Residue Findings of QuPPe-Compounds in Samples of Plant Origin from the German Market Collected in 2024

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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 compilation should help other institutions in deciding which QuPPe compounds are worthwhile targeting in the various types of samples and on how to reasonably plan sampling when focusing QuPPe compounds. With the knowledge communicated here the EURL-SRM ultimately aims at contributing to a more targeted and efficient use of lab resources within the EU-OfLs.

At CVUA Stuttgart, 49 QuPPe-compounds were routinely monitored in 2024 (see Table 1). Some of these compounds are not legally relevant as they are not part of the legal residue definition, but are still of interest for potential exposure and risk-assessment evaluations.

Table 1: Scope of QuPPe-compounds that were routinely monitored by the CVUA Stuttgart in 2024

Compound	Notes on legal aspects	General notes
4-Methylimidazoline	Non regulated metabolite	Marker of propylene-bis-dithiocarbamates (propineb). Limited specificity at very low concentrations (<0.005 mg/kg).
Aminocyclopyrachlor	MRLs are set at the LOQ in all products	Non-approved herbicide
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 the fumigant methylbromide. Mostly originating from soil and irrigation water. Counter ion of certain quarternary ammonium cations such as benzalkonium, didecyldimethylammonium (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 (approval expired on 31/12/2018). Chloridazon-desphenyl is quite persistent in the environment, thus residues in succeeding crops, and in water, have been reported.
Chlormequat	MRLs refer to chlormequat chloride	EU-Approved growth regulator with a wide range of applications. It has also been reported as a processing contaminant formed during the thermal degradation of choline (and its natural derivates) in presence of chloride ions. Formation has been for example reported during thermal treatment of egg powder, wheat flour, barley and coffee.
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 EU-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 trimerises to cyanuric acid. **Mono-, Di- and Trichloroisocyanurates:** Used as disinfectants, algaecides and bactericides, e.g. in sanitation liquids, 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).
Cyromazine	Since August 2023 all MRLs in food of plant origin are set at the LOQ. MRLs for food of animal origin are also set at the LOQ with exception of sheep tissues (The MRL for sheep milk is set at LOQ)	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

Compound	Notes on legal aspects	General notes
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
Difluoroacetic acid	Regulated metabolite of flupyradifurone	
Dimethoate-O-desmethyl	Non-regulated metabolite	Also known as Metabolite X of dimethoate
Diquat	Specific MRLs set for products where desiccation takes place prior to harvest (e.g. potatoes, pulses, oilseeds) and for some other products, (e.g. citrus, stone fruit, tree nuts, oats, strawberries, eggs)	Non-approved herbicide, formerly used for desiccation in potatoes (EU-approval expired in Dec. 2019)
Diquat dipyridone	Non-regulated metabolite	Metabolite of diquat
Diquat monopyridone	Non-regulated metabolite	Metabolite of diquat
Diquat Met. TOPPS	Non-regulated metabolite	Metabolite of diquat
Ethephon		Approved growth regulator with multiple applications. Very frequent findings in pineapples where it may be used during flowering and to promote ripening. The later application leads to higher levels. Also frequently encountered in grapes, figs and mushrooms.
HEPA	Non-regulated metabolite	Metabolite of ethephon. Likelihood of a natural formation by bacteria in the intestines of cattle under anaerobic conditions was reported by the EURL-SRM in 2019. Detected by the EURL-SRM in all analyzed samples of bovine liver (levels around 0.5 mg/kg). These levels are considered natural artefacts. Manure from cows, sheep and horse (collected from organic farms) and analysed by the EURL-SRM contained in all cases HEPA (highest level in cow dung 1.3 mg/kg and in sheeps dung 8.7 mg/kg). Application of HEPA in fields is therefore likely to lead to HEPA residues in certain organic products. This aspects has been meanwhile also investigated by FiBL, which case to the same conclusion[1].
ETU (ethylene thiourea)	Non-regulated degradant	Degradant of ethylen-bis-dithiocarbamates. Reported as impurity in formulations based on EBTCs. Also formed during food processing. Marker compound for the screening of DTC-residues of products with EBTC-application history. Where EU and ETU are detected simultaneously the likelihood of relevant CS2 levels increases. Note: Most EBDTCs lost approval within the EU (Mancozeb expired on Jan 2021 with the period of grace ending in Jan 2022; Maneb expired in Jan 2017, Metiram expired end of 2024 (period of grace till Nov 2024), Zineb and Nabam didn't receive EU-approval).
EU (2-Imidazolidinone)	Non regulated metabolite	Degradant of ethylen-bis-dithiocarbamates. Degradant of ETU (see above). Marker compound for the screening of DTC-residues of products with EBTC-application history. Where EU and ETU are detected simultaneously the likelihood of relevant CS2 levels increases. See also ETU.
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 Phosphonate-based water-softening agents (e.g. ATMP. HEDP, DTPMP), that are used in cleansing agents contain some residual phosphonic acid, which may lead to small (rather insignificant) contamination of food, e.g. when in contact with surfaces that were not sufficiently rinsed after washing. Formation of phosphonic acid and derivatives thereof, such as HEPA, through the reduction of phosphates within the anaerobic environment in intestines of ruminants and other animals is likely. In dung of sheep's dung of organic farming analyzed by the EURL-SRM phosphonic acid was found at 0.25 mg/kg. To which extend phosphonates formed here will lead to relevant residue levels in organic products needs to be investigated.
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, mainly relevant for potatoes and onions.

[1] https://orgprints.org/id/eprint/54058/1/schleiffer-speiser-2024-Pilotstudie_HEPA-p1-20.pdf

Compound	Notes on legal aspects	General notes
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 *Sophora* 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 *Sophora* root extracts in fertilizers in Italy. Together with oxymatrine, often found in so-called "acacia honey" from China, which mostly originated from flowers of *Sophora* plants. *Sophora* extracts are also used in traditional Asian medicine and cosmetics. Co-harvesting of licorice and *Sophora* roots results in a considerable contamination of licorice and licorice products with matrine (and oxymatrine).
Oxymatrine	MRL of 0.01 mg/kg applies (listed in EU-pesticide database)	Quinolizidine alkaloid present in *Sophora* 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) and from urea fertilizers, where it is formed through trimerisation of urea 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 hydrolyses 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, and kitchenware as well as in moulding and packaging materials. Also used as a fire-retardant.
Mepiquat	MRLs refer to mepiquat chloride	Approved growth regulator. Similar to chlormequat, mepiquat has been reported to be formed as a natural processing contaminant through maillard-like reactions, e.g. during roasting of coffee and barley grain with the latter being use for the production of brewery malt, which is a main ingredient of beer.
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 used together with oleic acid to assist emulsification of wax and facilitate wax handling. In the EU, the use of morpholine in fruit coating is not permitted, but it is widely used in other parts of the world.
Nereistoxin	Non-regulated metabolite	Transformation product of various members of the nereistoxin pesticides (e.g. bensultap, sultap, cartap, thiocyclam). There are rumors that it is also illegally used as such in agriculture.
Nicotine	Specific MRLs set for rose hips, herbs, edible flowers, wild fungi, teas, herbal infusions and spices.	Non-approved insecticide. Nicotine originating from tobacco may contaminate food at all stages of food production, through air, soil and human contact. Crops experiencing intensive human contact during harvest or processing are particularly affected. MRLs for certain spices (e.g. cinnamon and vanilla) were raised in 2024. For such crops MRLs will be revised when information on origin of background levels becomes available.
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	Current approval end on 15/06/2025	Approved fungicide, mainly relevant for vegetables, e.g. root-, bulb-, fruiting-, and leafy vegetables
Propamocarb N-desmethyl	Non regulated metabolite	Metabolite of propamocarb
Propamocarb-N-oxide	Non regulated metabolite	Metabolite of propamocarb
PTU (propylene thiourea = 4-Methyl-2-imidazolidinethione)	**Formerly** regulated in infant- and baby food Reg. EC 125/2006 and 141/2006 . Nowadays not regulated	Degradant of propylen-bis-DTCs (i.e. propineb). Also impurity in propineb-based PPPs. Also formed from propineb during food processing (heating). 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.	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 the animals are fed with brassica crops. Also naturally formed in animals (e.g. in saliva). Collection of data on background levels would help introducing reasonable MRLs that consider background levels.
Thiram metabolite M1	Non regulated metabolite	Marker of dimethyldithiocarbamates. Specificity questionable at low levels.
Trifluoroacetic acid	Non regulated metabolite of many pesticides	A metabolite of a multitude of pesticides, veterinary and human drugs. Also metabolite of many widely used fluorochemicals, such as Fluoropolymers, e.g. Teflon®, flame retardants, impregnation agents for fabrics, fluorinated refrigerants and blowing agents, such as 1,1,1-trifluoroethane and 2,3,3,3-tetrafluoropropene and 1,3,3,3-tetrafluoropropene. Very persistent in the environment and an ubiquitous contaminant with some regional hotspots including in surface waters and in groundwater. Included in the working document for MANCPs. Classified as a PFAS.
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. Also known as trimethylsulfonium cation.

Residue Findings:

In 2024, a total of 2763 samples, mainly fruit and vegetables, but also cereals, pulses, processed goods, tea and others, were analyzed for QuPPe-amenable compounds at the CVUA Stuttgart. 2258 samples (82 %) 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 2024) by detection frequency

Frequency of findings > respective RL	Compounds (pesticides and legally relevant metabolites shown in bold)
> 10 % of samples.	***Phosphonic acid***, *Cyanuric acid, Perchlorate, TFA and* ***Chlorate***
> 1 - 10 % of samples.	*Melamine,* ***Thiocyanate***[1], ***Propamocarb***, ***Bromide***[2], *Propamocarb-N-oxide,* ***Diquat***[3], *Propamocarb-N-desmethyl, Ethephon met. HEPA,* ***Trimesium, Paraquat***[3], ***Chlormequat-chloride, Ethephon, Mepiquat-chloride, Nicotine***,
0.1 -1% of samples	***Chloridazon-desphenyl, Glufosinate met. MPPA, Maleic hydrazide, Fosetyl, Glyphosate,*** *4-Methylimidazoline, EU, Thiram met. M1, DFA, Dimethoate-O-desmethyl, Morpholine,* ***Glufosinate***
<0.1 - LOQ	*Glyphosate met. AMPA, ETU, PTU,* ***Cyromazine****, Matrine, Nereistoxin,*
Not detected above LOQ	***Aminocyclopyrachlor, Amitrole, Daminozide, Difenzoquat****, Diquat-dipyridone, Diquat met. TOPPS, Diquat-*mono-pyridone*, Glyphosate met. N-Acetylglyphosate, Mepiquat-4-hydroxy,* ***N-Acetyl-glufosinate*** *and Oxymatrine*
[1] ***No MRLs were deemed necessary for potassium thiocyanate.*** [2] ***Bromide is ubiquitous and virtually every sample is positive. The RL of 5 mg/kg represents the lowest MRL is food of plant origin.*** [3] ***Paraquat and Diquat analysis was semi-targeted. Main focus were dry commodities such as pulses, oily seeds and cereals as well as potatoes***	

Table 3: Residue findings of QuPPe-compounds (CVUA Stuttgart 2024) by compound

Compound	# samples	# pos. [1]	% pos.	Max (mg/kg)	Mean[2] (mg/kg)	Median[2] (mg/kg)	# >MRL[3]	% >MRL	RL[4]
Fosetyl sum (Phosphonic acid)	2763	1276	46	144	0.064	0.096	0		0.02
Cyanuric acid	2763	895	32	4.1	2.1	0.014	Not part of RD		0.005
Perchlorate	2763	587	21	5.9	0.055	0.014	5[5]		0.005
TFA	2763	519	19	1.9	0.12	0.055	Not part of RD		0.02
Chlorate	2763	389	14	3.2	0.065	0.018	4		0.005
Melamine	2763	244	8.8	1	0.086	0.038	0[4]		0.01
Thiocyanate	2763	224	8.1	74.1	11.1	4.3	0		0.1
Propamocarb	2763	123	4.5	4.6	0.14	0.020	0		0.005
Bromide	2763	112	4.1	96.6	19.6	14.0	0		5[7]
Propamocarb-N-oxide	2763	93	3.4	0.33	0.047	0.019	0		0.005
Diquat	177	5	2.8	0.033	0.023	0.027	0		0.01
Propamocarb-N-desmethyl	2763	72	2.6	0.087	0.015	0.009	Not part of RD		0.005
Ethephon metabolite HEPA	2763	69	2.5	7.9	0.30	0.067	Not part of RD		0.01
Trimesium	2763	66	2.4	0.67	0.065	0.026	8[6]		0.005
Paraquat	177	4	2.3	0.029	0.019	0.019	0		0.01
Chlormequat-chloride	2763	36	1.3	0.26	0.049	0.025	2		0.005
Ethephon	2763	36	1.3	0.73	0.13	0.063	1		0.01
Mepiquat chloride	2763	32	1.2	0.29	0.0314	0.013	1		0.005
Nicotine	2763	28	1	0.3	0.068	0.022	7		0.01
Chloridazon-desphenyl	2763	24	0.9	0.19	0.018	0.008	0		0.005
Glufosinate met. MPPA	2763	25	0.9	0.24	0.052	0.028	0		0.01
Maleic hydrazide	2763	25	0.9	25.2	7	5.2	0		0.01
Fosetyl	2763	22	0.8	1.8	0.25	0.062	0	0	0.01
Glyphosate	2763	14	0.5	3.4	0.38	0.11	0		0.02
4-Methylimidazoline[8]	2763	9	0.3	0.03	0.013	0.009	Not part of RD		0.004
EU[7]	2763	7	0.3	1.3	0.23	0.035	Not part of RD		0.02
Thiram M1[8]	2763	7	0.3	0.015	0.005	0.003	Not part of RD		0.002
DFA[9]	2763	5	0.2	0.26	0.10	0.076	0		0.05
Dimethoate-O-desmethyl	2763	6	0.2	0.049	0.021	0.013	Not part of RD		0.005
Morpholine	2763	5	0.2	1.9	0.85	0.55	additive		0.02

Compound	# samples	# pos. [1]	% pos.	Max (mg/kg)	Mean[2] (mg/kg)	Median[2] (mg/kg)	# >MRL[3]	% >MRL	RL[4]
Glufosinate	2763	4	0.1	0.68	0.41	0.47	0		0.01
Glyphosate met. AMPA	2763	2	0.07	0.031	0.026	0.026	Not part of RD		0.01
ETU[8]	2763	2	0.07	0.17	0.11	0.11	Not part of RD		0.02
PTU	2763	2	0.07	0.005	0.005	0.005	Not part of RD		0.005
Cyromazine	2763	1	0.04	0.012	0.012	-	1		0.005
Matrine	2763	1	0.04	0.077	0.077	-	0		0.01
Nereistoxin	2763	1	0.04	0.011	0.011	-	Not part of RD		0.005

[1] The number of positive samples refers to samples exceeding the RL.
[2] Mean and median of positives
[3] Numerical MRL-exceedances
[4] RL= Reporting Limit (exemplary for fruits and vegetables)
[5] Perchlorate and melamine are legally contaminants. In six cases the ML of perchlorate, as defined in Reg.(EC) No. 1881/2006, was exceeded
[6] MRL-exceedances of trimesium are in most cases most likely due to the formation of trimesium during processing
[7] Bromide is ubiquitous and virtually every sample is positive. The RL of 5 mg/kg represents the lowest MRL in food of plant origin. Analytically much lower levels can be quantified.
[8] Additional findings below LOQ were used for dithiocarbamate screening purposes.
[9] DFA was only found in 5 samples out of 51 positive with residues of flupyradifurone. DFA was found in eggplant (2x), chilli, okra, grapes

MRL exceedances

In 32 samples (thereof 10 organic) MRLs of different compounds were numerically exceeded. In 11 of these samples (thereof 5 organic) the MRLs were exceeded even after deducting 50% measurement uncertainty. Table 4 gives an overview of these exceedances. In 8 samples (thereof 2 organic) the MRL-exceedance concerned trimesium, which is known to be generated naturally during the drying process of plants.

Table 4: Samples with residues of QuPPe-compounds exceeding existing MRLs* (CVUA Stuttgart 2024)

Compound	Commodity	Country of Origin	Conc. (mg/kg)	>2x MRL**	Note
Chlorate *(herbicide. but chlorinated water used in irrigation or sanitation is mostly responsible for levels found in food)*	Lime	Brazil	0.07		
	Lime	Vietnam	0.056		
	Okra (Ladyfingers)	Spain	0.15		
	Zucchini	Spain	0.42	x	
Chlormequat chloride	Chick pea	Canada	0.015		
	Ginseng	China	0.11	x	
Cyromazine	Melon	Brazil	0.012		
Ethephon	Mango	Brazil	0.063		
Fosetyl, sum *(phosphonic acid was the only detected compound in most cases)*	Buckwheat	China	0.46		organic
	Lupin, sweet	Germany	0.16		organic
	Asparagus	Germany	2.95		
	Green beans	Morocco	11.7	x	
Mepiquat chloride	Lupin coffee	Unknown	0.29		organic
Nicotine *(insecticide, but tobacco-related contamination mostly responsible for levels found in food)*	Broad bean	Morocco	0.019		
	Ashwagandha	Unknown	0.16		organic
	Bell peppers	Unknown	0.018	x	
	Borecole	Germany	0.011		organic
	Cress/Garden cress	Germany	0.10	x	organic
	Leek	Germany	0.017		
	Rucola	Germany	0.013	x	organic
Perchlorate *(contaminant in fertilizers)*	Pitahaya	Turkey	0.063		
	Pomegranate	Peru	0.066		
	Prickly pear	Italy	0.051		
	Kale, frozen	Germany	0.22	x	
	Borecole	Germany	0.22	x	organic
Trimesium *(Counter ion of glyphosate but also natural formation during drying process of crops)*	Moringa powder	Unknown	0.29	x	organic
	Coriander, dried	Germany	0.67		
	Rosmary powder	Peru	0.37		
	Black tea	Sri Lanka	0.08		
	Black tea	Sri Lanka	0.12	x	
	Black tea	Unknown	0.092		
	Hibiscus tea	Egypt	0.12	x	organic
	Beetroot powder	Germany	0.37		

* >1xMLR
** >2xMRL means that the sample exceeded MRL even after deducting measurement uncertainty of 50%

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

Compound	Commodity	Country of origin	Residue level (mg/kg)
Phosphonic acid *(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)*	Hops pellets	Germany	144
	Hops pellets	Germany	112
	Walnut, ground	Unknown	91.4
	Hops pellets	Germany	71.7
	Strawberry	Germany	62.8
	Hops pellets	Germany	57.2
	Wine grapes	Germany	48.9
	Wine grapes	Germany	45.8
	Dill leaves	Kenya	45.4
	Hops pellets	Germany	41.4
	Pepper	Vietnam	38.7
	Blackberry	Germany	38.5
	Grapes	Turkey	36.4
	Pear	Italy	32.1
	Raspberry	Germany	31.6
Cyanuric acid *(non-regulated pesticide metabolite and contaminant in fertilizers)*	Food supplement, chlorella	Germany	4.1
	Food supplement, mixture	Germany	3.2
	Juices	Unknown	2
	Orange juice	Unknown	1.5
	Orange juice	Unknown	1.3
	Orange juice	Unknown	1.2
	Orange juice	Unknown	1
	Paprika	Unknown	1
	Pineapple	Costa Rica	0.95
	Pineapple	Costa Rica	0.93
	Parsley root (Hamburg parsley)	China	0.8
	Pineapple	Costa Rica	0.76
	Melon	Brazil	0.74
	Pineapple	Costa Rica	0.71
	Pineapple	Costa Rica	0.7
Perchlorate *(Regulated as contaminant)*	Pepper	China	5.9
	Food supplement, mixture	Germany	2.4
	Green tee	Unknown	0.57
	Herbal tea	Germany	0.49
	Moringa powder	Germany	0.49
	Oregano dried	Unknown	0.43
	Parsley	Spain	0.43
	Cumin	Unknown	0.42
	Cinammon	Turkey	0.4
	Coriander, dried	Germany	0.39
	Moringa powder	Tanzania	0.37
	Oregano dried	Unknown	0.32
	Cinammon	Unknown	0.32
	Dill leaves	Spain	0.32
	Cumin	Unknown	0.32
Trifluoroacetic acid	Oregano dried	Unknown	1.9
	Flax seed	Kazakhstan	1.9
	Oregano dried	Unknown	1.5
	Oregano dried	Unknown	1.5
	Mugwort dried	Germany	0.79
	Kiwi	Italy	0.76
	Moringa powder	Germany	0.74
	Oregano dried	Unknown	0.67
	Mugwort dried	Germany	0.65
	Parsley	Germany	0.62
	Hibiscus tea	Egypt	0.61
	Chamomile tea	Unknown	0.57
	Hops pellets	Germany	0.56
	Hops pellets	Germany	0.56
	Pepper	China	0.56

Compound	Commodity	Country of origin	Residue level (mg/kg)
Chlorate *(herbicide, but chlorinated water used in irrigation or sanitation mostly responsible for levels found in food)*	Food supplement, mixture	Germany	3.2
	Paprika powder	Unknown	2.4
	Paprika powder	Unknown	1.6
	Paprika powder	Unknown	1.5
	Paprika powder	Unknown	1.1
	Paprika powder	Turkey	0.97
	Paprika powder	Unknown	0.62
	Zucchini	Spain	
	Olives, also stuffed, preserved	Unknown	0.38
	Paprika powder	Unknown	0.37
	Dill leaves	Spain	0.36
	Paprika powder	Unknown	0.31
	Lambs lettuce	Italy	0.3
	Dill leaves	Spain	0.28
	Paprika powder	Unknown	0.22
Melamine *(Metabolite of cyromazine, but also contaminant originating from multiple sources; regulated as contaminant)*	Lambs lettuce	Germany	1
	Barley grass powder	Germany	0.87
	Parsley	Spain	0.73
	Chives	Germany	0.69
	Carrot	Germany	0.65
	Parsley	Spain	0.64
	Potato	Germany	0.56
	Moringa powder	Germany	0.55
	Potato	Germany	0.55
	Hops pellets	Germany	0.51
	Hops pellets	Germany	0.49
	Parsley	Germany	0.49
	Potato	Germany	0.38
	Bell peppers	Germany	0.36
	Orange	Spain	0.35
Thiocyanate *(mostly of natural origin, especially in brassica crops)*	Brussels sprout	The Netherlands	74.1
	White cabbage	Germany	66
	Brussels sprout	The Netherlands	62.9
	Broccoli	Spain	60.5
	Savoy cabbage	Germany	55.9
	Rape seed	Germany	51.6
	Brussels sprout	The Netherlands	51.1
	Horseradish	Germany	47.4
	Brussels sprout	The Netherlands	46.8
	Brussels sprout	The Netherlands	44.4
	Savoy cabbage	Germany	43.5
	Brussels sprout	The Netherlands	42.2
	Brussels sprout	The Netherlands	40.8
	Broccoli	Italy	39.8
	Brussels sprout	The Netherlands	39.8
Propamocarb	Dill leaves	Spain	4.6
	Cucumber	Morocco	1.3
	Cucumber	Spain	0.96
	Kale, frozen	Belgium	0.94
	Cucumber	Unknown	0.91
	Cucumber	Spain	0.65
	Cucumber	Spain	0.62
	Cucumber	Morocco	0.46
	Cucumber	Spain	0.46
	Cucumber	Greece	0.42
	Cucumber	Spain	0.41
	Cucumber	Spain	0.31
	Cucumber	Spain	0.3
	Cucumber	Unknown	0.27
	Tomato	Spain	0.23
Bromide	Cumin	Unknown	96.6
	Spinach powder	Germany	68.2
	Moringa powder	Tanzania	66.1

Compound	Commodity	Country of origin	Residue level (mg/kg)
	Lemon grass	Tanzania	60
	Carrot leaves	Germany	58.2
	Moringa powder	Germany	44.9
	Pepper	Unknown	44.7
	Cumin	Unknown	41
	Hibiscus tea	Egypt	39.1
	Dill leaves	Spain	36.3
	Pepper	Unknown	32.7
	Rosmary dried	Peru	32.5
	Carrot leaves	Germany	32.2
	Pepper	Unknown	31.9
	Chamomile tea	Unknown	31.8
Propamocarb-N-oxide	Cucumber	Morocco	0.33
	Cucumber	Morocco	0.33
	Kale, frozen	Belgium	0.28
	Cucumber	Spain	0.28
	Cucumber	Spain	0.26
	Cucumber	Spain	0.24
	Cucumber	Spain	0.22
	Cucumber	Greece	0.16
	Cucumber	Spain	0.14
	Cucumber	Unknown	0.14
	Cauliflower	Unknown	0.13
	Potato	Germany	0.11
	Cucumber	Spain	0.081
	Melon	Spain	0.063
	Potato	Germany	0.05
Propamocarb-N-desmethyl	Cucumber	Spain	0.087
	Kale, frozen	Belgium	0.069
	Dill leaves	Spain	0.067
	Cucumber	Spain	0.058
	Cucumber	Unknown	0.046
	Cucumber	Morocco	0.034
	Cucumber	Greece	0.033
	Cucumber	Morocco	0.032
	Tomato	Spain	0.031
	Melon	Honduras	0.026
	Potato	Germany	0.025
	Potato	Germany	0.025
	Cucumber	Spain	0.024
	Cucumber	Spain	0.023
	Cucumber	Spain	0.018
Ethephon met. HEPA	Food supplement, spirulina	Unknown	7.9
	Food supplement, spirulina	Poland	3.2
	White button mushroom	Poland	0.67
	White button mushroom	Germany	0.64
	White button mushroom	Germany	0.63
	White button mushroom	Germany	0.49
	White button mushroom	Poland	0.43
	White button mushroom	Germany	0.41
	White button mushroom	Poland	0.36
	White button mushroom	Poland	0.34
	White button mushroom	Germany	0.33
	Apple	Germany	0.32
	White button mushroom	Poland	0.32
	White button mushroom	Unknown	0.31
	White button mushroom	Poland	0.30
Trimesium *(Counter ion of glyphosate but also natural formation during drying process of crops)*	Coriander, dried	Germany	0.67
	Rosmary dried	Peru	0.37
	Beetroot powder	Germany	0.37
	Rosehip, dried	Unknown	0.32
	Moringa powder	Unknown	0.29
	Rosehip, dried	Unknown	0.2

Compound	Commodity	Country of origin	Residue level (mg/kg)
	Spinach powder	Germany	0.15
	Herbal tea	Germany	0.14
	Black tea	Sri Lanka	0.12
	Hibiscus tea	Egypt	0.12
	Black tea	Unknown	0.092
	Food supplement, mixture	Germany	0.086
	Maca root	Unknown	0.081
	Rosehip, dried	Chile	0.081
	Black tea	Sri Lanka	0.080

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)
Chlormequat chloride	Food supplement, mixture	Germany	0.26
	Wheat flour	Germany	0.22
	Vegan creme	Unknown	0.14
	Ginseng	China	0.11
	Wheat	Germany	0.086
	Wheat flour	Unknown	0.086
	Paprika powder	Unknown	0.072
	Paprika powder	Unknown	0.067
	Wheat	Germany	0.064
	King oyster mushroom	Germany	0.063
Ethephon	Pineapple	Costa Rica	0.73
	Figs	Turkey	0.57
	Grapes	Spain	0.44
	Grapes	South Africa	0.31
	Grapes	Chile	0.26
	Pineapple	Costa Rica	0.26
	Paprika	Unknown	0.22
	Grapes	Lebanon	0.21
	Grapes	Peru	0.21
	Pineapple	Costa Rica	0.16
Mepiquat chloride	Lupin coffee	Unknown	0.29
	Paprika powder	Unknown	0.090
	Paprika powder	Unknown	0.090
	White button mushroom	Poland	0.058
	Chamomile tea	Unknown	0.049
	White button mushroom	Poland	0.044
	White button mushroom	Poland	0.042
	Paprika powder	Unknown	0.038
	Barley	France	0.029
	White button mushroom	Germany	0.025
Nicotine	Carrot leaves	Germany	0.30
	Oregano dried	Unknown	0.28
	Food supplement, mixture	Germany	0.23
	Ashwagandha powder	Unknown	0.16
	Ashwagandha powder	Unknown	0.15
	Cinammon	Turkey	0.15
	Cress/Garden cress	Germany	0.11
	Nettle	Unknown	0.088
	Green tee	Unknown	0.054
	Moringa powder	Germany	0.05
Chloridazon-desphenyl	Coriander, dried	Germany	0.19
	Borecole	Germany	0.034
	Parsley	Unknown	0.032
	Dill leaves	Italy	0.018

Compound	Commodity	Country of origin	Residue level (mg/kg)
	Parsley	Germany	0.017
	Oakleaf lettuce	Germany	0.01
	Dill, frozen	Germany	0.009
	Parsley, frozen	Germany	0.009
	Dill leaves	Germany	0.009
	Spinach, frozen	Unknown	0.008
Glufosinate MPPA	Grapes	Namibia	0.24
	Nectarine	South Africa	0.14
	Grapefruit	South Africa	0.1
	Paprika powder	Unknown	0.099
	Paprika powder	Unknown	0.096
	Pepper	China	0.079
	Avocado	Peru	0.071
	Paprika powder	Unknown	0.061
	Passion fruit	South Africa	0.048
	Grapes	Namibia	0.041
Maleic hydrazide	Potato	Germany	25.2
	Potato	Germany	21.7
	Potato	Germany	18.6
	Potato	Germany	15.5
	Potato	France	11.5
	Potato	Germany	10.5
	Onion	Germany	9.7
	Potato	Israel	8.4
	Potato	Germany	7.7
	Onion	Unknown	7.5
Fosetyl (levels of additionally determined **phosphonic acid** in the specific sample)	Hops pellets	Germany	1.8 (144)
	Cucumber	Germany	0.7 (19.9)
	Cumin	Unknown	0.61 (1.8)
	Melon	Honduras	0.58 (13.4)
	Hops pellets	Germany	0.45 (71.7)
	Grapes	Spain	0.31 (5.7)
	Melon	Honduras	0.26 (6.6)
	Rucola	Italy	0.21 (31.1)
	Grapes	Turkey	0.14 (36.4)
	Wine grapes	Germany	0.09 (22.0)
Glyphosate	Green lentil	Czech Republic	3.4
	Pea	Unknown	0.58
	Paprika powder	Unknown	0.4
	Flax seed	Germany	0.23
	Chick pea	France	0.15
	Black tea	Sri Lanka	0.15
	Parsley root (Hamburg parsley)	China	0.14
	Lime	Unknown	0.078
	Pear	Italy	0.073
	Onion	France	0.047
4-Methylimidazoline DTC-Marker	Avocado	Colombia	0.03
	Pomelo	China	0.024
	Melon	Costa Rica	0.016
	Avocado	Colombia	0.012
	Melon	Costa Rica	0.009
	Grapes	India	0.009
	Pomegranate	Peru	0.008
	Melon	Unknown	0.005
	Chili peppers	Unknown	0.005
EU (2-Imidazolidinone), EBDTC	Radish leaves	Italy	1.3
	Radish, small	Italy	0.1

Compound	Commodity	Country of origin	Residue level (mg/kg)
	Parsley	Germany	0.083
	Parsley	Germany	0.035
	Pear	South Africa	0.033
	Sour Cherry, frozen	Unknown	0.025
	Grapes	Turkey	0.021
Thiram M1	Plum	Turkey	0.015
	Pear	Italy	0.007
	Pear	Turkey	0.004
	Spring onion	Italy	0.003
	Apricot	Turkey	0.003
	Pear	Germany	0.003
	Apricot	Italy	0.003
DFA	Okra (Ladyfingers)	Spain	0.26
	Chili peppers	Turkey	0.077
	Grapes	Turkey	0.0761
	Aubergine	Unknown	0.0628
	Aubergine	Spain	0.043
Dimethoate-O-desmethyl	Onion	Germany	0.049
	Melon	Mauretania	0.039
	Raisin and Sultana	Afghanistan	0.015
	Grapes	India	0.011
	Onion	Germany	0.006
	Garlic	Spain	0.006
Morpholine	Vegan oats creme	Unknown	1.9
	Kale, frozen	Belgium	1.5
	Spinach, frozen	Unknown	0.55
	Orange	Greece	0.25
	Almond, ground	USA	0.098
Diquat[1)]	Sesame	Unknown	0.033
	Sesame	Paraguay	0.031
	Chick pea	Lebanon	0.027
	Flax seed	Germany	0.013
	Cumin	Turkey	0.011

[1)] Further results on diquat, paraquat and metabolites thereof were compiled during a pilot monitoring project of EURL-SRM in 2024, entailing samples collected from different countries. Those results are included in a separate EURL-SRM pilot monitoring report.

Findings in organic samples

A look at the residues encountered in organic products gives an insight on compounds that potentially end up in food products from natural sources and on the matrices affected by such background contamination.

In 2024, the vast majority of the findings in organic products concerned compounds known to contaminate food products either naturally, or from applications other than the use of pesticides. Thiocyanate is naturally occurring in various crops of the brassica and allium family. Bromide is ubiquitous and is always contained in living organisms. Chlorate is often a result of using chlorinated water for irrigation or for sanitation purposes in packing and processing facilities (e.g. for washing surfaces or the products themselves). The contaminant perchlorate is often contained in fertilizers, including guano, which is used in organic agriculture. Nicotine contamination may occur through a multitude of pathways, e.g. when crops are grown on contaminated soil, when products are exposed to nicotine-containing smoke or air, or when products are touched by smokers (e.g. during harvest or processing). Melamine and cyanuric acid may also originate from fertilizers. Trimesium is naturally formed when certain products are dried, and can be thus considered a processing contaminant. Phosphonic acid may originate from past applications as it is quite persistent both in perennial plants and the soil. Contamination of organic products with HEPA and phosphonic acid naturally formed in manure used to fertilize fields (or in dung used as a substrate in mushroom cultivation) is also possible. In the case of phosphonic acid some findings raise the suspicion of a recent misuse and require further investigation. After all phosphonic acid is a very popular fungicide. Chloridazon-desphenyl is a metabolite of chloridazon, which is quite persistent in the environment, thus residues in succeeding crops, and in water, are encountered. Trifluorocaetic acid is a universal contaminant with multiple sources, beyond the use of fluorinated pesticides, such as Teflon, fabric impregnation products and blowing agents in sprays for personal use.

Table 7: Overview of findings in 356 organic samples (no. of findings ≥5); (CVUA in 2024)

Compound Name	No. of samples	RL (mg/kg)	No. of findings >RL	Percentage of positives	Mean (mg/kg)	Max (mg/kg)	Remarks
Bromide	483	5	25	5.2	20.0	68.2	Ubiquitous element
Chlorate	483	0.005	53	11	0.026	0.18	May end up in organic products through irrigation or through sanitation procedures in the processing facilities
Chloridazon-desphenyl	483	0.01	7	1.4	0.008	0.009	Metabolite of chloridazon quite persistent in the environment, thus residues in succeeding crops, and in water, are encountered. Findings concerned the following commodities: Spinach frozen (2x), chives (2x), green beans, dill frozen, melon
Cyanuric acid	483	0.005	152	31.5	0.064	4.1	May originate from fertilizers (incl. urea fertilizers)
Ethephon Met. HEPA	483		10	2.1	1.21	7.91	Findings concerned the following commodities: Mushrooms (3x), wheat (3x), spirulina (2x), rice, thyme
Melamine	483	0.005	32	6.6	0.11	0.87	May originate from fertilizers (incl. urea fertilizers)
Nicotine	483		10	2.1	0.059	0.16	Contamination with nicotine can occur at various stages of food production and affect conventional and organic products alike. Findings concerned the following commodities: Ashwagandha powder (2x), Psyllium (2x), Moringa powder, Cress/Garden cress, Green tee, Rosemary, Rucola, Borecole
Perchlorate	483	0.005	114	23.6	0.050	0.57	May originate from fertilizers inclusion guano
Phosphonic acid	483	0.02	125	25.9	0.40	38.7	Phosphonic acid used to be employed by organic farmers in the past as it was marketed as a "leaf fertilizer" suitable for organic farming. As the compound is quite persistent, residues are still found. Contamination through manure is also conceivable source especially in vegetables.
Thiocyanate	483	0.1	37	7.7	14.2	74.1	Naturally occurring in various *allium* and *brassica* products, such as onions and kale
Trifluoro-acetic acid	483	0.02	73	15.1	0.165	1.9	May originate from various sources, distributed via air and water often found on leafy vegetables, herbs and exotic fruit
Trimesium	483	0.005	23	4.8	0.077	0.32	Was shown to be formed naturally during the drying process of various products