	2.1
	Vegetable powder, moringa oleifera	Germany	0.62
	Vegetable powder, moringa oleifera	Unknown	0.59
	Food supplement	Germany	0.57
	Food supplement	Germany	0.54
	Food supplement	Germany	0.51
	Vitamins and minerals	Germany	0.51
	Vegetable powder, moringa oleifera	Kenya	0.48
	Food supplement	India	0.46
	Vegetable powder, moringa oleifera	Austria	0.44
	Spices, cumin	Turkey	0.40
	Cinnamon	Unknown	0.37
	Spinach	Italy	0.34
	2-Chloroethanol	Food supplement	Germany
Vegetable powder, moringa oleifera		Unknown	1030

Compound	Commodity	Country of origin	Residue level (mg/kg)
	Food supplement	Unknown	863
	Vegetable powder, moringa oleifera	Unknown	733
	Food additives, HPMC	South Korea	540
	Vegetable powder, moringa oleifera	Unknown	410
	Vitamins and minerals	Austria	170
	Food supplement	Austria	164
	Food additives, HPMC	Unknown	158
	Food supplement	The Netherlands	97
	Food supplement	Germany	95
	Vitamins and minerals	Austria	67
	Vitamins and minerals	Germany	65
	Food supplement	Unknown	50
	Food supplement	Unknown	37
	Chlorate <i>(herbicide, but chlorinated water used in irrigation or sanitation mostly responsible for levels found in food)</i>	Paprika (spice)	Poland
Okra (frozen)		Egypt	4.8
Dill (dried)		Unknown	3.6
Paprika (spice)		Unknown	2.9
Paprika (spice)		Unknown	2.4
Paprika (spice)		Hungary	2.0
Romaine lettuce		Spain	1.9
Paprika (spice)		Unknown	1.7
Paprika (spice)		Spain	1.7
Paprika (spice)		Unknown	1.6
Paprika (spice)		Unknown	1.5
Paprika (spice)		Unknown	0.99
Chives (frozen)		Germany	0.79
Paprika (spice)		Unknown	0.77
Vegetable products, chorella	Germany	0.64	
Melamine <i>(Metabolite of cyromazine, but also contaminant originating from multiple sources; regulated as contaminant)</i>	Spices, mugwort	Germany	3.3
	Spinach	Italy	0.99
	Celeriac	Germany	0.97
	Coconut milk	Thailand	0.95
	Beer ingredients, hop	Germany	0.95
	Beer ingredients, hop	Germany	0.92
	Celeriac	Germany	0.88
	White button mushroom	Poland	0.82
	Celeriac	Germany	0.81
	Chives (frozen)	Germany	0.81
	Parsley	Germany	0.81
	Parsley	Unknown	0.78
	White button mushroom	Poland	0.78
	Celeriac	Germany	0.75
Tomato	Tunisia	0.68	
Thiocyanate <i>(mostly of natural origin)</i>	Spices, mustard seeds	Ukraine	214
	Savoy cabbage	Germany	49
	Brussels sprout	The Netherlands	43
	Brussels sprout	The Netherlands	39
	Brussels sprout	The Netherlands	34
	Brussels sprout	The Netherlands	31
	Brussels sprout	The Netherlands	30
	Savoy cabbage	Germany	29
	Brussels sprout	The Netherlands	28
	Brussels sprout	The Netherlands	26
	Brussels sprout	Belgium	26
	Savoy cabbage	Germany	26
	Broccoli	Italy	26
	Brussels sprout	The Netherlands	25
White cabbage	Germany	24	
Propamocarb	Head lettuce	Germany	9.5
	Cucumber	Spain	1.0
	Cucumber	Spain	0.47
	Cucumber	Germany	0.42
	Cucumber	Spain	0.42

Compound	Commodity	Country of origin	Residue level (mg/kg)
	Cucumber	Spain	0.37
	Cucumber	Spain	0.36
	Cucumber	Spain	0.31
	Parsley	Unknown	0.3
	Cucumber	Spain	0.29
	Cucumber	Belgium	0.28
	Zucchini	Spain	0.27
	Spinach	Spain	0.26
	Cucumber	Spain	0.23
	Cucumber	Spain	0.21
Propamocarb-N-oxide	Head lettuce	Germany	0.46
	Cucumber	Spain	0.26
	Brussels sprout	The Netherlands	0.17
	Brussels sprout	The Netherlands	0.16
	Cucumber	Spain	0.14
	Brussels sprout	The Netherlands	0.14
	Cucumber	Spain	0.13
	Cucumber	Germany	0.10
	Brussels sprout	The Netherlands	0.10
	Cucumber	Spain	0.089
	Cucumber	Spain	0.082
	Cucumber	Germany	0.076
	Potato	Germany	0.076
	Cucumber	Spain	0.052
Potato	Germany	0.047	
Bromide	Algae (dried)	Norway	392
	Algae (dried)	Germany	389
	Algae (dried)	Unknown	297
	Algae (dried)	Germany	279
	Food supplement	India	82
	Vegetable powder, moringa oleifera	Kenya	72
	Vegetable powder, moringa oleifera	Germany	70
	Algae (dried)	South Korea	56
	Spinach	France	54
	Food supplement	Germany	53
	Food supplement	Germany	48
	Vitamins and minerals	Germany	42
	Dill (dried)	Unknown	40
	Beer ingredients, hop	Germany	32
Dill leaves	Spain	31	
Trimesium <i>(Counter ion of glyphosate but also natural formation during drying process of crops)</i>	Dill (dried)	unknown	1.2
	Vegetable powder	Unknown	0.55
	Jasmine tea	Taiwan	0.47
	Dill (dried)	Unknown	0.4
	Dill (dried)	Unknown	0.29
	Green tee	China	0.29
	Black tea	Sri Lanka	0.27
	Dill (dried)	Unknown	0.24
	Food supplement	Germany	0.21
	Black tea	Sri Lanka	0.20
	Dill (dried)	unknown	0.20
	Spices, oregano	Unknown	0.18
	Black tea	Sri Lanka	0.16
	Green tea	China	0.16
	Baby and infant foods	Unknown	0.15
Nicotine	Cinnamon	Sri Lanka	0.36
	Black tea	India	0.33
	Cinnamon	Indonesia	0.29
	Paprika (spice)	Hungary	0.25
	Vitamins and minerals	Germany	0.22
	Cinnamon	Unknown	0.19
	Algae (dried)	Norway	0.16
	Algae (dried)	Unknown	0.14

Compound	Commodity	Country of origin	Residue level (mg/kg)
	Algae (dried)	Germany	0.13
	Algae (dried)	Germany	0.12
	Paprika (spice)	Spain	0.12
	Cinnamon	Unknown	0.11
	Dill (dried)	Unknown	0.093
	Cinnamon	Unknown	0.090
	Black tea	Sri Lanka	0.089

Table 6: Top 10 residue levels of less frequently found QuPPE-compounds (with < 50 findings in total)

Compound	Commodity	Country of origin	Residue level (mg/kg)
HEPA <i>(Non-regulated metabolite of Ethephon)</i>	Oyster mushroom	Poland	2.5
	Bell peppers	Turkey	2.2
	Oyster mushroom	unknown	0.42
	White button mushroom	unknown	0.40
	White button mushroom	Poland	0.38
	White button mushroom	Poland	0.37
	Spices, cardamom	unknown	0.30
	Grapes	South Africa	0.23
	Wild mushrooms	Romania	0.20
	Cinnamon	unknown	0.19
Propamocarb-N-desmethyl	Head lettuce	Germany	0.40
	Brussels sprout	The Netherlands	0.044
	Cucumber	Spain	0.043
	Potato	Germany	0.036
	Potato	Germany	0.035
	Cucumber	Spain	0.034
	Cucumber	Spain	0.033
	Spinach	Spain	0.033
	Cucumber	Germany	0.029
	Brussels sprout	The Netherlands	0.026
Chlormequat chloride	Dill (dried)	unknown	0.68
	Cucumber	Turkey	0.64
	Paprika (spice)	Spain	0.25
	Cultivated mushroom (dried)	China	0.21
	Oyster mushroom	Poland	0.19
	Cultivated mushroom (dried)	China	0.19
	Vegan/vegetarian food	unknown	0.15
	Paprika (spice)	unknown	0.14
	Wheat flour	Germany	0.14
	Paprika (spice)	unknown	0.13
Ethephon	Bell peppers	Turkey	5.6
	Figs	Turkey	0.88
	Grapes	Spain	0.74
	Tomato	Poland	0.59
	Pineapple	Ghana	0.32
	Pineapple	Costa Rica	0.30
	Melon	Turkey	0.28
	Grapes	Peru	0.25
	Grapes	South Africa	0.21
	Pineapple	Costa Rica	0.17
Ammelide <i>(Metabolite of some triazine herbicides as well as of melamine, see boave)</i>	Cinnamon	unknown	1.6
	Cultivated mushroom (dried)	China	1.4
	Vegetable products	Germany	0.53
	Shiitake mushroom	Germany	0.29
	King oyster mushroom	South Korea	0.26
	Cultivated mushroom (dried)	China	0.23

	King oyster mushroom	Germany	0.22
	Green tea	China	0.16
	Jasmine tea	Taiwan	0.16
	Pineapple	Ghana	0.15
Chloridazon-desphenyl	Dill (dried)	unknown	0.18
	Dill (dried)	unknown	0.16
	Dill (dried)	unknown	0.16
	Dill (frozen)	Germany	0.040
	Mint	Germany	0.025
	Chives (frozen)	unknown	0.022
	Spinach (frozen)	unknown	0.015
	Spinach (frozen)	unknown	0.014
	Basil	Germany	0.009
	Celery	Germany	0.008
Maleic hydrazide	Potato	Germany	19
	Potato	unknown	13
	Potato	France	10
	Potato	Germany	9.4
	Potato	Germany	7.7
	Potato	France	6.7
	Potato	Germany	6.7
	Potato	Germany	6.0
	Onion	The Netherlands	2.2
	Onion	Germany	1.7
Dimethoate-O-desmethyl	Leek	Germany	0.58
	White cabbage	Germany	0.055
	Rutabaga (swedish turnip, swede)	unknown	0.055
	Onion	Germany	0.043
	Wine leaves, prepared in brine	Egypt	0.034
	Chives (frozen)	Germany	0.031
	Celeriac	Germany	0.018
	Sesame	unknown	0.018
	Mandarine	Spain	0.017
	Radish	Germany	0.014
Glufosinate Met. MPP	Cherry	Turkey	0.14
	Cherry	Turkey	0.11
	Almond	USA	0.062
	Kaki	Africa	0.055
	Grapes	South Africa	0.047
	Almond	unknown	0.038
	Plum	Germany	0.028
	Almond	unknown	0.028
	Pear	South Africa	0.024
	Plum	South Africa	0.018
Mepiquat chloride	Cultivated mushroom (dried)	China	0.14
	Cultivated mushroom (dried)	China	0.11
	Oyster mushroom	Germany	0.016
	White button mushroom	Germany	0.015
	Okra (frozen)	Egypt	0.013
	White button mushroom	Poland	0.013
	White button mushroom	Poland	0.011
	King oyster mushroom	Germany	0.011
	King oyster mushroom	Germany	0.010
	White button mushroom	Poland	0.009
Cyromazine	White button mushroom	Poland	0.84
	White button mushroom	Poland	0.61
	Pomegranate	Turkey	0.062
	Physalis	Colombia	0.051
	Sugarsnap peas (frozen)	Unknown	0.041

	Melon	Brazil	0.029
	Melon	Spain	0.022
	Pomegranate	Turkey	0.017
	Melon	Brazil	0.017
	Melon	Brazil	0.015
Fosetyl	Grapes	Turkey	0.35
	Grapes	Turkey	0.33
	Melon	Honduras	0.26
	Grapes	Italia	0.17
	Grapes	Turkey	0.12
	Mandarine	Spain	0.066
	Cucumber	Spain	0.066
	Wine grapes	Germany	0.060
	Strawberry (frozen)	Unknown	0.030
	Head lettuce	Germany	0.023
ETU	Rucola	Germany	0.39
	Wine leaves (in brine)	Turkey	0.31
	Wine leaves (in brine)	Turkey	0.19
	Rucola	Germany	0.19
	Parsley	Germany	0.14
	Wine leaves (in brine)	Egypt	0.078
	Parsley	Unknown	0.057
	Parsley	Italia	0.039
	Cucumber	Spain	0.033
	Radish leaves	Germany	0.022
Glyphosate	Lentil	Unknown	0.87
	Black tea	Sri Lanka	0.26
	Pomegranate	Turkey	0.18
	Plum	Republic of Moldavia	0.11
	Lime	Brazil	0.088
	Apple	Germany	0.036
	Pomegranate	Turkey	0.023
	Mandarine	Turkey	0.020

Residues of Ethylene oxide / 2-Chloroethanol

In 2021 a total of 616 samples, mainly highly processed products were analyzed for residues of a fumigation with ethylene oxide. Ethylene oxide fumigations are not approved within the EU but are not uncommon elsewhere. The main purpose is disinfestation and disinfection. Since ethylene oxide is carcinogenic, mutagenic and reprotoxic and since 2-chloroethanol is a suspected mutagenic, EU-MRLs are set at the analytical limit of determination (practical zero tolerance).

In 12 % of the samples 2-chloroethanol, a reaction product of ethylene oxide, could be detected and quantified. In many cases, the residues concerned processed products and mixtures, which made it difficult to legally evaluate the findings. 2-Chloroethanol was mainly found in sesame, spices, plant powders, food supplement, food additives like HPMC, minerals and thickeners. Residues of the highly volatile and reactive ethylene oxide were not be found in any of the tested samples.

Table 7: Residue findings of 2-chloroethanol (CVUA in 2021)

Compound	# samples	# pos.	% pos.	Max (mg/kg)	Mean (mg/kg)	Median (mg/kg)	# >MRL	% >MRL	RL
2-Chlorethanol	616	73	12	4040	121	5.9	11	1.8	0.05

Table 8: Overview of products analyzed for ethylene oxide/ 2-chloroethanol (CVUA in 2021)

Product group	No. of samples analysed	No. of samples with levels>RL	Meanlevel mg/kg	Median (mg/kg)	Min level mg/kg	Max level mg/kg
Cereals and cereal products	45	3	0.43	0.36	0.35	0.59
Food additives	23	4	176	82.1	0.31	540
Nutritional supplement	168	35	167	10.0	0.21	4040
Instant Noodles	63	24	4.1	2.1	0.054	17
Spices, seasonings	71	3	4.7	1.5	0.13	12
Vegan/vegetarian products	10	1	0.065	0.065		
Vegetable powders	40	3	724	733	410	1030
Ice cream powder	35	0				
Other	161	0				
Overall	616	73	121		0.054	4040

For detailed reports see also:

Chemicals Rather than Bacteria? – Neither is Permitted in the EU

Part 1: Residues of Fumigations with Ethylene Oxide in Sesame Seeds

https://www.cvuas.de/pesticides/beitrag_en.asp?subid=1&Thema_ID=5&ID=3295&Pdf=No&lang=EN



Part 2: Plant powder and nutritional supplements

https://www.cvuas.de/pesticides/beitrag_en.asp?subid=1&Thema_ID=5&ID=3434&Pdf=No&lang=EN



Part 3: Instant Noodles – Asian: also fumigated with ethylene oxide!

https://www.cvuas.de/pesticides/beitrag_en.asp?subid=1&Thema_ID=5&ID=3438&lang=EN



The results of the pilot monitoring study on EtO/2-CE run by the EURL-SRM, will be presented in an extra report.