Federal Office of
Consumer Protection
and Food Safety

“Pesticide residues in food”

National reporting 2022 Federal Republic of Germany –
condensed version

Summary

The report presents the results of the analysis of food for pesticide residues. In accordance with Regulation (EC) No 396/2005, the compliance with current legislation was checked and analyses to assess consumer exposure were carried out.

In 20 official laboratories of 16 federal states, 21,601 food samples were analysed for the presence of pesticide residues. 6,179 of these samples were taken at random in the framework of the monitoring programme, in order to be able to make representative statements about consumer exposure. However, with regard to the selection of the other 15,422 samples, foodstuffs known for presenting higher risks were preferred. For this reason, the results do not allow to draw conclusions on the contamination level of the entirety of all foodstuffs available on the market.

For reporting to the European Food Safety Authority (EFSA) and the European Commission, the samples are divided in "surveillance" and "follow-up enforcement" samples. The routine and monitoring samples are denominated as "surveillance" samples, while suspect samples, complaint samples and persecution samples are summarised as "follow-up enforcement" samples. In the reporting year, a total of 20,676 samples fell under the category "surveillance" and 925 samples under the category "follow-up enforcement".

In 2022, 1,945 samples were analysed in the framework of the coordinated multiannual Community control programme. These samples were part of the 21,601 samples analysed in total.

Link to the „Nationale Berichterstattung Pflanzenschutzmittelrückstände in Lebensmitteln 2022“: Link to the complete report "Pflanzenschutzmittelrückstände in Lebensmitteln 2022"

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1 Information about maximum residue levels

"Maximum Residue Level" (MRL) means the upper legal level of a concentration for a pesticide residue in or on food. For setting MRLs, data on the toxicology of the substance and on the intake quantity of the respective foodstuff as well as data from field studies carried out in accordance with good agricultural practice are taken into consideration.

The report distinguishes between the exceedance of a MRL and the objection (non-compliance) of samples. Not all samples with MRL exceedances are objected (non-compliant) by the respective responsible authority, as for an objection (non-compliance) further arguments like the analytical measurement uncertainty have to be taken into account. When it is established that a consumer risk through pesticide residues in a foodstuff cannot be excluded, the European Rapid Alert System for Food and Feed (RASFF) is notified, so that all responsible authorities in the EU are informed accordingly.

In 2022, Germany issued 133 notifications due to pesticide residues; 30 of these were alerts.

2 Food-related view on the results

(only "surveillance" samples without substances which are proven (mainly) not to stem from pesticide use (see Chapter 6))

In total 362 different foodstuffs were analysed. As every year, the majority were fruit and vegetables.

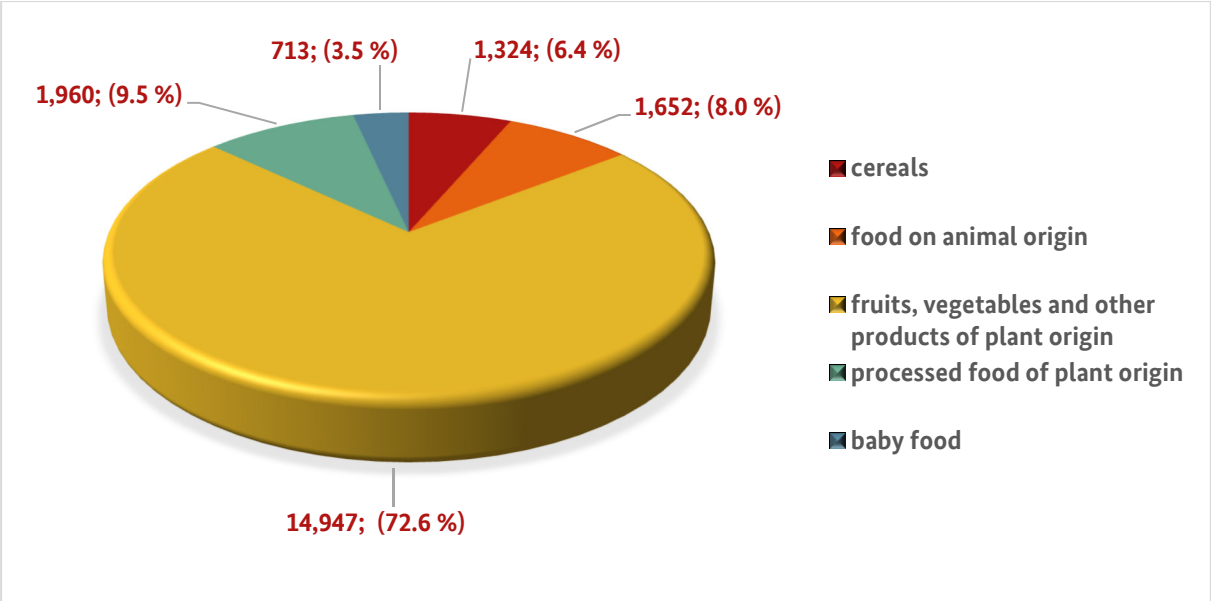

Figure 1: Distribution of sample numbers between the various food groups in 2022

Potatoes (664 samples), apples (636 samples), strawberries (619 samples) and also processed cereal-based food and baby food (542 samples) were analysed the most frequently.

Table 1: Residues in the various food groups in 2022

Food group	Number of samples total	Samples with residues < limit of quantification	Samples with quantified residues	Samples with residues > MRL[1]	Samples with residues > MRL objected
Cereals	1,324	526 (39.7 %)	798 (60.3 %)	130 (9.8 %)	82 (6.2 %)
Food of animal origin	1,652	1,196 (72.4 %)	456 (27.6 %)	49 (3.0 %)	18 (1.1 %)
Fruit, vegetables and other products of plant origin	14,947	5,146 (34.4 %)	9,801 (65.6 %)	474 (3.2 %)	252 (1.7 %)
processed food of plant origin	1,960	783 (39.9 %)	1,177 (60.1 %)	52 (2.7 %)	37 (1.9 %)
Food for infants and young children	713	423 (59.3 %)	290 (40.7 %)	53 (7.4 %)	2 (0.3 %)
Total	**20,596**	**8,074 (39.2 %)**	**12,522 (60.8 %)**	**758 (3.7 %)**	**391 (1.9 %)**

Compared to the previous year, the exceedance and objection rates for '**cereals**' rose significantly. 9.8% of the samples had residues above the maximum residue level, 6.2% were objected. Most of the objections occurred in chia seeds, which were increasingly tested for copper in 2022. Even if the use of chia seeds is more analogous to oilseeds, according to Regulation (EC) No. 396/2005, the maximum copper content for pseudo-cereals (10 mg/kg) applies. Due to their physiology fatty or oleiferous plants, such as chia, can absorb copper contained in the soil and accumulate it to a high degree. It is therefore assumed that the presumably natural copper content in chia seeds already leads to the exceedance of the maximum residue level (MRL). The copper levels detected are considered harmless for human nutrition within the limits of normal consumption levels.

For '**foods of animal origin (terrestrial animals)**', 3.0% of the samples showed residues above the maximum residue level. The most exceedances were verified in sheep liver, which was also increasingly examined in 2022, and in particular the MRL for copper was often exceeded. In the case of copper findings, it should be noted that in addition to pesticide residues and contamination of air, water and soil, copper can also be introduced through the ingestion of copper-containing feed, as copper is regularly approved as a nutritional additive for use in feed. The physiologically caused accumulation of copper in the liver also contributes to the comparatively high copper contents and the increased proportion of maximum residue levels being exceeded.
However, the origin of the copper cannot be determined from the total copper content determined in the food.

[1] MRL = maximum residue level

In the category '**food for infants and young children**', 7.4 % of the samples contained residues above the MRL, mainly copper residues in processed cereal-based food and baby food. It must be taken into account that special law specifies a maximum amount of the essential trace element copper in food for infants and young children that is higher than the maximum residue levels. Here too, the origin of the copper cannot be derived from the total copper content determined.
0.3 % (two samples baby foods for infants and young children based on fruit) were objected due to the residue definition for the fungicide fosetyl (sum).
Residue definition of fosetyl includes the fungicidal active compounds fosetyl and phosphonic acid and also its salts. It should be noted that phosphonic acid not only results from the use of the fungicide fosetyl, but can also originate from other sources such as authorised fertiliser. In general, predominantly phosphonic acid was detected in all food groups.

As in the previous year, in the group of '**processed food of plant origin**', particularly processed vine leaves were conspicuous. The maximum residue levels were exceeded in 70.6 % of the vine leaves, arranged and prepared in brine, these exceedances led all to objections.
In addition, frequent exceedances were detected for fruit spices made from paprika or chilli powder and also for dried wild mushrooms.

For '**fruit, vegetables and other products of plant origin**', the range of pesticide contaminations was particularly large. Spanning from foodstuffs in which no residues were quantified to products with objection rates of 50.0 % (guaves). However, foodstuffs with objection rates of 3.0 % and more were beans with pods, pomegranates, tea (black and green), fresh herbs, ginger roots, aubergines/eggplant and dried lens.

Since pomegranates, peppers/chillies and fruit spices made from them as well as vine leaves and guaves already are often conspicuous due to excessive levels of pesticide residues, guaves from India, peppers/chillies from various countries of origin or pomegranates and vine leaves from Turkey have already been included in the "Implementing Regulation (EU) 2019/1793 on the temporary increase of official controls and on emergency measures governing the entry into the Union of certain goods from certain third countries". Goods originating in third countries listed in one of the annexes are subject to (temporarily) increased official controls.

Fortunately, as in former years, many foodstuffs with particularly high intake like apples, carrots, potatoes or tomatoes only had few MRL exceedances and objections (0-0.9 %).

Table 2 summarises the 'fruit, vegetables and other products of plant origin' products without objections. Only foods with at least 100 analyzed samples are considered.

Table 2: Fruit and vegetables without objections in 2022 (≥ 100 samples)

Food	Number of analysed samples	Objections [%]
Mandarins	204	0.0
Oranges	191	0.0
Lemons	183	0.0
Plums	459	0.0
Blueberries	248	0.0
Kiwifruits	164	0.0
Carrots	315	0.0
Onions	118	0.0
Cucumbers	283	0.0
Broccoli	114	0.0
Brussels sprout	131	0.0
Kohlrabi	119	0.0
Asparagus	459	0.0

The ten foodstuffs with the highest objection rates are presented in Table 3 (at least 100 samples).

Table 3: Fruit and vegetables with the highest number of objections in 2022 (≥ 100 samples)

Food	Number of analysed samples	Objections [%]
Beans (with pods)	160	10.0
Pomegranates	150	9.3
Tea (black and green)	199	8.0
Fresh herbs	394	3.8
Ginger roots	192	3.1
Aubergines/eggplant	128	3.1
Dried lens	101	3.0
Cherries	170	2.4
Sweet peppers/chillis	362	2.2
Avocadoes	103	1.9

Also in 2022, organic products (3,498 samples) were controlled for residues. The contamination of these samples was much lower than that of conventionally produced samples. Only 34.9 % of the products stemming from organic farming contained analytical quantified residues, compared to 64.2 % of other products. In 4.3% of the 'organic samples' the residues proved were above the specified maximum residue levels. 2.0% of these samples were objected.

3 View with regard to origin

("surveillance" samples and "follow-up enforcement" samples without chlorate and QAC)

21,506 samples (surveillance sampling"- and „follow-up enforcement sampling) were controlled, 41.4 % thereof from Germany, 22.1 % from other EU-Member States[2] and 21.7 % from Third Countries. 14.8 % of the samples were of unknown origin.

Nearly two thirds of the samples were purchased from retail food traders and about less than one fifths from wholesalers. The rest was bought from growers, manufacturers and packers as well as from service providers, e. g. restaurants or delivery services.

Big differences can be observed in the contamination level of foods with pesticide residues depending on their origin. In 2022 maximum residue levels were exceeded in 1.3 % of the analysed products (only "surveillance sampling") from Germany (2021: 1.1 %) and in 1.5 % of the analysed products from other EU-Member States (2021: 1.8 %). With regard to products from Third Countries, this was the case in 9.8 % of the samples (2021: 10.9 %). Nevertheless, the percentage of samples without any quantifiable pesticide residues is still the highest in German foodstuffs.

4 Substance-related view on the results

("surveillance sampling" and "follow-up enforcement sampling")

The range of pesticide substances tested for in 2022 comprised 1,055 different substances (including the legal residue definitions of sums, their isomers, metabolites and/or breakdown or reaction products). For active ingredients with complex residue definitions, in addition to the results of the sum-regulated residue definitions, the results of their single components (active ingredients, metabolites, isomers and/or breakdown or reaction products) are also presented.

No sample was analysed for all substances. On average, each food sample was analysed for 362 different substances.

At 620 (58.8 %) of the assessed 1,055 substances quantifiable levels were not detected in any sample. On the other hand, for 192 substances (18.2 %) residues above the valid maximum residue levels were detected.

The most noticeable substances among the 833 samples with stated MRL exceedances were copper, paraquat, dithiocarbamates, ethylene oxide and chlorpyrifos (objection rates of 0.23-2.23 %).

There are different causes for the detection of **copper** in food (compare chapter 2). The origin of copper (residue from pesticides, contamination from the environment or added additive) is no longer apparent from the total copper content determined. However, for the legal assessment of active ingredient residues in food, Regulation (EC) No. 396/2005 must be applied, regardless of the origin or entry path.

[2] Including other states of the European Economic Area (EEA)

Because of its high toxicity, the herbicidal active ingredient **paraquat** has no longer been approved in plant protection products in the EU since 2007, but is still used in many third countries, including industrialized countries.

The use of **ethylene oxide** as a pesticide has been banned in Germany since 1981 and in the EU since 1991. In 2020 and 2021, high levels of ethylene oxide residues in sesame seeds originating from India were the subject of various warnings in the RASFF rapid alert system. It is presumed that sesame seeds are treated inadmissibly with the gas ethylene oxide for the protection against salmonella and other microbiological contamination. Due to further ethylene oxide findings, in addition to sesame seeds, other foods of plant origin such as okra or spices, but also instant soups and additives and thickeners have been included since October 2020 in Annexes I and II of the Implementing Regulation (EU) 2019/1793 on the temporary increase of official controls and on emergency measures governing the entry into the Union of certain goods from certain third countries.

The determination of **dithiocarbamates** (Maneb, Mancozeb, Metiram, Propineb, Thiram, Ziram) occurs nonspecific as carbon disulfide (CS2). Therefore, it cannot be concluded analytically which dithiocarbamates were used. Besides also natural sources of CS2, as certain plants with natural sulfur or carbon disulfide compounds (for example Brassicaceae such as cabbage and rapeseed or allium species), can lead to false positive results. Meantime, work is being done on methods that should enable both a more sensitive and more selective analytical determination of the individual dithiocarbamates. In addition, a general review of the maximum residue levels for dithiocarbamates is currently exe-cuting, taking into account the natural background exposure to CS2.

Plant protection products with the active ingredient **chlorpyrifos** are no longer approved in Germany; the use-by period ended on April 2, 2015 and May 6, 2015. In the EU, the approval for chlorpyrifos as an active ingredient in plant protection products expired on January 31, 2020. Due to the ban, Regulation (EU) 2020/1085, which came into force on November 13, 2020, lowered the maximum residue levels for all products to the analytical limit of quantification of 0.01* mg/kg.

5 Findings of multiple residues

("surveillance sampling" and "follow-up enforcement sampling")

In 33.2 % of all samples, more than one substance was detected in quantifiable quantities. The percentage distribution of the number of quantified residues is presented in the following figure:

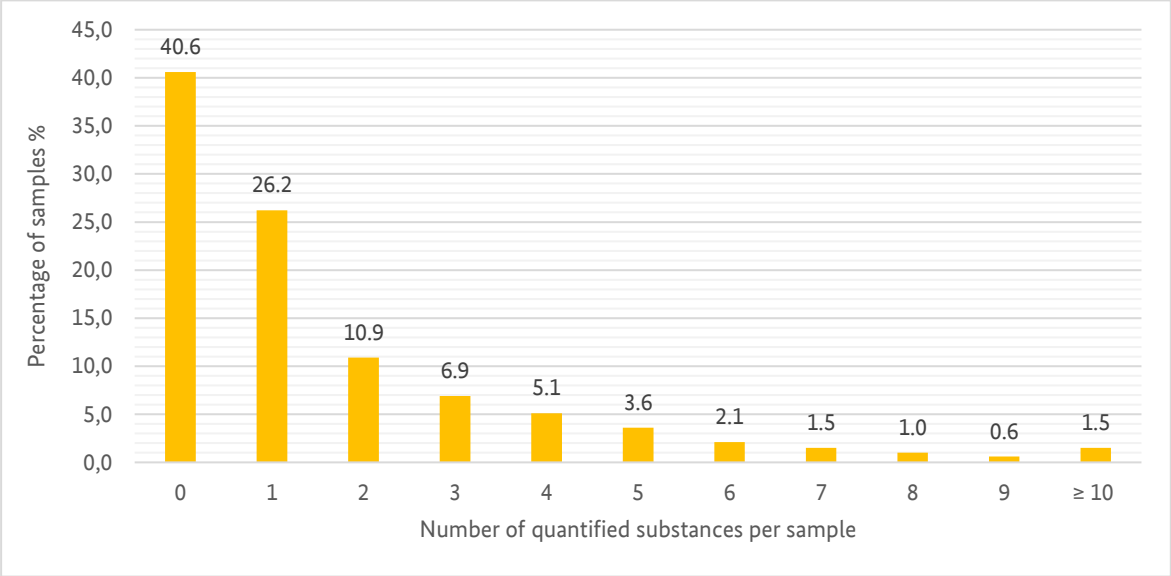

Figure 1: Percentage of samples without any residues or with residues of 0 to ≥ 10 substances.

Multiple residues above 75.0 % were verified particularly in cherries, mandarins, table grapes, oranges, grapefruits/pomelos/sweeties, peaches/nectarines and strawberries.

6 Substances which are proven to (mainly) not stem from pesticide use

Some substances are legally regulated as pesticides, but their residues mainly originate from other sources than pesticide treatments. In order not to distort the overall picture of pesticide contamination, the quaternary ammonium compounds didecyldimethylammonium chloride (DDAC) and benzalkonium chloride (BAC) as well as chlorate are treated separately in the report.

Residues of **chlorate** can enter the food during processing, e. g. through washing and disinfection steps.

With Regulation (EU) 2020/749, which entered into force on 28th June 2020, specific maximum residue levels (MRL) were established for chlorate. The maximum levels were set for each entire product groups.

In 2022, chlorate was quantified in 9.4 % of 5,318 samples tested for it. In 0.6 % of the samples, residues were exceeding the MRL. Chlorate was objected in 0.2 % of the samples.

4,209 samples of 'Fruit, vegetables and other products of plant origin' were examined, of which 17 samples (0.4 %) exceeded the maximum residue levels and six samples (0.1 %) were objected. 341 'cereal' samples were tested for chlorate, hereof maximum residue levels were exceeded in two samples (0.6 %), but none of the samples were objected. Five samples (2.0 %) of 'Food of animal

origin’ (a total of 246 samples) were above the MRL. This food group showed the highest objection rate (1.2 %). For ‘processed food of plant origin’ (a total of 245 samples), the objection rate was 0.4 %. In the case of ‘food for infants and young children’ (a total of 277 samples), five samples (1.8 %) were above the maximum residue limit, of which two samples (0.7 %) were objected.

In 78 (7.7 %) of a total of 1.009 samples of products from organic farming chlorate quantifiable residues were detected. In 0.4 % of these samples the maximum residue levels of chlorate were exceeded and 0.2 % of samples were objected.

In 2022, 9,155 samples were analysed for residues of the **quaternary ammonium compounds (QAC) DDAC and/or BAC**.
Regulation (EU) No. 1119/2014 of 16th October 2014 set provisional maximum residue levels for BAC and DDAC of 0.1 mg/kg for all products in Annex III of Regulation (EC) No. 396/2005. With Regulation (EU) 2023/377, which came into force on 14th September 2023, the corresponding provisional maximum residue levels in Annex III were adjusted.
‘Food of animal origin’ is particularly contaminated with BAC and DDAC. They are used among other things to disinfect milking plants and tanks. For this reason, they are often detected in dairy products. In 2022, too, the highest levels (at 2.6%) of DDAC and/or BAC exceeding the maximum level were detected in foods of animal origin.
Overall, the maximum levels for DDAC or BAC were exceeded in 0.3 % of the samples examined. This led to complaints in 0.5 % of the samples.

In products from organic farming, the residue situation with regard to DDAC and BAC is also better than in conventional products. Only in 0.4 % of 1.,612 samples of organic origin, quantifiable residues of DDAC or BAC were detected, one sample (0.1 %) contained residues above the MRL, no sample was objected.