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SCIENTIFIC REPORT

# The 2023 European Union report on pesticide residues in food

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The declarations of interest of all scientific experts active in EFSA's work are available at https://open.efsa.europa.eu/experts

## Abstract

Under European Union legislation (Article 32, Regulation (EC) No 396/2005), the European Food Safety Authority publishes an annual report assessing the pesticide residue levels in food. In 2023, as part of the EU-coordinated multiannual control programme subset, 13,246 samples placed on the European market were analysed, with a 1.0% found to be non-compliant. Risk-based sampling procedures were used for the remaining 132,793 samples with a 2.0% non-compliant rate. Both dietary acute and chronic risk to consumers' health were estimated providing the probabilities of exceedance of the health-based guidance values (HBGV) for the pesticides in food by the different subpopulation of European consumers. This meant dropping the deterministic assessment used in the past. Overall, the dietary risk was found to be very low for most of the EU subpopulation groups. Recommendations were provided to risk managers to increase the effectiveness of European control systems and to ensure a high level of consumer protection throughout the EU.

**KEYWORDS**

acute, chronic, dietary exposure, European Union, food safety, maximum residue levels, national monitoring programme, pesticide residues, probability, risk assessment

# CONTENTS

## SUMMARY

The 2023 EU report on pesticide residues in food provides an overview of the official control activities on pesticide residues carried out in the EU Member States,*[1] Iceland and Norway. It summarises the results of both the EU-coordinated control programme (EU MACP) and the national control programmes (MANCP).

The analysis of the results from all reporting countries is presented in a data visualisation format,[2] making it easy for stakeholders to understand and digest the European situation related to the findings. The conclusions and recommendations derived from the findings within this report give risk managers a tool for designing future monitoring programmes and make informed decisions on which pesticides and food products should be targeted.

Additionally, the report also includes acute and chronic probabilistic risk assessments of single substances to all the quantified pesticide residues in the three-year cycle 2021–2023. It provides the probabilities of exceedance of the health-based guidance values (HBGV) for the pesticides in food of the different subpopulations of European consumers.

EU-coordinated multiannual control programme (EU MACP)

The EU MACP uses a random sampling procedure, covering the most consumed food products by European citizens, representing the EU market. The control of these products is distributed across a 3-year cycle programme as indicated in the EU MACP Regulation (EU) 2022/741,[3] so that every 3 years the same products are analysed. A snapshot of the situation in 2023 of the pesticide residues present in those food products is provided and compared with 2020 and 2017.

In 2023, the 12 food products selected in the EU MACP were: carrots, cauliflowers, kiwi fruits (green, red and yellow), onions, oranges, pears, potatoes, dried beans, brown rice, rye, bovine liver and poultry fat. A total of 13,246 samples were analysed.[4] Overall, 13,000 samples (98.0%) were found to be within the legal limits. MRLs[5] were exceeded in 246 samples (2%), of which 135 samples (1.0%) were found to be non-compliant when considering measurement uncertainty (very similar compliant rate for the same commodities sampled in 2020, which stood at 0.9%). On average, 60.3% of the samples analysed were domestic, 20.8% were from other reporting countries, 14.6% from third countries and 4.3% were of unknown origin. Similar rates were observed in 2022, except for the domestic samples that decreased from 66.7% in 2022 to 60.3% in 2023 and for the import control from third countries that increased from 7.7% in 2022 to 14.6% in 2023.

National programmes (EU MACP + MANCP)

The 2023 programmes (both EU MACP and MANCP) amounted to a total of 132,793 samples. Of the total number of samples analysed, 127,816 samples (96.3%) fell within the legal limits. In total, MRLs were exceeded in 4977 samples (3.7%). When taking into account measurement uncertainty, 2694 samples (2.0%) triggered legal sanctions or enforcement actions. Overall results remain steady in comparison with the previous year.

Dietary estimated exposure assessment

Acute and chronic exposure to consumers was performed using probabilistic exposure modelling. The applied model aims at quantifying the probability of true consumers being exposed to residues at levels leading to an exceedance of the HBGV. This approach deviates from the deterministic assessment so far calculated where the consumer was an 'hypothetical' one applying very conservative assumptions and which is no longer used in the frame of this report. The probabilistic calculations provide a realistic estimation of what consumers are exposed to, as it reflects real consumption events.

The probabilistic acute risk assessment showed that for 292 active substances of the 353 assessed, the probability of an individual consumer per day exceeding the HBGV was estimated to be less than 1 individual-day out of 1,000,000 for the 40 commodities assessed. In the probabilistic chronic risk assessment, based on the surveys used and their size, the probability to exceed the acceptable daily intake (ADI) was estimated to be less than 1 subject out of 1,000,000 for 350 out of 353 active substances. The remaining three active substances exceeded the HBGV for a few EU population groups.

Overall, in the samples analysed in the framework of 2021–2023 monitoring programmes, the estimated dietary exposure to single pesticide residues for which HBGVs are available is very low for most of the EU subpopulation groups assessed. Thus, the risk to EU consumers' health associated with pesticide individual substances is low. Previous assessments on cumulative exposure to pesticides affecting the nervous system, the thyroid and the craniofacial alterations concluded

[1]*In accordance with the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community, and in particular Article 5(4) of the Windsor Framework (see Joint Declaration No 1/2023 of the Union and the United Kingdom in the Joint Committee established by the Agreement on the withdrawal of the United Kingdom of Great Britain and Northern Ireland from the European Union and the European Atomic Energy Community of 24 March 2023, OJ L 102, 17.4.2023, p. 87) in conjunction with section 24 of Annex 2 to that Framework, for the purposes of this Regulation, references to Member States include the United Kingdom in respect of Northern Ireland.

[2]A dedicated website where EU MACP and MANCP results are presented: https://multimedia.efsa.europa.eu/pesticides-report-2023/.

[3]Commission Implementing Regulation (EU) 2022/741 of 13 May 2022 concerning a coordinated multiannual control programme of the Union for 2023, 2024 and 2025 to ensure compliance with maximum residue levels of pesticides and to assess the consumer exposure to pesticide residues in and on food of plant and animal origin and repealing Implementing Regulation (EU) 2021/601. OJ L 137, 16/5/2022, p. 12–24. OJ L 127, 14.4.2021, p. 29–41.

[4]These samples exclude those of baby food requested under the EU MACP.

[5]The 'maximum residue level' (MRL) is defined as the upper legal level of concentration for a pesticide residue in or on food or feed set in accordance with Regulation (EC) No. 396/2005, based on good agricultural practice and the lowest consumer exposure necessary to protect vulnerable consumers.

that the threshold for regulatory consideration established by risk managers was not exceeded. In most of the cases where the estimated exposure for a specific pesticide/product combination was calculated to exceed the HBGV, the competent authorities took appropriate and proportionate corrective measures to address potential risks to consumers such as withdrawing the product from the market or recalling it before even being placed on it.

# 1 | BACKGROUND

## 1.1 | Legal Basis

The European Union (EU) has established a comprehensive legislative framework that defines rules for the approval of active substances under Regulation 1107/2009,[6] their use in plant protection products (PPP)[7] and their permissible residues[8] in food. These permissible residues in food are known as the 'maximum residue levels' (MRLs). The MRLs represent the upper legally tolerated concentration of a pesticide residue in or on food, when a PPP is applied in accordance with its Good Agricultural Practice (GAP). MRLs are authorised only after consumer health risks have been assessed.

The MRL can be numerically exceeded with no legal consequences. However, if MRLs are exceeded after having taken into account the measurement uncertainty of the analytical result (European Commission, 2021), is an infringement of the legal MRL value and is called a non-compliant sample. Non-compliant samples, triggers legal actions and lots may be recall from the market. Non-compliant samples do not necessarily mean a risk to consumers. The non-compliant result is checked against the HBGV. This value is a benchmark used to assess the safety of pesticide residues in food. It represents the maximum amount of a substance that can be consumed daily (for acute values) or over a lifetime (for chronic values) without posing a significant risk to health. The HBGVs consider current safety data, uncertainties in these data, and the likely duration of the consumption. These help regulatory authorities determine the permissible levels of pesticide residues in food, ensuring that even if these levels are exceeded, there is still a margin of safety before reaching a level that could pose a health risk.

The MRLs are established in Regulation (EC) No 396/2005.[9] EU-harmonised MRLs are set covering 378 food products/food groups. The description of what the MRL covers is known as 'residue definition for enforcement' or 'RD'. However, there may be other residue definitions such as the 'residue definition for risk assessment', which includes all relevant metabolites with toxicological relevance. These risk assessment residue definitions are not used in the remit of this report due to the lack of a consolidated database compiling them or the conversion factors used to convert residue concentration from an enforcement residue definition into a risk assessment one. Furthermore, a default MRL of 0.01 mg/kg is applicable to the pesticides which are not explicitly mentioned in the MRL legislation[10] or to those substances non-renewed, where the MRL can be set to the lowest quantifiable level which sometimes can be lower than 0.01 mg/kg. Regulation (EC) No 396/2005[9] imposes the obligation on Member States to carry out controls to ensure that food placed on the market is compliant with the legal limits. There are different control programmes for which samples collected under those are reported to EFSA and presented in this report:

- EU-coordinated control programme: this programme defines the food products and pesticides that should be monitored by all Member States*[1] as well as the number of samples per MSs that are to be taken in respect of their population size (EFSA, 2015a) to ensure compliance with maximum residue levels of pesticides and to assess the consumer exposure to pesticide residues. The EU-coordinated programme (EU MACP)[11] relevant for the calendar year 2023 was set up in Implementing Regulation (EU) 2022/741[3] hereafter referred to as '2023 EU MACP Regulation' or '2023 monitoring programme'.
- National control programmes: Member States*[1] define the scope of national control programmes, focussing on certain products, which are expected to contain residues in concentrations exceeding the legal limits, or on products that are more likely to pose risks for consumer safety (Regulation (EU) No 2021/1355,[12] hereafter referred to as 'MANCP').
- Temporary increase of official controls and emergency measures control programmes: in accordance with Regulation

[6]Regulation (EC) No 1107/2009 of the European Parliament and of the Council of 21 October 2009 concerning the placing of plant protection products on the market and repealing Council Directives 79/117/EEC and 91/414/EEC. OJ L 309, 24.11.2009, p. 1–50.

[7]The term plant protection products (PPP) used throughout this report and its annexes, pertains to a product containing an active substance and other substances added and/or their products to ensure, among others, plant protection against harmful organisms, influence their life processes (e.g. growth regulators), destroy or prevent growth of undesired plants or parts of them in the fields, etc.

[8]The term pesticide residue is used throughout this report and its annexes, to refer to measurable amounts of an active substance and/or related metabolites and/or degradation products that can be found on harvested crops or in foods of animal origin.

[9]Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC. OJ L 70, 16.3.2005, p. 1–16.

[10]https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en.

[11]https://food.ec.europa.eu/plants/pesticides/maximum-residue-levels/enforcement/eu-multi-annual-control-programmes_en.

[12]Commission Implementing Regulation (EU) 2021/1355 of 12 August 2021 on multiannual national control programmes for pesticides residues to be established by Member States. OJ L 291, 13.8.2021, p. 120–121.

(EU) No 2019/1793[13] and its annual revisions[14,15,16] applicable to 2023, certain food products listed in its annexes are subject to requiring a temporary increase of official controls or emergency measures. These official controls are done at border control posts (BCPs) or at control points (CPs) at their entry into the Union, for a given hazard (e.g. pesticide residues, not approved food additives, mycotoxins, pentachlorophenol, dioxins and microbiological contamination) and for non-animal origin food and feed coming from a given third country. The outcome of these controls is to be reported through the information management system for official controls (IMSOC).[17] This system does not use the same terminology as the one in EFSA. Until the two systems are aligned with each other, the Commission requested Member States*[1] to submit the results of those controls also to EFSA.[18] The analysis of these controls based on the data submitted, is presented in Section 4.2.3. However, during 2023 annual revisions,[15,16,17] composite foods were included in the annexes to be monitored. This type of food is outside the scope of Regulation (EC) 396/2005 and thus outside of this report. Nonetheless, an analysis has been included in the dedicated section, based on the subset collected. Samples collected under increased import controls are not considered on the exposure/risk assessments (Section 5).

Food samples intended for infants and young children are also collected in the frame of the above-mentioned programmes. These samples have specific MRLs set in Article 4 of Regulation (EU) 2016/127,[19] Article 3 of Regulation (EU) 2016/128[20] and Article 7 of Directive 2006/125/EC[21] but considering the residue definitions as set out in Regulation (EC) No 396/2005.[9] Following the precautionary principle, the legal limit for these types of food products, was set at the low level (limit of quantification). In general, a default MRL of 0.01 mg/kg is applicable unless lower legal limits for the residue levels are defined in the above-mentioned legislations.

Regulation (EU) 2018/848[22] on organic production and labelling of organic products, defines the restrictions in place for the use of plant protection products in this type of samples also collected under the above-mentioned programmes. Regulation (EU) No 2021/1165[23] provides authorisation of certain products and substances for use in organic production. However, the MRLs set in Regulation (EC) No 396/2005[9] apply equally to organic food and to conventional food.

Active substances for which legal limits are set under Regulation (EC) No 396/2005,[9] may also be covered by Regulation (EU) No 37/2010 on pharmacologically active substances.[24] For these so-called dual use substances, Member States*[1] perform official controls in accordance with Delegated Regulation (EU) 2022/1644[25] and Delegated Regulation (EU) 2022/1646[26] for veterinary medicinal products (VMPR). Results of the official controls for dual use substances are reported within this report if the MS Competent Authority flagged it as pesticide in the remit of the 2024 ChemMon data collection (EFSA, 2024b). Otherwise, results are reported in another EFSA output on VMPR residues (EFSA, 2025c).

[13]Commission Implementing Regulation (EU) 2019/1793 of 22 October 2019 on the temporary increase of official controls and emergency measures governing the entry into the Union of certain goods from certain third countries implementing Regulations (EU) 2017/625 and (EC) No 178/2002 of the European Parliament and of the Council and repealing Commission Regulations (EC) No 669/2009, (EU) No 884/2014, (EU) 2015/175, (EU) 2017/186 and (EU) 2018/1660. OJ L 277, 29.10.2019, p. 89–129.

[14]Commission Implementing Regulation (EU) 2022/913 of 30 May 2022 amending Implementing Regulation (EU) 2019/1793 on the temporary increase of official controls and emergency measures governing the entry into the Union of certain goods from certain third countries implementing Regulations (EU) 2017/625 and (EC) No 178/2002 of the European Parliament and of the Council. OJ L 158, 13.6.2022, p. 1–26.

[15]Commission Implementing Regulation (EU) 2023/174 of 26 January 2023 amending Implementing Regulation (EU) 2019/1793 on the temporary increase of official controls and emergency measures governing the entry into the Union of certain goods from certain third countries implementing Regulations (EU) 2017/625 and (EC) No 178/2002 of the European Parliament and of the Council. OJ L 25, 27.1.2023, p. 36–66.

[16]Commission Implementing Regulation (EU) 2023/1110 of 6 June 2023 amending Implementing Regulation (EU) 2019/1793 on the temporary increase of official controls and emergency measures governing the entry into the Union of certain goods from certain third countries implementing Regulations (EU) 2017/625 and (EC) No 178/2002 of the European Parliament and of the Council. OJ L 147, 7.6.2023, p. 111–141.

[17]Commission Implementing Regulation (EU) 2019/1715 of 30 September 2019 laying down rules for the functioning of the information management system for official controls and its system components (the IMSOC Regulation) OJ L 261, 14.10.2019, p. 37–96.

[18]Agenda point A.17 of the 18–19 September 2023 SCoPAFF meeting: https://food.ec.europa.eu/system/files/2023-10/sc_phyto_20230918_ppr_sum.pdf.

[19]Commission Delegated Regulation (EU) 2016/127 of 25 September 2015 supplementing Regulation (EU) No 609/2013 of the European Parliament and of the Council as regards the specific compositional and information requirements for infant formula and follow-on formula and as regards requirements on information relating to infant and young child feeding. OJ L 25, 2.2.2016, p. 1–29.

[20]Commission Delegated Regulation (EU) 2016/128 of 25 September 2015 supplementing Regulation (EU) No 609/2013 of the European Parliament and of the Council as regards the specific compositional and information requirements for food for special medical purposes (OJ L 25, 2.2.2016, p. 30).

[21]Commission Directive 2006/125/EC of 5 December 2006 on processed cereal-based foods and baby foods for infants and young children. OJ L 339, 6.12.2006, p. 16–35.

[22]Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007. OJ L 150, 14.6.2018, p. 1–92.

[23]Commission Implementing Regulation (EU) 2021/1165 of 15 July 2021 authorising certain products and substances for use in organic production and establishing their lists. OJ L 253, 16.7.2021, p. 13–48.

[24]Commission Regulation (EU) No 37/2010 of 22 December 2009 on pharmacologically active substances and their classification regarding maximum residue limits in foodstuffs of animal origin. OJ L 015 20.1.2010, p. 1.

[25]Commission Delegated Regulation (EU) 2022/1644 of 7 July 2022 supplementing Regulation (EU) 2017/625 of the European Parliament and of the Council with specific requirements for the performance of official controls on the use of pharmacologically active substances authorised as veterinary medicinal products or as feed additives and of prohibited or unauthorised pharmacologically active substances and residues thereof. OJ L 248, 26.9.2022.

[26]Commission Implementing Regulation (EU) 2022/1646 of 23 September 2022 on uniform practical arrangements for the performance of official controls as regards the use of pharmacologically active substances authorised as veterinary medicinal products or as feed additives and of prohibited or unauthorised pharmacologically active substances and residues thereof, on specific content of multi-annual national control plans and specific arrangements for their preparation. OJ L 248, 26/09/2022, p. 32–45.

## 1.2 | Terms of Reference

In accordance with Article 32 of Regulation (EC) No 396/2005,[9] EFSA is responsible for preparing an Annual Report on pesticide residues. This annual report shall include at a minimum, the following information:

- an analysis of the results of the controls on pesticide residues provided by EU Member States,*[1]
- a statement of the possible reasons why the MRLs were exceeded, together with any appropriate observations regarding risk management options,
- an analysis of chronic and acute risks to the health of consumers from pesticide residues,
- an assessment of consumer exposure to pesticide residues based on the information provided by Member States*[1] and any other relevant information available, including reports submitted in accordance with Delegated Regulation (EU) 2022/1644[26] and Delegated Regulation (EU) 2022/1646.[27]
- In addition, the report may include a recommendation on the pesticides, products or combinations of them that should be included in future monitoring programmes.

# 2 | INTRODUCTION

This report provides a detailed insight into the control activities at European level and the results from the official control activities performed by the EU Member States,*[1] including Iceland and Norway as members of the European Free Trade Association (EFTA) and of the European Economic Area (EEA).[27] This report is intended to provide information to the different stakeholders with an interest and responsibilities in the food chain, particularly food supply chain operators. Its aim is to present a comprehensive overview of residue findings in food placed on the EU market, including possible non-compliances with legal limits, and to assess the potential exposure of consumers to pesticide residues and possible health risks. Furthermore, it gives recommendations on various possible risk management options where appropriate. The report's findings are systematically used by the European Commission and the Member States*[1] to establish priorities for controls of food on the market, including the most relevant substance/commodity combinations to be included in the EU MACP regulation or in the national control programmes of Member States.*[1] At the same time, the report aims to address questions such as:

- How frequently were pesticide residues found in food?
- Which food products frequently contained pesticide residues?
- Compared with previous years, are there any notable changes?
- In which products were breaches of the legal limits identified by the Member States*[1]? and what could be the reasons for these breaches?
- Were actions taken by the national competent authorities sufficient to ensure that pesticide residues in food non-compliant with European food standards were not placed on the EU market?
- Do the residues in food pose a risk to consumer health?

EFSA developed a data visualisation tool to help end-users gain insights from the vast amount of data underpinning this report. The 2023 control programme results are presented in Appendix B – Annex I[2]. An overall summary evaluation can still be found in Sections 3 and 4 of this report, but figures, maps and tables are in Annex I. The results of the dietary exposure assessments to individual pesticides are described in Section 5. Appendix B – Annex II to Annex VIII with complementary data to this report are published in the Open Science platform Zenodo.[28] Information on the content of these annexes can be checked in Appendix B.

The raw data provided by reporting countries and anonymised by EFSA, can also be downloaded from Zenodo[29] by typing: 'Member-State-Name results from the monitoring of pesticide residues in food'. A subset of these raw data, aggregated and used to prepare this report, is published for the first time under Annex VIII. Along Annex VIII, an explanatory document will be published helping the user understand the data filters applied.

In addition, EFSA compiled a technical report (EFSA, 2025d) containing the descriptive information on the pesticide monitoring activity by year and submitted by the reporting countries. Here, further details at national level are provided. The names and websites of the reporting data national competent authorities can be seen in Appendix A.

# 3 | EU-MULTIANNUAL COORDINATED CONTROL PROGRAMME (EU MACP)

In accordance with Annex II of Regulation (EU) 2022/741,[3] reporting countries were to sampled and analysed a given number of pesticide/food product combinations (Appendix B – Anne II – Table 2.1).

[27]Iceland and Norway are considered as second countries in respect to EU MSs* considered first. The rest of the countries are referred in this report as third countries.
[28]10.5281/zenodo.14765085.
[29]https://zenodo.org/.

The EU MACP covers the most consumed food products in Europe sampled in a randomised way, aiming at reflecting the real situation of the pesticide residues in the EU market in terms of frequency and levels. The listed food products are distributed across a three-year cycle, so that every 3 years the same products are analysed. In 2023, the food products included were carrots, cauliflowers, kiwi fruits (green, red and yellow), onions, oranges, pears, potatoes, dried beans, brown rice, rye, bovine liver and poultry fat. The Regulation allowed in case not enough samples of rye to be retrievable, to sample the corresponding rye flour.

A total of 13,246 samples were reported under the 2023 EU MACP covering a total of 197 pesticides to be analysed. In 9253 of those samples (69.9%) no quantifiable residues were reported (residues were below the limit of quantification (LOQ)). The number of samples with pesticide residues within legally permitted levels (at or above the LOQ but below or at the MRL) was 3747 (28.3%). MRLs were exceeded in 1.9% (246) of samples, of which 1.0% (135) were found to be non-compliant after taking into account measurement uncertainty[30] (a very similar compliant rate for the same commodities sampled in 2020, which stood at 0.9%).

The overall MRL exceedance rate[33] decreased from 2.1% in 2020 to 1.9% in 2023. In 2017, the rate was 1.7%, but bovine liver was not sampled whereas, instead, sheep fat was covered by the EU MACP. Among individual food commodities, MRL exceedance rate rose the most in dry beans (from 2.3% in 2017 to 4.9% in 2020 and to 6.9% in 2023). In brown rice, the exceedance rate remained above 5% (from 5.1% in 2017 to 6.7% in 2020 and back to 5.1% in 2023). Increases in MRL exceedance rates were also observed in pears (from 2.3% in 2017 and 2020, to 3.2% in 2023), carrots (from 1.9% in 2017, to 1.2% in 2020, to 2.4% in 2023), potatoes (from 1.2% in 2017, to 0.8% in 2020, to 1.4% in 2023) and onions (from 0.3% in 2017, to 0.2% in 2020, to 0.8% in 2023). In oranges, kiwi fruits (green, red and yellow) and cauliflower, the rates were lower in 2023 than in 2020, but higher than in 2017. MRL exceedance rates decreased along the two monitoring cycles in rye (from 1.9% in 2017 to 0.8% in 2023). In bovine liver and poultry fat one exceedance was reported (one in 2023 and the other in 2020, respectively).

In dried beans, the pesticides contributing the most to a MRL exceedance were fosetyl (RD), glyphosate (RD) and chlorpyrifos (RD). Only glyphosate (RD) had an authorised use in this food. Whereas in brown rice, the pesticides contributing the most to a MRL exceedance were tricyclazole (RD), propiconazole (RD), imidacloprid (RD)[31] and chlormequat chloride (RD). None of these pesticides were authorised in rice in the EU.

The overall non-compliant rate remained practically the same from 0.9% in 2020 to 1.0% in 2023. Out of the 31 results leading to non-compliances in dried beans, samples from Argentina and Madagascar had the highest rate. Instead, out of the 45 results leading to non-compliances in rice, the highest rate came from India and Pakistan samples.

EFSA recommends including dried beans and brown rice in all control programmes and check for those pesticide that have led to high MRL exceedance rate as well as for samples with country of origin with the highest non-compliant rates. Dried beans and rice are bulked products, for which tracking the country of origin may sometimes be difficult. EFSA recommends Member States to investigate further and try to elucidate the real country of origin, to better understand which countries are using non-authorised active substances in crops intended to be imported in the EU.

The minimum number of 683 samples set in the EU MACP Regulation was reached for all commodities except for rye (654 samples, of which 235 samples were of wholemeal flour). Not all countries fulfilled the legal requirement respect to the minimum number of samples taken. Thus, EFSA recommends EU MSs to fulfil the legal requirements when it comes to type of products as well as minimum number of each one.

The countries taking the highest number of samples were Germany (15.1%), France (10.6%) and Poland (10.3%). However, the Regulation set a minimum number based on the population size of each country. Therefore, those EU MS*,[1] sampling the most in respect of the legal requirement were Northern Ireland (3.7 times more), Romania (3.3), Denmark and Lithuania (2.9). Instead, those sampling the least in respect to the minimum number given on the Regulation were Bulgaria (0.6) and Italy (0.9).

Out of the 13,246 samples collected, 60.3% were domestic samples, 20.8% were from other reporting countries, 14.6% from third countries and 4.3% were of unknown origin. The percentages were very similar to 2020 results (60%, 22%, 14% and 4%, respectively) where the same food products were to be taken.

Reporting countries do not have a common approach to take the same rate of domestic, EU or third country samples. However, it is aimed to reflect the market share present in their country. Thus, countries with more than 80% of domestic samples were Lithuania (100%), Spain (91.4%), Greece (87.0%) and Italy (82.9%). Those countries that sampled the most from third countries were Northern Ireland (51.2%), Latvia (26.2%) and Croatia (26.2). Belgium (30.2%), The Netherlands (14.2%) and Germany (12.1%) have more than 10% of samples with origin unknown. Providing to EFSA the country of origin is recommended and will be mandatory from next year data collection, as it must be known by the competent authorities to track traceability in case of non-compliant.

Out of 135 non-compliant samples reported under the EU MACP, 42.2% were of EU origin whereas, in 54.8% the place of origin was outside the European market and the remaining 3% were reported to be of unknown origin. These 135 non-compliant samples corresponded to 157 results. Among the authorised uses that resulted in non-compliant samples, 8.3% originated from the EU, compared to 13.4% from third countries. For non-authorised uses leading to non-compliant

[30]The differences between MRL exceedances and non-compliant results are that in the first, the comparison is only numerical -used in the remit of this report-, while in the latter, legal actions may be triggered (European Commission, 2021).

[31]For imidacloprid despite an emergency authorisation was granted in 2023 (https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/ppp/screen/home) in some cereals, none were on rice.

outcomes, 31.2% were attributed to samples from the EU, while 43.9% came from third countries. Although the percentage of non-compliance is higher in samples from third countries, the figures for EU-origin samples are still significant.

Information on non-compliant results, is provided in Appendix B – Annex I – chapter one.[2] Those pesticide/crop combinations where more than one result was reported, are summarised as follows:

- in samples with EU origin, nine different pesticide/crop combinations were reported as authorised at EU level. The most frequent, was chlorpropham (RD) in potatoes (5 samples).[32] Non-authorised uses leading to non-compliance results were given on 33 different pesticide/crop combinations. The highest rates were on chlorpyrifos (RD) and linuron (RD) in carrots (two and three samples, respectively), imidacloprid (RD) in cauliflowers (three samples), chlorpyrifos (RD) in oranges (three samples), mepiquat chloride (RD) in pears two samples) and in rice diflubenzuron (RD), imidacloprid (RD) and tricyclazole (RD) (two samples, each),
- among samples reported to come from outside the EU internal market leading to non-compliant results, 12 different authorised uses were reported. The most frequent was on glyphosate (RD) in dried beans (five samples) and thiamethoxam (RD) in rice (six samples). On the non-authorised uses, 34 different combinations lead to non-compliant. Those with the highest reporting frequency were: chlorpyrifos (RD) (4 samples mainly from Madagascar), ethylene oxide (RD) (2 samples) and fosetyl (RD) (8 samples) in dried beans, fenamiphos (RD) and thiabendazole (RD) in carrots (2 samples, each), buprofezin (RD) and chlorpyrifos (RD) in oranges (2 samples from Türkiye and 2 samples from Egypt, respectively), diflubenzuron (RD) in pears (2 samples) and in rice acetamiprid (RD) (2 samples from Pakistan), carbendazim (RD) (3 samples from Pakistan), chlormequat chloride (RD) (2 samples from Cambodia), chlorpyrifos (RD) (4 samples from Pakistan and 1 sample from India), imidacloprid (RD) (2 samples from Pakistan), propiconazole (RD) (5 samples) and tricyclazole (RD) (7 samples mainly from India).

EFSA recommends reporting countries, to keep analysing these combinations in their scope of analysis of their analytical methods.

Samples from organic production systems were to be taken too in proportion to the market share of each commodity within each reporting country with a minimum of one sample per listed commodity. In total, 1078 organic samples were analysed. Out of 30 reporting countries, only 21 reported organic samples. EFSA recommends MS to fulfil the requirement on sampling by taking at least one sample per given commodity, if organic farms for the relevant products are available at country level.

In addition, five samples of infant formulae and five samples of follow-on formulae were to be sampled by each reporting country. The total number of samples reported under these two food categories amounted to 624 samples.[33] EFSA recommends MS to fulfil the requirement on sampling per given type of commodities. A comprehensive analysis of these results is reported in Section 4.3.3 where the data for all these types of samples are pooled together. This category of samples has not been included in Appendix B – Annex II – chapter one.[2]

Annex I of Implementing Regulation (EU) 2022/741 also provides the list of pesticides to be analysed in each EU MACP sample taken by the EU official laboratories. In total, 197 pesticides were listed, of which 172 pesticides were to be analysed in only plant origin commodities, 9 pesticides in only animal origin and 16 in both, plant and animal commodities. Therefore, a target number of required analysis was calculated considering the minimum number of samples (683 samples per commodity) to be reported by each country and comparing it against the total number of reported results. Sixteen pesticides did not reach this minimum number of results: mepiquat chloride (RD), haloxyfop (RD), ethylene oxide (RD), glufosinate equivalents (RD), bromide ion (RD), glyphosate (RD), 2,4-D (RD), dithianon (RD), fosetyl (RD), dithiocarbamates (RD), chlormequat chloride (RD), pencycuron (RD), 2-phenylphenol (RD), fluazifop (RD), ethephon (RD) and captan (RD). Most of these substances (except pencycuron (RD) and 2-phenylphenol (RD)) require a single residue method (SRM) to be quantified. Although, the number of pesticides not reaching the minimum number of analyses has reduced in the past years (31 in 2022), EFSA still sees the need of encouraging MSs to take the necessary measures to be able to enforce properly these substances. Moreover, on average, 118 different pesticide residues out of the 197 of the EU MACP were analysed per sample per reporting countries. Only 9 EU MS fulfilled the targeted scope of analysis of 197 pesticides. EFSA recommends reporting countries to take the necessary measures to make sure the full list of pesticides in the EU MACP is covered.

Of the 13,246 samples, 3993 had quantified results (30.1%). Of those, more than one pesticide was quantified in 2244 samples (16.9%). The food products with a higher rate of multiple residues were pears (65%) and oranges (64%). The highest number of multiple residues were found in two samples of pears, one of which was grown in the EU, where 14 different pesticides were quantified, all below the MRL values. The other, was grown in a third country where also 14 different pesticides were quantified, one of which led to a non-compliant result and the lot was not released on the market.

Detailed analyses are presented in Appendix B – Annex I – chapter one.[2]

[32]There is a temporary MRL set above the default MRL of 0.01 mg/kg as monitoring data show that there may be a contamination of potatoes when stored in facilities with a history of chlorpropham use. Therefore, this authorisation is to be considered as a contamination due to practices in the past and not as having a supported GAP. The temporary MRL will be reviewed based on monitoring data submitted to the European Commission.

[33]The minimum number of 5 plus 5 samples of baby food category mentioned in the EU MACP was not reached by Bulgaria (no samples reported), Iceland (no samples reported), Czechia (only one sample), France (three samples), Portugal (three samples), Latvia (four samples), Romania (five samples) and Finland (nine samples). Further information on baby food samples by MSs has been reported in the National Summary Report (EFSA, 2025d).

# 4 | OVERALL MONITORING PROGRAMMES (EU MACP AND MANCP)

The MANCP are risk-based sampling programmes in accordance with Regulation (EU) No 2021/1355.[13] The focus is placed on products likely to contain pesticide residues or for which MRL infringements were identified in previous monitoring programmes. These programmes are not designed to provide statistically representative results for residues expected in food placed on the European market.

The reporting countries define the priorities for their national control programmes considering several factors such as the importance of food products in trade or in the national diets, products with historically high residue prevalence or non-compliance rates in previous years, the use pattern of pesticides and national laboratory capacities. The results of national control programmes cannot be used to compare countries directly as there are specific needs in each country and their dietary habits and access to local products may differ among them. The number of samples and/or the number of pesticides analysed by any reporting country is determined by the capacities of their national control laboratories and available budget resources.

The data analysis of this section is also presented in Appendix B – Annex I – chapter two.[2] The data is displayed into three different sections: geospatial visualisation based on overall number of samples by reporting countries, findings at residue level and analysis at food product level. Risk managers consider non-compliant findings useful to take decisions on designing the risk-based national monitoring programmes in future years. The findings are also a valuable source of information for food business operators and can be used to enhance the efficiency and safety of self-control systems. The section on reasons for MRL exceedance remain in this report (Section 4.4). More information on the national control programmes can be found in a separate EFSA technical report that summarises the national results (EFSA, 2025d).

## 4.1 | Geospatial findings

In 2023, the EU Member States,*[1] Iceland and Norway, analysed a total of 132,793 samples for pesticide residues on/in food products covered by Regulation (EC) No 396/2005.[9] This marks for the secondary year an increase on the total number of samples taken over the last 10 years.

Additionally, 11 countries reported 1760 feed samples, and 17 countries reported 2155 fish samples. No MRLs are established in/on feed nor fish under Regulation (EC) No 396/2005.[9] However, a short summary of the pesticides found in fish has been included in Appendix B – Annex I – chapter two.[2]

Of the total 132,793 samples analysed, 43.2% were domestic samples (i.e. those were the origin and the reporting country are the same), 10.7% from a different reporting country, while 42.1% had been imported to the EU from a third country. The remaining 4% were reported as being of unknown origin.

The countries with the highest sampling rates of imported products from third countries were Bulgaria (99.2%) and Croatia (67.4%). Lithuania and Italy focussed mainly on domestic sampling (more than 80% of the samples analysed). Further, Germany, Belgium, Czechia and Iceland reported a rate of samples of unknown origin, higher than 10%.

Of the 71,617 samples (53.9%) coming from one of the reporting countries, 45,701 samples (63.8%) were found not to contain any residue above the LOQ, while 24,614 samples (34.4%) contained residues at or above the LOQ but below or equal to the MRL. A 1.8% (1302 samples) of the samples, exceeded the MRL and of these, 1.0% (687 samples) were non-compliant with the MRL. The remaining 55,932 samples (42.1%) were imported from third countries, of which 28,457 samples (50.9%) were reported as without quantifiable residues, while 24,014 samples (42.9%) contained quantifiable residues within the legal limits. The samples exceeding the MRL were 3461 (6.2%). Of these, 1892 samples (3.4%) resulted in non-compliant samples after considering measurement uncertainty. The non-compliance rate in samples coming from third countries (3.4%) was three times higher than the ones from the reporting countries (1.0%). The main third countries from which non-compliant products enter the EU market were Türkiye, India and Egypt. Most of these third country consignments were stopped at border.

The remaining 5244 samples (4.0%) of the total number were reported as unknown origin. A 4.1% (214 samples) exceeded the MRL and 2.2% (115 samples) led to non-compliant samples. Still a very high percentage of samples where the country of origin is not reported. Thus, EFSA recommends reporting countries to make sure the country of origin which should be a known data element, be reported to EFSA.

## 4.2 | Results by pesticide residues

Of the total of 132,793 samples analysed in 2023, 76,962 samples (58.0%) did not contain quantifiable residues (results below the LOQ for each pesticide analysed) while 50,854 (38.3%) of the samples contained quantified residues not exceeding the legal limits. Thus, in total, 96.3% of the samples fell within the legal limits (127,816 samples). This tendency seems to be constant for the last years (96.3% in 2022, 96.1% in 2021; 94.9% in 2020). The MRL exceedance rate of 3.7% (4977 of the samples) and the non-compliant rate[33] of 2.0% (2694 of the samples) kept also the tendency of the last years (3.9% in 2021 and 3.7% in 2022 respect to MRL exceedance, and 2.5% in 2021 and 2.2% in 2022 respect to non-compliances).

More than 26 million analytical determinations (individual residue results) were submitted to EFSA (see Appendix B – Annex II – Table 2.3). The number of determinations for which residue levels were quantified at or above the LOQ amounted for 147,249 (i.e. 0.6% of the total determinations) in relation to the overall number of 132,793 samples.

In total, the maximum number of different pesticide residues analysed in the scope of the official laboratories by the reporting countries was 741. On average, 249 different pesticide residues were analysed per sample. An analytical scope higher than 600 pesticides at country level, was noted for Malta (741 pesticides), Germany (717 pesticides), Belgium (631 pesticides), Luxembourg (627 pesticides), Spain (625 pesticides), Austria (618 pesticides) and Croatia (602 pesticides).

The pesticides quantified in more than 300 samples and quantification rate higher than 10% were: copper compounds (RD) (92.8%), fosetyl (RD)[34] (17.6%), bromide ion (RD) (12.2%) and mercury (RD) (11.2%). The pesticides where the MRL exceedance rate was higher than 1% for a minimum number of 300 samples reported were: phosphane (RD) (1.6%), copper compounds (RD) (1.4%) and ethylene oxide (RD) (1.1%).

- Phosphane (RD), an approved fumigant in the EU, was analysed in 321 samples. Of which, in five samples the MRL was exceeded (1.6%) and three samples (0.9%) led to non-compliant results. All MRL exceedances were due to misuses of authorised GAPs from imported foods such as, two rice samples coming from Myanmar/Burma and Thailand, respectively, one sunflower seed sample coming from Ukraine, one thyme sample coming from Türkiye and one sample of peas without pods coming from the United States.
- Copper compounds (RD)[35] was reported to have been analysed in 4814 samples. Of which, in 68 samples the MRL was exceeded (1.4%) and 40 samples (0.8%) led to non-compliant results. Most of the non-compliant samples were of wild terrestrial vertebrate animals (19 samples), honey and other apicultural products (5 samples) and bovine liver (4 samples). Copper findings tend to be linked to different sources rather than uniquely from a pesticide use. It is a naturally occurring substance in food and drinking water, a nutrient, but it can also be present in the diet as food additive or in feed given to livestock and fertiliser. Considering EFSA's scientific opinion on the re-evaluation of the HBGV on copper (EFSA, 2023a), an update on the maximum residue levels (MRLs) for copper compounds having considered all sources of exposure has recently been published (EFSA, 2025b). Furthermore, Regulation (EU) No 2024/989[36] requests copper to be analysed as part of 2025 EU MACP.
- Ethylene oxide (RD) was analysed in 3651 samples. Being a pesticide not approved at EU, its MRLs are set at the LOQ level. In 40 samples the MRL was exceeded (1.1%) and in 24 samples (0.7%) led to non-compliant results. Of those, 13 samples have origin India and 4 samples Türkiye. A decrease in the number of notifications was observed compared to 2022 (European Commission, 2024).[37]

EFSA recommends analysing these pesticides in the commodities where non-compliant results were reported. Details on the samples exceeding the MRL can be consulted in Appendix B – Annex II – Table 2.2.

### 4.2.1 | Multiple pesticide residues

Multiple residues in one single sample may result from the application of different types of pesticides (e.g. application of herbicides, fungicides or insecticides against different pests or diseases) or the use of different active substances aiming at avoiding the development of resistant pests or diseases and/or uptake of residues from soil from treatments used in previous seasons or spray/dust drift to fields adjacent to treated fields. In addition to multiple residues resulting from the agricultural practice, multiple residues may also occur as a result of mixing or blending products with different treatment histories at different stages in the supply chain, including contamination during food processing. According to the present EU legislation, the presence of multiple residues within a sample remains compliant, as long as each individual residue level does not exceed the individual MRL set for each active substance.

Of the 132,793 samples analysed, 42.0% (55,831) of samples contained one or several pesticides in quantifiable concentrations. Multiple residues were reported in 25.5% (33,872) of samples; up to 37 different pesticides were reported in an individual sample of chilli peppers from Cambodia. This chilli pepper sample was deemed non-compliant, and the product lot from the wholesale was destroyed.

Out of the 33,872 samples with multiple residues, 94% were of unprocessed products. The highest frequency of samples with multiple residues was reported for sweet peppers (5717 samples), oranges (2756 samples), lemons (2032 samples), mandarins (1490 samples), apples (1238 samples), pears (1163 samples) and strawberries (1092 samples).

[34]Findings may include residues of two approved fungicides: disodium phosphonate and phosphonic acid, the latter resulting from the use of potassium and disodium phosphonates (which can also be used as foliar feed fertiliser). A residue definition for enforcement common to all was derived 'fosetyl-Al (sum of fosetyl, phosphonic acid and their salts, expressed as fosetyl)' (EFSA, 2018c).

[35]Only 6 countries reported data con copper compound. As this substance will be included in the EU MACP, it is recommended to official laboratories including it on the scope of analysis.

[36]Commission Implementing Regulation (EU) 2024/989 of 2 April 2024 concerning a coordinated multiannual control programme of the Union for 2025, 2026 and 2027 to ensure compliance with maximum residue levels of pesticides and to assess the consumer exposure to pesticide residues in and on food of plant and animal origin and repealing Implementing Regulation (EU) 2023/731. OJ L, 2024/989, 3.4.2024.

[37]https://food.ec.europa.eu/document/download/911d49f2-b3ef-4752-8ea3-5f20dbbe9945_en?filename=acn_annual-report_2023.pdf.

The remaining 6% were of processed products. The highest frequency of samples with multiple residues was reported in dried vine fruits (e.g. raisins) (193 samples), red wine (144 samples), wheat flour (78 samples) and processed apples (45 samples).

### 4.2.2 | Results on glyphosate

Glyphosate is approved for use in the EU until 15 December 2033.[38]

Giving glyphosate interest, EFSA considers appropriate presenting on this dedicated section all data received on the parent and on any metabolite/degradation products.

In 2023, glyphosate was reported by 26 countries analysing 16,283 samples of different products, of which 674 were samples from feed and 18 of fish samples. Regarding the remaining 15,591 food samples, in 15,256 of the samples (97.9%) glyphosate was not quantified. In 296 samples (1.9%), glyphosate was quantified at levels above the LOQ but below the MRL and in 39 samples (0.2%) the residue levels exceeded the MRL. Of these, after taking into account measurement uncertainty, 23 samples (0.1%) were non-compliant, mainly on dry beans, honey and other apicultural products and buckwheat and other pseudo – cereals. The exceedance rate was slightly lower than in 2022 (0.3%).

Glyphosate residues were analysed in 399 samples of food for infants and young children where all samples were below the LOQ.

Based on the specific provisions listed on the renewal of approval,[42] EFSA is currently working on an updated MRL review of glyphosate.[39]

Glyphosate metabolites were analysed in different food samples: AMPA (8308 samples), AMPA-N-acetyl (949 samples), N-acetyl glyphosate (5967 samples) and trimethyl-sulfonium cation (6309 samples). AMPA was quantified in 14 samples (0.2%), mainly in soyabeans. No quantified sample was reported for AMPA-N-acetyl nor N-acetyl glyphosate, which are only relevant to genetically modified crops.

In crops or parts of crops exclusively used for animal feed production,[40] where MRLs are not set, glyphosate related substances were quantified as follows: in 7 results out of 13 samples (54%) AMPA-N-acetyl was quantified; in 181 results out of 674 samples (27%) glyphosate was quantified and in 49 results out of 243 samples (20%) AMPA was quantified; no results were reported as above the LOQ on N-acetyl glyphosate nor trimethyl-sulfonium cation, resulting from the use of glyphosate.

According to the MRL review (EFSA, 2019b), there are uses authorised on grass and other feed items with very high application rates. With the new restrictions of approval, concentrations found in feed items are likely to decrease.

Trimethyl-sulfonium cation resulting from the use of glyphosate was analysed by 8 MSs and was quantified in 44 samples (0.7%), mainly in cultivated fungi, citrus fruits and teas.

### 4.2.3 | Results on temporary increase on import controls

Under Regulation (EU) 2019/1793[14] on temporary increase on import controls, certain foods were subject to an increased frequency of official controls for certain pesticides at border control posts (BCPs) into the EU territory. The data presented in this section, is a subset of the one sent by reporting countries to TRACES[41] through the Integrated Management System for Official Controls (IMSOC)[42] platform. Some of these controls may have entered the RASFF[43] of the European Commission. More information can be found in 2023 RASFF report[37] (European Commission, 2024).

The total number of samples reported to EFSA under this Regulation was 28,393 samples. The percentage of non-compliant was 2.6% mainly in sweet peppers/bell peppers with origin Türkiye and rice from India and Pakistan. Samples of composite food products[44] and feed were included amounting to 635 samples.

The results presented in this section are based on the data reported directly to EFSA for the sampling year 2023. Other data might have been reported directly to DG SANTE.[45] Therefore, this section may not give the overall picture of the situation under this Regulation.

[38]Commission Implementing Regulation (EU) 2023/2660 of 28 November 2023 renewing the approval of the active substance glyphosate in accordance with Regulation (EC) No 1107/2009 of the European Parliament and of the Council and amending Commission Implementing Regulation (EU) No 540/2011. OJ L, 2023/2660, 29.11.2023.

[39]https://open.efsa.europa.eu/questions/EFSA-Q-2024-00177?search=glyphosate.

[40]Other pesticides are analysed in feed. However, are not presented in this report as they are not part of Regulation (EC) 396/2005. Glyphosate and derived metabolites reported in feed, are presented in this report to allow readers having a complete overview of the monitoring data EFSA received.

[41]https://webgate.ec.europa.eu/IMSOC/tracesnt-help/Content/en/index.html.

[42]https://ec.europa.eu/dpo-register/detail/DPR-EC-02027.2.

[43]https://webgate.ec.europa.eu/rasff-window/screen/search.

[44]Composite food products are food made of more than one product, either plant based or/and animal commodities. The MRL that applies, needs to be recalculated on a case by case depending on the ingredients and proportion contained in the sample. The type of products the regulation listed were tea, whether or not flavoured; mucilage's and thickeners, whether or not modified, derived from locust beans or locust beans seeds; tomato ketchup and other tomato sauces; xanthan gum; guar gum; mixtures of food additives containing locust bean gum or guar gum; sauces and preparations thereof; mixed condiments and mixed seasonings; mustard flours and meals and prepared mustard; food supplements containing botanicals; instant noodles containing spices/ seasonings or sauces; calcium carbonate.

[45]Through IMSOC system, the real number of samples of import control are collected. More information on this can be requested through sante-import-controls@ec.europa.eu.

A description of the required controls regarding hazard analysis, type of food products and countries of origin, relevant for the calendar year 2023 can be found in Appendix B – Annex II – Table 2.4.

## 4.3 | Results by food products

### 4.3.1 | Results by processed versus unprocessed food products

The compliance of processed food samples is checked against the maximum residue levels in the respective raw agricultural commodity after applying a processing factor derived for the given processed technique as per Article 20[46] of Regulation (EC) No 396/2005. The latest compendium of processing factors was published early in 2024 (Kittelmann et al., 2024).[47]

Out of 132,793 total samples reported in 2023, 11,167 samples (8.4%) were of processed food (excluding 1504 samples of foods for infants and young children (Section 4.3.3)). In 512 processed samples (5.6%) the MRL was exceeded, of which 279 samples (3.1%) were non-compliant taking into account the measurement uncertainty. These rates are higher than in 2022 (3.7% and 2.3%, respectively).

The processed food products with a non-compliance rate higher than 10% and more than 10 samples reported were: grape leaves and similar species mainly canned/jarred and salted (39%), camomile flowers (18.2%), dried celery leaves (15.8%), dried basil and mint (15.8%), dried parsley (15.0%), processed dried beans (13.3%), dried liquorice (12.5%), coriander seed (12.5%), processed chards/beet leaves (11.8%), processed cumin seed (11.3%) and soyabeans oil (10.9%).

On the contrary, 120,122 samples (90.5%) were reported as unprocessed food products.[48] Of these, 4417 samples (3.7%) had residues exceeding the MRL, of which 2406 samples (2.0%) were non-compliant after taking into account measurement uncertainty. In 2022, these rates were the same (3.7% and 2.0%, respectively).

Those unprocessed food products for which more than 100 samples were reported and the non-compliance rate was higher than 10% were: grape leaves and similar species (20.2%),[49] cumin seed (12.9%), pitahaya (dragon fruit) (12.1%) and chilli peppers (11.0%). Other food products appearing in the visualisation[2] do not reach the 100 samples reported.

### 4.3.2 | Results on organic products

No specific MRLs are established for organic products. The MRLs set in Regulation (EC) No 396/2005[9] apply equally to organic food and to conventional food. However, Regulation (EU) No 2021/1165[29] authorises certain products and substances for use in organic production.

In 2023, 7074 samples labelled as organic were reported (excluding 477 reported as food for infants and young children), corresponding to 5.3% of the total samples, a slight decrease compared to 2022 (6.1%). Of those, 1078 samples were reported under the EU MACP.

Overall, 5663 samples flagged as organic did not contain quantifiable residues (80% vs. 79% in 2022) and 1346 samples contained quantified residues below or at the MRL level (19% vs. 18.6% in 2022). Those samples reported as having residue levels above their corresponding MRLs were 65 (0.9% vs. 2.4% in 2022), of which 25 samples (0.4% vs. 1.4% in 2022) were non-compliant.

In 2023, the quantification and MRL exceedance rates were lower in organic food compared to conventionally produced food (i.e. non-organic) for all food product categories, except for the exceedance rate in animal products which was slightly higher in organic. This was due to copper, a substance authorised in organic farming, having other uses such as feed supplement and fertilisers.

The pesticides with higher quantification rate (i.e. at levels above the LOQ but below the MRL) were copper compounds (RD)[50] (651 samples, 94.6%, mainly in wheat and rice), bromide ion (RD) (91 samples, 11.3%, mainly in vegetables (carrots and potatoes)) and chlorates (RD) (71 samples, 7.6%, mainly in lamb's lettuces/corn salads).

The pesticide exceeding the MRL the most was ethylene oxide (RD) (1.4%), copper (RD) (0.4%), chlorate (RD) (0.4%) and mercury RD (0.4%). Most of the quantified substances often present in samples flagged as organic, are either because they are authorised for use (e.g. copper compounds), they occur naturally (e.g. bromide ion), they occur as degradation product of a sanitisation process (e.g. chlorate; EFSA, 2023e) or are environmental contaminants (e.g. mercury (RD)).

The occurrence of other pesticides not authorised in organic farming (e.g. imazethapyr (RD), chlorpyrifos (RD), glyphosate (RD)) can – as for conventional products – be the result of spray drift, environmental contaminations or contaminations during handling, packaging, storage or processing of organic products. This occurrence could also be linked to the

[46]Information note on Article 20 of Regulation (EC) No 396/2005 as regards processing factors and composite food and feed. SANTE/10704/2021.

[47]European database of processing factors for pesticides residues in food. Zenodo publication: https://doi.org/10.5281/zenodo.1488652.

[48]In the framework of this report, unprocessed food products are considered those to which a MRL is directly applicable and are listed in Annex I to Regulation (EC) No 396/2005, i.e. products such as fermented tea, dried spices, dried herbal infusions etc.

[49]Grape leaves samples were not taken from the market (which they are placed as processed products). Normally these samples are taken at an earlier stage in the production chain: at retailers or primary production.

[50]Copper is authorised in organic production.[29]

incorrect labelling of conventionally produced food as organic food. Therefore, EFSA recommends reporting countries to elucidate possible reasons for occasionally quantified findings not permitted in products labelled as organic. EFSA also recommends widening the analytical scope on organic samples as much as possible.

### 4.3.3 | Results on food for infants and young children

Reporting countries analysed 1504 samples of foods for infants and young children as defined in Regulation (EU) No 2016/127,[20] Regulation (EU) 2016/128[21] and Directive 2006/125/EC,[22] herein referred to as food for infants and young children.

The types of samples were 577 samples of foods other than processed cereal-based foods, 390 samples of infant formulae, 234 samples of follow-on formulae, 187 samples of processed cereal-based foods for infants and young children and 116 samples of food for infants and young children.

From the overall number of these type of food samples analysed, 477 samples (31.7%) were flagged as organic samples. Of the total, 440 samples (29.3%) were flagged as EU MACP.

In 1373 samples (91.3%) no residues were quantified (a rate higher than in 2022–80.8%). Quantified samples with residues at or above the LOQ but below the MRL, were found in 83 samples (5.5%). In 48 samples (3.2%) the MRL was exceeded of which 9 samples (0.6%) were considered non-compliant when taking the measurement uncertainty into account, practically the same as in 2022 (0.8%) and 2021 (0.6%).

The MRLs in food for infants and young children, are established at the default MRL of 0.01 mg/kg, except for a given number of substances which are set much lower[22] (EFSA, 2018b). In 2023, 902 different pesticides were analysed. The substance most widely found in quantified concentrations was copper compounds in 46.9% of the samples. Copper compound is a naturally occurring substance but can also be present in the diet being a food additive or intake by livestock through feeding stuff. Moreover, when reporting pesticide residues in this type of food, in accordance with Article 2 (3) of Regulation (EU) 2022/741[3], the results should be reported based on the reconstituted product. When reconstituting a sample mainly water is added to the process. The adding of water can be a significant contributor of copper (EFSA, 2023a). The presence of copper in food for infants and young children can also be explained by the authorisation as a microelement in the formulae's manufactured from cows' milk proteins or protein hydrolysates (EFSA, 2014).

The pesticides most frequently found to exceed the MRL were copper compounds (RD) (32.8% of samples) and chlorates (RD) (8.1% of samples). While copper compounds are naturally occurring substances, chlorate findings are explained as occurring after sanitisation practice in the food chain, thus its presence is not due to a pesticide use.

### 4.3.4 | Results on animal products

A total of 20,700 samples of animal products were reported. The results showed that 18,628 samples were free of quantifiable residues (90.0% vs. 92.4% in 2022) while 1907 samples (9.2%) contained pesticides in quantifiable concentrations at or below the MRL, a slightly increase compared to 2022 (6.6%). MRL exceedances were identified in 165 samples (0.8% vs. 1.0% in 2022), of which 121 (0.6%, as in 2022) were deemed non-compliant when measurement uncertainty was taken into account.

Regarding the pesticide residues with highest quantification rate in animal commodities, copper (RD) (49%) and chlordecone RD (18.9%) were the highest (above 10%). Copper was mostly quantified in swine and bovine kidney as well as in swine and poultry muscle. Chlordecone[51] was mostly quantified in bovine and swine fat; all samples were coming from French overseas territories. The highest non-compliance rates were shown in bromide ion (RD) in 11.1% of the samples, mainly in bovine liver; copper (RD) in 3.1% of the samples mainly wild terrestrial vertebrate animals and chlorates 1.5% of the samples in poultry muscle.

In honey, 1743 samples were collected. In 1537 samples (88.2%) no quantifiable levels of residues were reported (residues were below the LOQ). The number of samples with pesticide residues within the legally permitted levels (at or above the LOQ but below or at the MRL) was 176 (10.1%). MRLs were exceeded in 30 samples (1.7% vs. 3.6% in 2022), of which 21 samples (1.2% vs. 2.2% in 2022) were found to be non-compliant taking the measurement uncertainty into account. In total, 23 different pesticides were reported. The most frequent quantified pesticides were acetamiprid (RD) (85 samples), amitraz (RD) (30 samples) and boscalid (RD) (23 samples). The highest MRL exceedance rate was on acetamiprid (0.6%).

Despite no MRLs are applicable to fish under Regulation (EC) No 396/2005[9], 18,389 fish samples were reported, where 349 pesticides were covered by the laboratories' analytical scopes. In total, 11 different pesticides were quantified, being copper (RD) the one with the highest rate (341 samples of Atlantic salmon from Norway), cypermethrin (RD) (22 samples of Atlantic salmon from Norway), mercury (12 samples of trout from Denmark), DDT (RD) (13 results in fish meat from Northern Ireland). These findings cannot be directly linked to recent pesticide uses.

[51]This is a known issue to EFSA (EFSA, 2020a) and to the French Competent Authorities on their overseas territories: https://www.anses.fr/en/content/risks-dietary-exposure-chlordecone-french-caribbean.

## 4.4 | Reasons for MRL exceedances/non-compliances

The legal limits (MRLs) are established based on supervised residue trials that reflect the residue levels expected under field conditions, or animal feeding studies for animal products based on appropriate dietary requirements of different food producing animals. The MRL value is estimated using statistical methods and it is usually established to cover at least the upper confidence interval of the 95th percentile of the expected residue distribution (OECD, 2014). Therefore, even if Good Agricultural Practices (GAP) are fully respected, a low percentage of MRL exceedances are expected. A sample is non-compliant when at least one pesticide is quantified at a level that after considering measurement uncertainty, the lower tail of the distribution is above the MRL value (European Commission, 2021). When a non-compliant sample is identified, a call for action at Member State level in line with Article 50 of Regulation (EC) No 178/2002[52,53] is required. Generally, Member States* reply with appropriate measures to non-compliances (e.g. administrative fines, RASFF notifications[54] and follow-up actions, etc.).

In 2023, out of 132,793 samples reported, 4977 samples contained pesticide residues exceeding their respective MRLs (3.8%), very similar to 2022 (3.7%). When considering measurement uncertainty, 2694 samples resulted into non-compliance (2.0%), very similar to 2022 (2.2%).

Several possible reasons for MRL exceedances are summarised below:

- In samples coming from third countries:
  - The use of non-approved pesticides for which no import tolerance[55] is granted (either because not requested or because having done so, the request was unsuccessful) (e.g. chlorpyrifos: in rice from Pakistan and India, oranges from Egypt and cumin seed from India and Türkiye; imidacloprid: in rice from Pakistan and India and grape leaves and similar species from Egypt; tricyclazole: in rice and cumin seed from India; thiamethoxam: in rice from India and Pakistan and cumin seed from India; fenbutatin oxide: in lemons from Türkiye).
  - GAP not respected or registered use follows different treatment pattern: use of approved pesticide deviating from the application rates, pre-harvest intervals, number or method of applications (e.g. acetamiprid: in granate apples/pomegranates from Türkiye, rice from Pakistan and India and cumin seed from India, grape leaves and similar species from Egypt and sweet pappers/bell peppers from Türkiye; lambda-cyhalothrin: in grape leaves and similar species from Egypt and Türkiye and teas from China; buprofezin: in sweet peppers/bell peppers from Türkiye).
  - Misuses of non-approved pesticides (e.g. chlorpyrifos-methyl: in lemons, mandarins and sweet peppers/bell peppers from Türkiye; propiconazole: in chilli peppers from Cambodia, grape leaves and similar species from Egypt, rice from India and Paraguay, and oranges and lemons from Türkiye, and imidacloprid: in teas from Vietnam and chives from Kenya).

- In samples originating in the internal EU market (reporting countries):
  - Use of approved pesticides but not in the crop for which the GAP is authorised (e.g. acetamiprid in poppy seeds and celeries, flonicamid in broccoli).
  - GAP not respected in accordance with application rates, pre-harvest intervals, number or method of applications of the pesticide product (e.g. deltamethrin in spinaches).
  - Cross contamination: spray drift or other accidental contamination (e.g. fluopicolide in currants (black, red and white), proquinazid in cherries (sweet))
  - Use of non-EU approved pesticides (e.g. chlorpyrifos: in oranges and dried herbal infusions; linuron: in celeriacs/turnip rooted celeries and parsley roots/Hamburg roots parsley; chlordecone: in bovine fat; imidacloprid: in cauliflowers and peaches) that have not been subject to emergency authorisations[56] granted during 2023.
  - Natural presence of the substance in the crop (e.g. copper compounds in wild terrestrial vertebrate animals and honey and other apicultural products).
  - Presence of biocide residues used as pesticides in the past and continuing to be monitored under the pesticide legislation (e.g. chlorate in different food commodities).
  - Environmental contamination of persistent organic pollutants (POP) included in the Stockholm Convention of prohibited substances (UNEP, 2001). These substances are no longer used as pesticides but are very persistent in the environment and found to contaminate and concentrate in the food chain (e.g. dieldrin in pumpkins and heptachlor in courgettes).

[52]Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety. OJ L 31, 1.2.2002, p. 1–24.

[53]https://food.ec.europa.eu/system/files/2023-02/acn_working-instructions_2-2_pest-residues.pdf.

[54]https://webgate.ec.europa.eu/rasff-window/screen/search.

[55]As set in Regulation (EC) No 396/2005, an import tolerance is a MRL set for imported products to meet the needs of international trade different than the one in place in the EU, for which prevails no risk to EU consumers. The ones granted from 2009 to 2024 can be found: https://food.ec.europa.eu/document/download/32890e29-6ce2-44dc-a33a-a12fbf4c2585_en?filename=pesticides_mrl_guidelines_overview-it-table.pdf.

[56]An emergency authorisation in accordance with Article 53 of Regulation (EC) 1107/2009.

More details on the pesticide/crop combinations exceeding the legal limits are compiled in Appendix B – Annex III – Table 2.2 and in the National Summary Report (EFSA, 2025d).

# 5 | PROBABILISTIC DIETARY EXPOSURE RESULTS AND ANALYSIS OF THE HEALTH RISKS

Regulation (EC) No 396/2005,[9] Article 32, requests EFSA to conduct an analysis on the health risks to European consumers and publish this within its annual report on pesticide residues. This analysis is based on the results from the official controls provided by reporting countries, which are combined with data on food consumption to obtain estimates of exposure to those pesticide residues.

Based on the scientific and technical knowledge available, EFSA has decided to base the estimation of the exposure assessment on a probabilistic correlation between the residue level in the analysed food and the eaten amount reported in a given consumption survey using a Monte-Carlo simulation, i.e. samples are selected at random multiple times, capturing a more realistic situation when it comes to acute exposure estimation or on the Observed Individual Means (OIM) approach for chronic exposure. This probabilistic methodology provides an estimation of the exposure in relation to the underlying selected population. It calculates the overall risk in that population, based on the actual consumption of the most consumed food commodities by real consumers and based on all the occurrence data present in those food commodities. This methodology aims to gradually align with the one undergone in cumulative risk assessments (EFSA, 2020b; EFSA, 2020c; EFSA, 2022) and is in accordance with the agreed roadmap between EFSA and SANTE.[57] Still, the assessment to the risks of only the high exposure events could not be performed due to the time taken to develop this probabilistic methodology. It will be developed in the next year report.

## 5.1 | Data

### 5.1.1 | Primary input data

#### 5.1.1.1 | *Raw primary commodities*

The 35 raw primary commodities (RPCs) of plant origin that were once considered in the EU MACP were selected to carry out the probabilistic risk assessment to pesticide residues. In addition, courgettes were also included because according to EFSA's design assessment of the pesticide monitoring programme (EFSA, 2015a), courgettes are consumed in higher amounts than other commodities previously included in the EU MACP (e.g. spinach and broccoli). Foods specifically intended for infants and young children were integrated in the exposure assessment.

The full list of the included food commodities is provided in Table 1.

**TABLE 1** RPC list.

| Number of commodities | prodCode[a] | prodName[b] |
|---|---|---|
| 1 | P0110010A | Grapefruits |
| 2 | P0110020A | Oranges |
| 3 | P0110050A | Mandarins |
| 4 | P0130010A | Apples |
| 5 | P0130020A | Pears |
| 6 | P0140030A | Peaches |
| 7 | P0151010A | Table grapes |
| 8 | P0151020A | Wine grapes |
| 9 | P0152000A | Strawberries |
| 10 | P0162010A | Kiwi fruits |
| 11 | P0163020A | Bananas |
| 12 | P0211000A | Potatoes |
| 13 | P0213020A | Carrots |
| 14 | P0220020A | Onions |
| 15 | P0231010A | Tomatoes |
| 16 | P0231020A | Peppers |

[57] https://food.ec.europa.eu/system/files/2021-03/pesticides_mrl_cum-risk-ass_action-plan.pdf.

**TABLE 1** (Continued)

| Number of commodities | prodCode[a] | prodName[b] |
|---|---|---|
| 17 | P0231030A | Aubergines (egg plants) |
| 18 | P0232010A | Cucumbers |
| 19 | P0232030A | Courgettes |
| 20 | P0233010A | Melons |
| 21 | P0241010A | Broccoli |
| 22 | P0241020A | Cauliflower |
| 23 | P0242020A | Head cabbage |
| 24 | P0251020A | Lettuce |
| 25 | P0252010A | Spinach |
| 26 | P0260010A | Beans (with pods) |
| 27 | P0260040A | Peas (without pods) |
| 28 | P0270060A | Leek |
| 29 | P0280010A | Cultivated fungi |
| 30 | P0300010A | Beans (dry) |
| 31 | P0402010A | Olives for oil production |
| 32 | P0500010A | Barley |
| 33 | P0500050A | Oats |
| 34 | P0500060A | Rice |
| 35 | P0500070A | Rye |
| 36 | P0500090A | Wheat |
| 37 | PX100001A | Foods for infants and young children other than processed cereal-based foods |
| 38 | PX100003A | Processed cereal-based foods for infants and young children |
| 39 | PX100004A | Infant formulae |
| 40 | PX100005A | Follow-on formulae |

[a]Code of the raw primary commodity as defined by EFSA's harmonised terminology for scientific research (MATRIX catalogue; EFSA, 2024g).
[b]Name of the raw primary commodity as defined by EFSA's harmonised terminology for scientific research (MATRIX catalogue; EFSA, 2024g).

#### 5.1.1.2 | *Active substances*

The active substances under analysis are those having been quantified at least once in the last 3-year cycle, i.e. monitoring data from sampling years 2023, 2022 and 2021, both from EU coordinated and national programmes. The list of active substances is presented in Appendix B – Annex III – Table 3.1. The total number of active substances amount to 375.

#### 5.1.1.3 | *Residue definitions*

While the probabilistic risk assessment is executed at the level of the active substances, the occurrence data reported to EFSA refer to the residue definition for enforcement. As the residue definitions defined in Regulation (EC) No 396/2005[9] may change over time, single active substances may be associated to multiple residue definitions throughout the reference period 2021–2023. Therefore, all the residue definitions that were applicable to the selected food commodities and active substances during the reference period 2017–2019 were collected. The residue definitions retained are presented in Appendix B – Annex III – Table 3.1.

Depending on the metabolism of the active substance and the availability of analytical methods, the residue definitions for enforcement may be equal to the active substance (most typical case), may include additional metabolites, even incorporate multiple active substances or only a metabolite without the parent active substance.

When the residue definition includes additional metabolites specific to the parent active substance known as a *complex residue definition*, the measurement is assigned to the active substance assuming that the metabolite(s) will have the same toxicological properties as the parent compound.

When the residue definition includes or applies to multiple active substances having different toxicological properties is known as *unspecific residue definition*. The measurement is assigned to the different active substances that are authorised[58] (see Section 5.1.2.2). When doing this, molecular weight conversion factors are applied to convert the occurrence data as expressed in the residue definition, into the active substances. In the case of an unspecific residue definitions, there

[58]Except for the cases of dithiocarbamates and cypermethrin, where risk managers decision is still under discussion on the approval of the individual precursors.

are further distinctions on how the occurrence data is converted into one or more active substances. This depends on how likely is that all the active substances contribute to the occurrence data. If all the different active substances contribute, is known to be a *non-exclusive residue definition* (e.g. gamma and lambda-cyhalothrin). If contribution only comes from one of the active substances, is called *exclusive residue definition* (e.g. esfenvalerate/fenvalerate).

Regarding non-exclusive residue definition, as data on the proportions of conversion of the individual measurements and the active substance is not known to EFSA, a default proportion of 0.5 is assumed for all different conversions.

#### 5.1.1.4 | *Occurrence data*

The occurrence data collected under Article 31 of Regulation (EC) No 396/2005[9] are the most appropriate data available to EFSA for performing the probabilistic risk assessments. These data are obtained from the official control activities carried out in the EU Member States,*[1] Iceland and Norway and are reported to EFSA using the Standard Sample Description ver2 (SSD2) (EFSA, 2013). The occurrence data are collected at the level of residue definition (Section 5.1.1.3). The collected data after having been validated by EFSA, are integrated in the EFSA's Scientific Data Warehouse (sDWH). All occurrence data referring to the relevant food commodities (Section 5.1.1.1) and residue definitions (Section 5.1.1.3) were extracted from the sDWH. Only measurements validated under 2021, 2022 and 2023 sampling year, were included.

The following additional criteria were applied to the extracted data:

- Only samples resulting from the EU-coordinated control programme (EU MACP), national control programmes (MANCP)[59] or a combination of those were selected (i.e. SSD2 programme type codes K005A, K009A and K018A). Samples associated to increased control programmes (i.e. K019A) or any other type of programme were excluded as they were not considered to be representative of the market.
- Only samples obtained through objective or selective sampling[64] were retained (SSD2 sampling strategy codes ST10A and ST20A, respectively). Samples obtained through suspect sampling (ST30A), or any other type of sampling were not considered to be representative of the market and therefore excluded.

When the occurrence data were primarily reported for the RPC, samples for processed commodities were excluded and the assessment was based on the RPCs. However, when a sufficient number of samples for the processed foods were reported (or submitted), they were also retained in the assessment. The detailed list of the processed and unprocessed products retained for the assessment is reported in Table 2.

**TABLE 2** List of product treatments retained for the assessment.

| Prodcode[a] | PRODNAME[b] | PRODTREAT[c] | PRODTREAT_DESC[d] |
|---|---|---|---|
| P0110010A | Grapefruits | F28.A0C0S | PROCESS=Unprocessed |
| P0110020A | Oranges | F28.A07LN | PROCESS=Juicing |
| P0110020A | Oranges | F28.A0C0S | PROCESS=Unprocessed |
| P0110050A | Mandarins | F28.A0C0S | PROCESS=Unprocessed |
| P0130010A | Apples | F28.A0C0S | PROCESS=Unprocessed |
| P0130020A | Pears | F28.A0C0S | PROCESS=Unprocessed |
| P0140030A | Peaches | F28.A0C0S | PROCESS=Unprocessed |
| P0151010A | Table grapes | F28.A07KG | PROCESS=Drying (dehydration) |
| P0151010A | Table grapes | F28.A0C0S | PROCESS=Unprocessed |
| P0151020A | Wine grapes | F28.A0C00$F10.A0F2R | PROCESS=Winemaking,QUAL=White |
| P0151020A | Wine grapes | F28.A0C00$F10.A0F2S | PROCESS=Winemaking,QUAL=Red |
| P0151020A | Wine grapes | F28.A0C0S | PROCESS=Unprocessed |
| P0152000A | Strawberries | F28.A0C0S | PROCESS=Unprocessed |
| P0162010A | Kiwi fruits (green, red, yellow) | F28.A0C0S | PROCESS=Unprocessed |
| P0163020A | Bananas | F28.A0C0S | PROCESS=Unprocessed |
| P0211000A | Potatoes | F28.A0C0S | PROCESS=Unprocessed |
| P0213020A | Carrots | F28.A0C0S | PROCESS=Unprocessed |
| P0220020A | Onions | F28.A0C0S | PROCESS=Unprocessed |
| P0231010A | Tomatoes | F28.A0C0S | PROCESS=Unprocessed |

[59]Sensitive analysis conducted under the cumulative risk assessment (EFSA, 2020b), has evidenced that selecting programme type 'Official (National) programme' (K005A) or sample strategy 'Selective sampling' (ST20A), does not have significant differences from selection only programme type 'Official (EU) programme' (K009A) or sample strategy 'objective sampling' (ST10A). Thus, samples were able to be pooled under the exposure assessment without specific likelihood of biasing the analysis.

**TABLE 2** (Continued)

| Prodcode[a] | PRODNAME[b] | PRODTREAT[c] | PRODTREAT_DESC[d] |
|---|---|---|---|
| P0231020A | Sweet peppers/bell peppers | F28.A07KG$F28.A07LA | PROCESS=Drying (dehydration),PROCESS=Grinding / milling / crushing |
| P0231020A | Sweet peppers/bell peppers | F28.A0C0S | PROCESS=Unprocessed |
| P0231030A | Aubergines/eggplants | F28.A0C0S | PROCESS=Unprocessed |
| P0232010A | Cucumbers | F28.A0C0S | PROCESS=Unprocessed |
| P0232030A | Courgettes | F28.A0C0S | PROCESS=Unprocessed |
| P0233010A | Melons | F28.A0C0S | PROCESS=Unprocessed |
| P0241010A | Broccoli | F28.A0C0S | PROCESS=Unprocessed |
| P0241020A | Cauliflowers | F28.A0C0S | PROCESS=Unprocessed |
| P0242020A | Head cabbages | F28.A0C0S | PROCESS=Unprocessed |
| P0251020A | Lettuces | F28.A0C0S | PROCESS=Unprocessed |
| P0252010A | Spinaches | F28.A07KQ | PROCESS=Freezing |
| P0252010A | Spinaches | F28.A0C0S | PROCESS=Unprocessed |
| P0260010A | Beans (with pods) | F28.A0C0S | PROCESS=Unprocessed |
| P0260040A | Peas (without pods) | F28.A0C0S | PROCESS=Unprocessed |
| P0270060A | Leeks | F28.A0C0S | PROCESS=Unprocessed |
| P0280010A | Cultivated fungi | F28.A0C0S | PROCESS=Unprocessed |
| P0300010A | Beans (dry) | F28.A0C0S | PROCESS=Unprocessed |
| P0401070A | Soyabeans | F28.A0C0S | PROCESS=Unprocessed |
| P0402010A | Olives for oil production | F28.A0C02$F02.A068M | PROCESS=Oil production, PART=Vegetable fats and oils (as part-nature) |
| P0402010A | Olives for oil production | F28.A0C0S | PROCESS=Unprocessed |
| P0500010A | Barley | F28.A0C0S | PROCESS=Unprocessed |
| P0500050A | Oat | F28.A07LH | PROCESS=Flattening / rolling |
| P0500050A | Oat | F28.A0C0S | PROCESS=Unprocessed |
| P0500060A | Rice | F28.A0C0S | PROCESS=Unprocessed |
| P0500070A | Rye | F28.A0C03$F02.A067Z$F10.A06HR | PROCESS=Grain milling, PART=Flour/meal or finely ground powder (as part-nature),QUAL=Integral / not refined |
| P0500070A | Rye | F28.A0C0S | PROCESS=Unprocessed |
| P0500090A | Wheat | F28.A0C03$F02.A067Z$F10.A06HR | PROCESS=Grain milling, PART=Flour/meal or finely ground powder (as part-nature),QUAL=Integral / not refined |
| P0500090A | Wheat | F28.A0C03$F02.A067Z$F10.A07XK | PROCESS=Grain milling, PART=Flour/meal or finely ground powder (as part-nature),QUAL=White/ refined |
| P0500090A | Wheat | F28.A0C0S | PROCESS=Unprocessed |
| PX100001A | Foods for infants and young children other than processed cereal-based foods | F28.A0C0R | PROCESS=Processed |
| PX100003A | Processed cereal-based foods for infants and young children | F28.A0C0R | PROCESS=Processed |
| PX100004A | Infant formulae | F28.A0C0R$F03.A06JD | PROCESS=Processed, STATE=Powder |
| PX100005A | Follow-on formulae | F28.A0C0R$F03.A06JD | PROCESS=Processed, STATE=Powder |

[a]Code of the raw primary commodity as defined by EFSA's harmonised terminology for scientific research (MATRIX catalogue; EFSA, 2024g).

[b]Name of the raw primary commodity as defined by EFSA's harmonised terminology for scientific research (MATRIX catalogue; EFSA, 2024g).

[c]Codes of FoodEx2 facet describing the processing technique, including additional descriptors such as qualitative information, part consumed or the nature of the food (MTX catalogue; EFSA, 2015b).

[d]Names of FoodEx2 facet describing the processing technique, including additional descriptors such as qualitative information, part consumed or the nature of the food (MTX catalogue; EFSA, 2015b).

- Only measurements reported as a numerical (i.e. quantifiable) value or as a non-quantified value were considered useful for the assessment (SSD2 resType codes VAL and LOQ). Other result types were not considered valid and therefore excluded.

- Only measurements reported for the enforcement residue definition that was applicable at the time of sampling, or for the most complete subset of that enforcement residue definition were used (SSD2 paramType codes P004A and P005A). Measurements referring to parts of the residue definition (i.e. P002A) were excluded from the assessment.
- When a LOQ value for a complex residue definition could not be reported by the reporting countries, the SANCO/12574/2014[60] document was applied and the summed LOQ recalculated.
- When the LOQ value for a measurement was found to be more than 100 times higher compared to the median LOQ of all measurements referring to the same combination of commodity and residue definition, the measurement was no longer considered valid and excluded from the assessment.
- Measurements below the LOQ (i.e. left-censored data) are imputed with ½ LOQ for a number of samples equal to the number of samples with a quantified result (i.e. above the LOQ) for the same substance/commodity combination, provided that the use of the substance is authorised for that commodity (see Section 5.1.2.2) within the last year (i.e. 2023). For the non-authorised uses, results below the LOQ were imputed with a zero (i.e. assuming a no-residue situation). EFSA acknowledges that this approach may generate a bias; still this assumption better represents the market real state compared to the imputation considered in the past report (i.e. setting ½ LOQ to all results below the LOQ for a given substance, when at least one result was quantified) (EFSA, 2024c).
- When several measurements with overlapping residue definitions were reported on the same sample, only the measurement referring to the most recent enforcement residue definition was retained for assessment (e.g. in samples of infants and young children where different commodities can coexist, each with a different residue definition).

#### 5.1.1.5 | *Consumption data*

The EFSA Comprehensive European Food Consumption Database (Comprehensive Database) provides a compilation of existing national information on food consumption at individual level. Details on how the Comprehensive Database is used are published in the Guidance of EFSA (EFSA, 2011). Data reported in the Comprehensive Database may either refer to raw primary commodities (RPCs), RPC derivatives (i.e. single-component foods altered by processing) or composite foods (i.e. multicomponent). Consumption data for RPC derivatives and composite foods, however, cannot be used in exposure assessments when the occurrence data are reported for the RPCs.

To address the above issue, EFSA transformed the Comprehensive Database into a new RPC Consumption Database by means of the RPC model (EFSA, 2019a). This model converts the consumption data for composite foods or RPC derivatives into their equivalent quantities of RPCs, except foods for infants and young children.[61] The RPC model was applied to the Comprehensive Database as of 31 March 2018, when it contained results from different dietary surveys carried out in 23 different Member States covering 94,523 individuals.

Furthermore, in order to cover as many populations as possible without compromising the reliability of intake estimates at high percentiles of the distribution, only the dietary surveys with more than 300 survey consumers were retained, covering 17 different countries.

- Toddlers[62]: Bulgaria, Denmark, Finland, Germany, Netherlands.
- Other children[63]: Belgium, Bulgaria, Czechia, Finland, France, Germany, Greece, Netherlands, Spain, Sweden.
- Adults[64]: Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Netherlands, Romania, Spain, Sweden.

The full dataset is not reported in the remit of this report. However, the description of the variables is provided in Table 3.

**TABLE 3** Description of the variable contained in the food consumption database used.

| Name | Label | Description |
|---|---|---|
| Country | Country | Country where the dietary survey took place as defined by EFSA's harmonised terminology for scientific research (COUNTRY catalogue; EFSA, 2024g). |
| Survey | Survey | Acronym of the dietary survey |
| PopClass | Population class | Participant's population class, based on age, as defined by EFSA's harmonised terminology for scientific research (AGECLS catalogue; EFSA, 2024g). |
| ORSUBID | Consumer ID | A pseudonymised consumer ID number generated by EFSA upon receipt of the data |
| Weight | Body weight | Bodyweight of the consumer (in kg) |

[60]Working document on the summing up of LOQs in case of complex residue definitions. SANCO/12574/2014 rev.5.1, 1 December 2015 (European Commission, 2018).

[61]Consumption data for foods for infants and young children were not converted to their equivalent amounts of RPC because, in this case, chemical occurrence data are collected for the processed food commodity.

[62]The population class 'toddlers' refers to participants from ≥ 12 months to < 36 months old.

[63]The population class 'other children' refers to participants from ≥ 36 months to < 10 years old.

[64]The population class 'adults' refers to participants from ≥ 18 years to < 65 years old.

**TABLE 3** (Continued)

| Name | Label | Description |
|---|---|---|
| ndays | Number of survey days | Number of days on which the participant's consumption was surveyed |
| day | Survey day | Ordinal number of the day on which the participant's consumption was surveyed |
| prodCode | RPC code | Code of the raw primary commodity as defined by EFSA's harmonised terminology for scientific research (MATRIX catalogue; EFSA, 2024g). |
| prodName | RPC name | Name of the raw primary commodity as defined by EFSA's harmonised terminology for scientific research (MATRIX catalogue; EFSA, 2024g). |
| FoodEx2_Facets | Processing code | FoodEx2 facet code describing the processing technique, including additional descriptors such as qualitative information, part consumed or the nature of the food (EFSA, 2015b). |
| RPCD_amount | RPCD amount | Amount of raw primary commodity derivative (in grams) |
| RPC_amount | RPC amount | Amount of raw primary commodity (in grams) |

## 5.1.2 | Secondary input data

### 5.1.2.1 | *Maximum residue level*

Certain assumptions on the authorised uses require information on the MRLs. MRLs may have been modified throughout the reference period (i.e. years 2021–2023). In order to obtain a single list of MRLs, EFSA decided to use the MRLs as applicable on 31 December 2023 (i.e. the end of the current reference period). Hence it was assumed that those MRLs were applicable during the entire reference period, regardless of whether the MRL or residue definition may have changed during that period.

MRLs for the relevant food commodities (Section 5.1.1.1) and enforcement residue definitions (Section 5.1.1.3) were extracted from the EU Pesticides Database[10] and organised in a data format that could be used directly for exposure assessment.

### 5.1.2.2 | *Authorised uses*

In some cases, the imputations and simulations performed on the occurrence data rely on the authorisations for use of plant protection products containing the active substance(s) (Section 5.1.1.4). While the approval status of an active substance under Regulation (EC) No 1107/2009 is regulated at EU level, the authorisations for plant protections products (i.e. formulated products containing the active substances) are delivered at national level within the EU Member States. A centralised database compiling these national authorisations is not yet available at EU level.

National authorisations can be reported to EFSA under Regulation (EC) No 396/2005, either for an MRL application under Article 10 or for an MRL review under Article 12. There is, however, no legal obligation to systematically report all national authorisations in real time to EFSA. Therefore, a comprehensive overview of all pesticides authorisations within the EU is not available to EFSA. However, a tentative list of authorised uses was elaborated according to the following principles:

- When the MRL for a given combination of an active substance and RPC was not set at the LOQ (Section 5.1.2.1), the active substance was assumed to be authorised for use on that specific commodity. This assumption also accounted for uses authorised outside the EU (i.e. import tolerance) for which treated products may be placed on the EU market. Furthermore, this assumption concerns non-approved substances in the EU, including persistent organic pollutants, for which temporary MRLs on certain crops are set above the LOQ due to their long degradation period, and thus, considered authorised.
- When non-LOQ MRLs referred to *unspecific residue definitions* (i.e. including or applying to multiple active substances, see Section 5.1.1.3), only the substances approved under Regulation (EC) No 1107/2009 were assumed to be authorised for use on that crop. If none of the active substances was approved, it was assumed that any active substance may be authorised for use outside the EU.
- For the group of dithiocarbamates, which comprises six substances, Regulation (EC) No 396/2005 provides specific information on the active substances that were considered for deriving the MRLs. Authorised uses for these active substances were identified according to the legislation in place at the time of sampling.
- For the group of cypermethrins, currently under discussion by risk managers, different scenarios were built, covering also the case in which quantified residues would consist only of the more toxic and non-approved in EU alpha-cypermethrin.
- When non-LOQ MRLs refer to an active substance that is not renewed under Regulation (EC) No 1107/2009 (e.g. fenvalerate) but may still occur as a metabolite from another active substance (esfenvalerate) still approved, the MRL was not considered to represent an authorised use of the active substance that was no longer renewed.
- For the remaining combinations of active substance and RPC (i.e. where the MRL was set at LOQ), EFSA screened the relevant reasoned opinions issued under Article 12 and the subsequent reasoned opinions issued under Article 10, both under Regulation (EC) No 396/2005.[9] Any authorised use reported in those reasoned opinions was recorded. Otherwise,

it was assumed that the use was not authorised. The combinations that have been considered authorised are listed in the Appendix B – Annex III – Table 3.4.

#### 5.1.2.3 | *Processing factors*

Occurrence data for pesticide residues are collected at the level of the RPC (Section 5.1.1.4). Food consumption data may be collected at the level of RPC, RPC derivative or composite food. For the purpose of this assessment, consumption data for composite foods and RPC derivatives were converted into their equivalent quantities of RPCs (Section 5.1.1.5) except if the occurrence data were already reported as RPC derivative (e.g. juice, olive oil). In latter, a minimum number of 10 measurements is required in the RPC derivative, representing at least 95% of all the substances analysed in the RPC.

Combining occurrence and consumption data at RPC level implies that all residues present in the RPC will reach the end consumer. This assumption, however, is conservative. In reality, residue concentrations will most likely change due to processing, such as peeling, washing, cooking etc.

The effect of processing is usually addressed by means of processing factors. A processing factor accounts for the change in residue concentrations and is specific to each RPC, processing type and active substance. Processing factors are quantified by dividing the residue concentration in the processed commodity by the residue concentration in the raw commodity.

The European database on processing factors is the most recent and the most comprehensive compilation of processing factors currently available at EU level (Zincke et al., 2022). Processing factors for the active substances and RPCs under assessment were extracted from this database according to the following criteria:

- For each active substance, RPC and processing technique, only the median processing factor was extracted.
- Only the processing factors indicated as reliable, or indicative were extracted. Processing factors indicated as unreliable were excluded from the assessment.

Processing techniques reported in the processing factor database were then compared to the processing techniques reported in the RPC consumption dataset. The processing techniques from both databases were matched according to the following principles:

- When a generic processing technique was reported in the RPC consumption database (e.g. juice) while more specific processing techniques were reported in the processing factor database (e.g. pasteurised juice and unpasteurised juice), the specific processing technique with the highest processing factor was selected.
- When a specific processing technique was reported in the RPC consumption database (e.g. mashed potato) while a more generic processing technique was reported in the processing factor database (e.g. boiled potato), the generic processing factor was applied to the specific processing techniques.
- Processing factors were extrapolated between raw primary commodities with similar properties (i.e. oranges and mandarins, apples and pears, table and wine grapes, wheat and rye grain).
- Processing factors for peeling were applied to the corresponding fruit with inedible peel, even when the processing technique was not specified in the RPC consumption database (i.e. grapefruits, oranges, mandarins, bananas and melons).
- When more than one processing factor was reported for the same RPC and processing technique, which differs for the type of application (e.g. pre-harvest treatment / post-harvest treatment), the highest processing factor was selected.

The European database on processing factors is aimed to be the most comprehensive compilation of processing factors currently available at EU level. However, this compilation is limited to all processing factors having been evaluated by EFSA until 31 August 2023, in its second update. Meanwhile, additional processing factors may have been derived in the framework of Regulation (EC) No 396/2005 and Regulation (EC) No 1107/2009. Additional processing factors evaluated by EFSA until December 2024 will be integrated in future updates of the European PF database publicly available in Zenodo.[65]

The list of PFs used in this assessment is available in the Annex III – Table 3.4.

#### 5.1.2.4 | *Variability factors*

The occurrence data used for the assessment are related to the average concentrations in composite laboratory samples (Section 5.1.1.4). Consumers on the other hand are exposed to individual units of the commodity. Acute exposure assessments for pesticide residues should account for variability among the single commodity units of the composite laboratory samples. To account for this variability, several parameters are required for each food commodity.

- Unit weight: estimated weight for a single commodity unit.
- Units per sample: estimated number of units within a composite laboratory sample.

[65] https://doi.org/10.5281/zenodo.1488652.

- Variability factor (VF): expected variability among the single unit concentrations, which is defined as the ratio between the 97.5th percentile and mean of the distribution of unit concentrations.

Unit weights for each commodity were retrieved from the Pesticide Residues Intake Model rev. 3.0 (EFSA, 2018a). Residue concentrations may vary among the individual units, referred to as unit-to-unit variability. For RPCs that have a unit weight lower than 25g and for processed foods that were subject to blending or bulking, the unit-to-unit variability is not considered relevant since the residue concentration in the composite laboratory sample is expected to reflect the residue concentration in the portion that would be consumed (FAO, 2003).

The number of units per sample was obtained from Commission Directive 2002/63/EEC,[66] establishing community methods of sampling for the official control of pesticide residues in and on products of plant and animal origin. This directive defines a minimum weight and a minimum number of units for composite laboratory samples of each food category. Hence, the minimum number of units (as defined by Directive 2002/63/EEC) was used, unless the minimum sample weight divided by the corresponding unit weight was higher. In that case, the latter calculated value (rounded up to the next integer) was retained. The VFs were also retrieved from the Pesticide Residues Intake Model (PRIMo) rev. 3.0 (EFSA, 2018a).

While a fixed VF is usually applied for acute deterministic calculations, for probabilistic exposure assessment the use of a distribution of unit concentrations is considered more adequate than using a fixed VF. Therefore, unit-to-unit variability is modelled using a beta distribution, which can be bounded between 0 and an upper limit. If the average concentration in a composite sample is normalised to 1, the concentration in a single unit can never be higher than the number of units within the composite sample (assuming all other units have a concentration of zero). Hence, for each RPC with a unit weight exceeding 25g, the beta distribution was parametrised with the following restrictions.

- Lower bound = 0.
- Mean = 1.
- 97.5th percentile = VF.
- Upper bound = number of units per sample.

Stochastic VFs can then be drawn from the beta distribution and multiplied with the composite sample concentration to obtain a plausible estimate of the unit concentration. When the portion consumed by an individual is smaller than a single unit, the stochastic VF is directly applicable to the consumed portion. When the consumed portion is composed of multiple units however, multiple stochastic VFs will be drawn from the same beta distribution to estimate concentration in the whole portion consumed. Therefore, the concentration in the whole portion is estimated by multiplying the sample concentration with a weighted VF, which is calculated as follows.

$$\mathrm{WVF} = \mathrm{SVF}_n \qquad \text{if } n = 1$$

$$\mathrm{WVF} = \frac{\left(\sum_{i=1}^{n-1} \mathrm{SVF}_i\right) + \mathrm{SVF}_n \cdot \left(n_0 - n + 1\right)}{n_0} \qquad \text{if } n > 1$$

where WVF is the weighted VF;
$\mathrm{SVF}_i$ is the stochastic VF drawn for unit $i$;
$n_0$ is the estimated number of units within the consumed portion (unrounded), assuming the unit weights retrieved from PRIMo rev. 3.0 (EFSA, 2018a);
$n$ is the number of stochastic VFs to be drawn (i.e. ceiling of $n_0$).

In Table 4 the stochastic VFs parameters are shown for each RPC selected for the probabilistic risk assessment. If the information is missing, it means that the unit-to-unit variability is not relevant.

**TABLE 4** Variability factor parameters.

| prodCode[1] | prodName[2] | Cat_2002_63_EC[3] | Samp weight[4] | Minunits[5] | UnitWeight[6] | NrUnits[7] | VF[8] | $\alpha$[9] | $\beta$[10] |
|---|---|---|---|---|---|---|---|---|---|
| P0110010A | Grapefruits | Large, 250 g or more | 2000 | 5 | 270.5 | 8 | 5 | 0.341154 | 2.388078 |
| P0110020A | Oranges | Medium, 25 to 250 g | 1000 | 10 | 160 | 10 | 7 | 0.158731 | 1.428581 |
| P0110050A | Mandarins | Medium, 25 to 250 g | 1000 | 10 | 100 | 10 | 7 | 0.158731 | 1.428581 |

(Continues)

[66]Commission Directive 2002/63/EC of 11 July 2002 establishing Community methods of sampling for the official control of pesticide residues in and on products of plant and animal origin and repealing Directive 79/700/EEC. OJ L 187, 16.7.2002, p. 30–43.

**TABLE 4** (Continued)

| prodCode[1] | prodName[2] | Cat_2002_63_EC[3] | Samp weight[4] | Minunits[5] | UnitWeight[6] | NrUnits[7] | VF[8] | $\alpha$[9] | $\beta$[10] |
|---|---|---|---|---|---|---|---|---|---|
| P0130010A | Apples | Medium, 25 to 250 g | 1000 | 10 | 112 | 10 | 7 | 0.158731 | 1.428581 |
| P0130020A | Pears | Medium, 25 to 250 g | 1000 | 10 | 206.5 | 10 | 7 | 0.158731 | 1.428581 |
| P0140030A | Peaches | Medium, 25 to 250 g | 1000 | 10 | 127.6 | 10 | 7 | 0.158404 | 1.425633 |
| P0151010A | Table grapes | Large, 250 g or more | 2000 | 5 | 581.55 | 6 | 5 | 0.248312 | 1.241558 |
| P0162010A | Kiwi fruits | Medium, 25 to 250 g | 1000 | 10 | 83 | 13 | 7 | 0.184385 | 2.21262 |
| P0163020A | Bananas | Medium, 25 to 250 g | 1000 | 10 | 100 | 10 | 7 | 0.158731 | 1.428581 |
| P0211000A | Potatoes | Medium, 25 to 250 g | 1000 | 10 | 216 | 10 | 7 | 0.158731 | 1.428581 |
| P0213020A | Carrots | Medium, 25 to 250 g | 1000 | 10 | 80 | 13 | 7 | 0.184385 | 2.21262 |
| P0220020A | Onions | Medium, 25 to 250g | 1000 | 10 | 105.8 | 10 | 7 | 0.158731 | 1.428581 |
| P0231010A | Tomatoes | Medium, 25 to 250 g | 1000 | 10 | 142.5 | 10 | 7 | 0.158731 | 1.428581 |
| P0231020A | Peppers | Medium, 25 to 250g | 1000 | 10 | 154.9 | 10 | 7 | 0.158731 | 1.428581 |
| P0231030A | Aubergines (egg plants) | Large, 250 g or more | 2000 | 5 | 271 | 8 | 5 | 0.341154 | 2.388078 |
| P0232010A | Cucumbers | Large, 250 g or more | 2000 | 5 | 411.4 | 6 | 5 | 0.248312 | 1.241558 |
| P0232030A | Courgettes | Medium, 25 to 250g | 1000 | 10 | 114 | 10 | 7 | 0.158731 | 1.428581 |
| P0233010A | Melons | Large, 250 g or more | 2000 | 5 | 540 | 6 | 5 | 0.248312 | 1.241558 |
| P0241010A | Broccoli | Medium, 25 to 250 g | 1000 | 10 | 186 | 10 | 7 | 0.158731 | 1.428581 |
| P0241020A | Cauliflower | Large, 250 g or more | 2000 | 5 | 689.9 | 6 | 5 | 0.248312 | 1.241558 |
| P0242020A | Head cabbage | Large, 250 g or more | 2000 | 5 | 1281.9 | 6 | 5 | 0.248312 | 1.241558 |
| P0251020A | Lettuce | Large, 250g or more | 2000 | 5 | 534.7 | 6 | 5 | 0.248312 | 1.241558 |
| P0270060A | Leek | Medium, 25 to 250 g | 1000 | 10 | 168.8 | 10 | 7 | 0.158731 | 1.428581 |
| P0280010A | Cultivated funghi | Medium, 25 to 250 g | 1000 | 10 | 25 | 40 | 7 | 0.227164 | 8.859387 |
| P0300010A | Beans (dry) | | | | | | 1 | | |

Abbreviation: N/A, Not Applicable.

[1]Code of the RPC as defined by EFSA's harmonised terminology for scientific research (MATRIX catalogue; EFSA, 2024g).

[2]Name of the RPC as defined by EFSA's harmonised terminology for scientific research (MATRIX catalogue; EFSA, 2024g).

[3]Commodity classification defined by Table 4 of the Annex to Commission Directive 2002/63/EC.

[4]Minimum size of each laboratory sample (expressed in g) defined by Table 4 of the Annex to Commission Directive 2002/63/EC.

[5]Minimum size of each laboratory sample (expressed in number of units) defined by Table 4 of the Annex to Commission Directive 2002/63/EC.

[6]Estimated weight (expressed in g) for a single commodity unit as reported in the Pesticide Residues Intake Model (rev. 3) (EFSA, 2018a).

[7]Estimated number of units required to obtain the minimum size of a laboratory sample, both in terms of weight and number of units.

[8]Default VF as reported in the Pesticide Residues Intake Model (rev. 3) (EFSA, 2018a). This factor represents the variability among the single unit concentrations, which is defined as the ratio between the 97.5th percentile and mean of the distribution of unit concentrations.

[9]Computed $\alpha$ parameter of the beta distribution.

[10]Computed $\beta$ parameter of the beta distribution.

#### 5.1.2.5 | *Processing types*

Processing types were looked at in the acute assessment. Variability among the single commodity units of the composite laboratory samples is not relevant when the food consumed is subject to processing techniques that involve bulking and blending.

Therefore, all processing techniques reported in the RPC consumption data (Section 5.1.1.5) were extracted and the processes that normally involve blending or bulking identified. Typically, these are processing techniques performed at industrial level (e.g. milling, oil production, etc.). Household processes, however, were assumed not to involve any bulking or blending (e.g. boiling, stewing, etc.). Although juicing may also be carried out at household level, it is assumed that most fruit juices are produced at industrial level.

#### 5.1.2.6 | *Health-based guidance values*

The HBGVs selected were the Acute Reference Dose (ARfD, in mg of residue/kg bw) for acute (short-term) assessments and the (ADI, in mg of residue/kg bw per day) for chronic (long-term) assessments.

Both acute and chronic assessments have been categorised depending on the type of HBGV used:

- If it was established by EFSA under Regulation (EC) No 1107/2009 or Regulation (EC) No 396/2005, the outcome was considered 'primary' and is presented in Annex IV for acute and Annex VI for chronic.
- If the active substance was never reviewed by EFSA, but other bodies (e.g. EPA, JMPR) derived a HBGV (even if only a tolerable daily intake (TDI), in mg of residue/kg bw per day), the assessment was considered 'tentative'. Tentative outcome can be consulted in Annex V for acute and Annex VII for chronic.
- In case it was agreed that an ARfD/ADI was not needed, no acute/chronic risk assessment was performed.
- In case no HBGV was available at the time of the assessment, no risk assessment was possible. This was the case for 22 substances. These were: azinphos-ethyl, bromide ion,[67] captafol, chloroxuron, copper,[68] cycluron, ethylene oxide, fenobucarb, fluacrypyrim, isocarbophos, isoprocarb, matrine, mepronil, metominostrobin, nitenpyram, nitrofen, oxymatrine, pirimiphos-ethyl, promecarb, pyrifenox, thiophanate-ethyl and trimethyl-sulfonium cation.

The list of HBGVs under each category, is available in the Appendix B – Annex III – Table 3.2.

## 5.2 | Methodology

The methodology used is presented in Figure 1. This figure presents the general process used in probabilistic dietary exposure assessment to single substances, both the acute and chronic scenarios.

[67]Bromide, for which HBGVs have been recently reviewed was among these 22 active substances. However, EFSA Scientific Committee (EFSA, 2025a) recommended generating data to allow robust dietary exposure assessments to be conducted. Thus, EFSA will wait until risk manager decision is provided.

[68]Copper, for which an ADI has been recently stablished was among these 22 active substances. However, the exposure estimate performed by the EFSA scientific committee, including sources other than pesticides followed a slightly different exposure approach. EFSA considers postponing the assessment until the final methodology is agreed by risk managers.

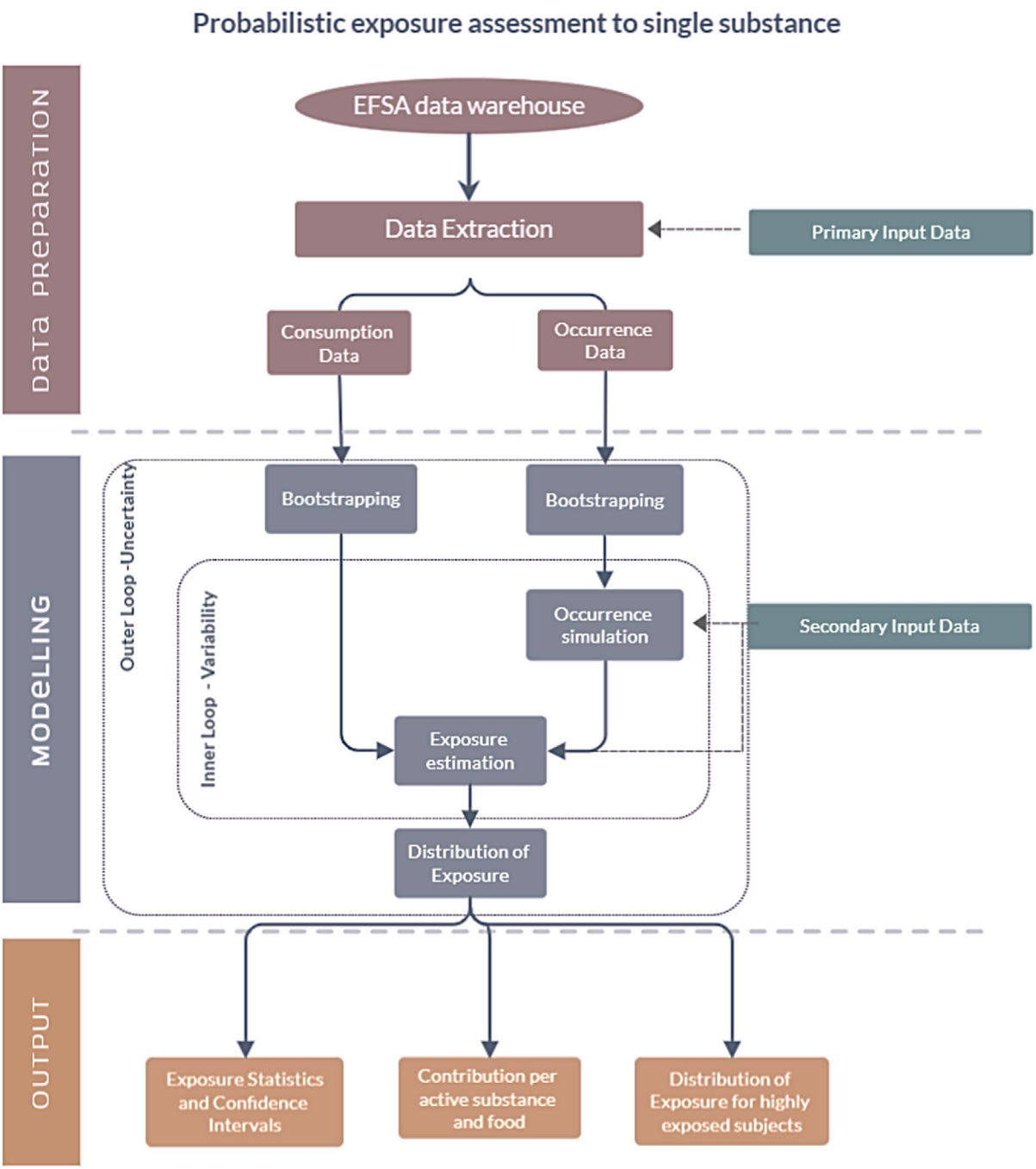


**FIGURE 1** General process implemented for the probabilistic estimation of exposure to single substances.

The primary input data requires the occurrence data (i.e. the pesticide residues measured in foods during the years 2021, 2022 and 2023) and food consumption data (i.e. the types and amounts of those foods consumed in a person's diet). These data are extracted from the EFSA Data Warehouse for the relevant food commodities, active substances, associated residue definitions and dietary surveys. See Section 5.1.1 for a full description of the data used.

Within the inner loop execution, occurrence data are subject to several simulations and imputations. These adjustments are intended to account for uncertainties and missing information in the occurrence data set (e.g. unspecific measurements, measurements below the analytical LOQ, etc.).

The exposure modelling also accounts, where possible, for the effect of processing prior to consumption, either by using available monitoring data in the processed food, or by incorporation of a specific processing factor. When information on the effect of processing was not available (i.e. no PF available), it was assumed that all residues present in the RPC will reach the end consumer without any loss of residues (i.e. PF = 1), which is generally expected to overestimate the actual exposure.

Acute and chronic calculations present differences in the inner loop execution:

### Acute methodology

The acute probabilistic exposure to pesticide residues was assessed in accordance with the guidance on probabilistic modelling of dietary exposure to pesticide residues for the annual review of monitoring data (EFSA, 2012a). Acute exposure

estimates were obtained using a two-dimensional method where variability of exposure within the population is modelled by means of an inner loop execution. The consumption data and adjusted occurrence data are then used to estimate acute dietary exposures using an empirical Monte Carlo simulation (i.e. with 100,000 iterations), by assigning to each food consumption event of an individual, a random sample from the occurrence data[69] for the same food category consumed. This results in a distribution that represents the variability of acute exposures within the population. The different simulations performed during the inner loop execution require the use of additional data, referred to as secondary input data (processing factors (PFs), variability factors, processing types, MRL and authorisation status).

The acute dietary exposure accounts for the unit-to-unit variability for all food commodities which may contain non-uniform residue distributions (see Section 5.1.1). As described above, the unit-to-unit variability is modelled using a beta distribution.

All acute exposure estimates (e.g. percentiles of the distribution) are expressed as percentage of ARfD. Hence, a calculated value greater than 100% suggests that the estimated exposure exceeds the ARfD for that active substance. This also allows to calculate within each subpopulation the percentage of individual consumer-day that have an exposure exceeding the ARfD. Next year the assessment of the risks to only the high exposure events will be performed.

**Chronic methodology**

Chronic estimates were also obtained using a two-dimensional method where variability of exposure within the population is modelled by means of an inner loop execution However, whereas acute exposure (within the inner loop execution) is modelled through a Monte Carlo simulation, the chronic exposure is modelled through the observed individual means (OIM) approach (EFSA, 2012b). This method uses the mean consumption over the survey days of each individual to estimate the individuals' long-term consumption for each food commodity. Individuals who participated for only 1 day of the dietary survey were excluded because at least two survey days per individual are normally required to assess repeated exposure (EFSA, 2011). Using the individuals' bodyweight and the mean occurrence values calculated for each food commodity, the individuals' chronic exposures resulting from each food commodity are calculated and added to obtain the individuals' total chronic exposure.

Chronic risks depend on the average chronic exposure, and not on single exposure events, as this is the case for acute effects. Hence, chronic exposure assessments rely on the assumption that all commodities contain an average residue concentration, calculated from the available monitoring data.

Exposure estimates (e.g. percentiles of the distribution) are then expressed as percentage of ADI. Hence, a calculated exposure greater than 100% suggests that the estimated exposure exceeds the ADI for that active substance, and a health risk cannot be excluded. This also allows to calculate within each subpopulation the percentage of consumers that have an exposure exceeding the ADI.

To quantify the confidence around the acute and chronic exposure distributions, the model uses an outer loop execution where the inner loop execution is repeated several times. Prior to each execution, the original consumption and occurrence data sets are modified by means of bootstrapping, a random resampling technique for quantifying uncertainty. By repeating the inner loop execution multiple times (i.e. 100), the model produces multiple distributions of exposure. The differences between those distributions reflects the impact of the sampling variability, i.e. the uncertainty depending on the sample size.

During the output preparation, summary statistics are generated for the multiple distributions, resulting in multiple estimates for each percentile of exposure. The *outer loop execution* allows to estimate the 95% confidence intervals around the calculated percentage of individual-days exceeding the ARfD (in the acute methodology) or the individuals exceeding the ADI (for chronic scenario). For these percentages, the lower bound (LB, i.e. 2.5th percentile), middle bound (MB, i.e. 50th percentile) and upper bound (UB, i.e. 97.5th percentile) are estimated.

Subsequently, to identify risk drivers, details on the highly exposed consumers are extracted (i.e. consumers with exposure exceeding the 99th percentile) and average contributions per food commodity are calculated.

The overall risk assessment formula is expressed as the hazard quotient (HQ) in percentage.

For the acute assessment:

$$HQ_{ids} = \sum_{c \in Commodities} \sum_{p \in Processes_c} \begin{cases} \dfrac{RPCD_{idcp} \cdot X_{idcps}}{BW_i \cdot ARfD_s \cdot 10^3}; & \text{if Case 1} \\ \dfrac{RPC_{idcp} \cdot X_{idcps} \cdot WVF_{idcps}}{BW_i \cdot ARfD_s \cdot 10^3}; & \text{if Case 2} \\ \dfrac{RPCD_{idcp} \cdot PF_{cps} \cdot X_{idcps} \cdot WVF_{idcps}}{BW_i \cdot ARfD_s \cdot 10^3}; & \text{if Case 3} \end{cases}$$

*Case 1*: occurrence data on the commodity *c* with the processing type *p* is retained for the assessment.

[69]Under the acute assessment, the input value of the occurrence is the value reported for each result (not the highest value as it was the case in previous reports).

*Case 2*: occurrence data on the commodity *c* with the processing type *p* is not retained for the assessment and a $PF_{cps}$ is not available.

*Case 3*: occurrence data on the commodity *c* with the processing type *p* is not retained for the assessment and a $PF_{cps}$ is available.

Where:

- $HQ_{ids}$ is the hazard quotient of individual *i* on day *d* for the substance *s*;
- Commodities is the set of raw primary commodities as listed in Table 1 (Section 5.1.1.1);
- $Processes_c$ is the set of processes related to the commodities *c* for which specific consumption data is retained; the subset of processes for which occurrence data is also retained for the assessment is listed in Table 2 (Section 5.1.1.4);
- $RPC_{idcp}$ is the amount of commodity *c* with processing type *p* consumed by individual *i* on day *d*, expressed in g of RPC;
- $RPCD_{idcp}$ is the amount of commodity *c* with processing type *p* consumed by individual *i* on day *d*, expressed in g of RPC derivative;
- BW is the body weight of individual *i*, expressed in kg;
- $WVF_{idcps}$ is the weighted VF that was randomly assigned to individual *i* on day *d* for substance *s* in commodity *c* with processing type *p*;
- $PF_{cps}$ is the Processing Factor for substance *s* in commodity *c* with processing type *p*;
- $ARfD_s$ is the Acute Reference Dose for substance *s*, expressed in mg/kg body weight;
- $X_{idcps}$ is the imputed concentration of the substance *s* in a sample that was randomly assigned to individual *i* on day *d* for commodity *c* with processing type *p*, expressed in mg/kg, calculating $X_{idcps}$ depending on the type of case:

$$X_{idcps} = \begin{cases} VAL_{zs} \cdot MWF_s; & \text{if Case A} \\ \frac{1}{2}\left(VAL_{zs}\right) \cdot MWF_s; & \text{if Case B} \\ \frac{1}{2}LOQ_{zs} \cdot MWF_s; & \text{if Case C; for a random sample } z \in Samples_{cps} \\ \frac{1}{2}\left(\frac{1}{2}LOQ_{zs}\right) \cdot MWF_s; & \text{if Case D} \\ 0; & \text{if Case E} \end{cases}$$

*Case A:* if the result for *z* is quantified, and the assignment of the residue definition to the active substance is *exclusive* (Section 5.1.1.3).

*Case B:* if the result for *z* is quantified, and the assignment of the residue definition to the active substance is *not exclusive* (Section 5.1.1.3).

*Case C:* if the result for *z* is not quantified, and the sample is within the randomly select samples for which a positive concentration is imputed, and the assignment of the residue definition to the active substance is *exclusive* (Section 5.1.1.3).

*Case D:* if the result for *z* is not quantified, and the sample is within the randomly select samples for which a positive concentration is imputed, and the assignment of the residue definition to the active substance is *not exclusive* (Section 5.1.1.3).

*Case E:* if the result for *z* is not quantified, and the sample is not within the randomly select samples for which a positive concentration is imputed.

Where:

- $Sample_{cps}$ is the set of samples of commodities *c* with processing type *p* analysed for the substance *s;*
- $VAL_{zs}$ is the quantified concentration in the sample *z* for the substance *s*
- $LOQ_{zs}$ is the analytical Limit of Quantifications in the sample *z* for the substance *s;*
- $MWF_s$ is the Molecular Weight Factor from the residue definition analysed to the substance *s*.

The hazard quotient per individual i on day *d* for the substance *s* that are above 1, will result in the probability of exceedance the HBGV under the acute assessment.

For the chronic assessment:

$$HQ_{is} = \sum_{c \in Commodities} \sum_{p \in Processes_c} \begin{cases} \frac{RPCD_{icp} \cdot X_{cps}}{BW_i \cdot ADI_s \cdot 10^3}; & \text{if Case 1} \\ \frac{RPC_{icp} \cdot X_{icps}}{BW_i \cdot ADI_s \cdot 10^3}; & \text{if Case 2} \\ \frac{RPCD_{icp} \cdot PF_{cps} \cdot X_{icps}}{BW_i \cdot ADI_s \cdot 10^3}; & \text{if Case 3} \end{cases}$$

Case 1: occurrence data on the commodity c with the processing type p is retained for the assessment;

Case 2: occurrence data on the commodity c with the processing type p is not retained for the assessment and a $PF_{cps}$ is not available;

Case 3: occurrence data on the commodity c with the processing type p is not retained for the assessment and a $PF_{cps}$ is available.

Where:

- $HQ_{is}$ is the hazard quotient of individual *i* for the substance *s*;
- Commodities is the set of raw primary commodities as listed in Table 1 (Section 5.1.1.1);
- $Processes_c$ is the set of processes related to the commodities *c* for which specific consumption data is retained; the subset of processes for which occurrence data is also retained for the assessment is listed in Table 2 (Section 5.1.1.4);
- $RPC_{icp}$ is the average amount of commodity *c* with processing type *p* consumed by individual *i*, expressed in g of RPC; $RPC_{icp} = \sum_{d=1}^{n_{day}} RPC_{idcp}/n_{day_i}$
- $RPCD_{icp}$ is the average amount of commodity *c* with processing type *p* consumed by individual *i*, expressed in g of RPC derivative; $RPCD_{icp} = \sum_{d=1}^{n_{day}} RPCD_{idcp}/n_{day_i}$
- $n_{day_i}$ is the total number of days the individual *i* participated to the consumption survey
- BW is the body weight of individual *i*, expressed in kg;
- $WVF_{icps}$ is the weighted VF that was randomly assigned to individual *i* for substance *s* in commodity *c* with processing type *p*;
- $PF_{cps}$ is the Processing Factor for substance *s* in commodity *c* with processing type *p*;
- $ADI_s$ is Acceptable Daily Intake for substance *s*, expressed in mg/kg body weight day;
- $X_{cps}$ is the imputed average concentration of the substance *s* for commodity *c* with processing type *p*, expressed in mg/kg, calculating $X_{cps}$ depending on the type of case:

$$X_{cps} = \sum_{z \in Samples_{cps}} \begin{cases} VAL_{zs} \cdot MWF_s; & \text{if Case A} \\ \frac{1}{2}(VAL_{zs}) \cdot MWF_s; & \text{if Case B} \\ \frac{1}{2}LOQ_{zs} \cdot MWF_s; & \text{if Case C}/n_{Samples_{cps}} \\ \frac{1}{2}\left(\frac{1}{2}LOQ_{zs}\right) \cdot MWF_s; & \text{if Case D} \\ 0; & \text{if Case E} \end{cases}$$

Case A: if the result for *z* is quantified, and the assignment of the residue definition to the active substance is *exclusive* (Section 5.1.1.3).

Case B: if the result for *z* is quantified, and the assignment of the residue definition to the active substance is *not exclusive* (Section 5.1.1.3).

Case C: if the result for *z* is not quantified, and the sample is within the randomly select samples for which a positive concentration is imputed, and the assignment of the residue definition to the active substance is *exclusive* (Section 5.1.1.3).

Case D: if the result for *z* is not quantified, and the sample is within the randomly select samples for which a positive concentration is imputed, and the assignment of the residue definition to the active substance is *not exclusive* (Section 5.1.1.3).

Case E: if the result for *z* is not quantified, and the sample is not within the randomly select samples for which a positive concentration is imputed.

Where:

- $Sample_{cps}$ is the set of samples of commodities *c* with processing type *p* analysed for the substance *s;*
- $n_{Samples_s}$ is the number of samples in the set $Sample_{cps}$;

- $VAL_{zs}$ is the quantified concentration in the sample *z* for the substance *s;*
- $LOQ_{zs}$ is the analytical Limit of Quantifications in the sample *z* for the substance *s;*
- $MWF_s$ is the Molecular Weight Factor from the residue definition analysed to the substance *s*.

The hazard quotient per individual *i* per substance *s* that are above 1, will result in the probability of exceedance the HBGV under the chronic assessment.

All extractions, simulations, imputations and calculations were programmed with SAS® Studio 3.81 (Enterprise Edition).

## 5.3 | Probabilistic dietary exposure assessment results

### 5.3.1 | Acute results

The acute probabilistic exposure assessment aims at estimating the probabilities of exceedance of the ARfD of a given active substance in different subpopulation groups of European consumers for which surveys (with more than 300 consumers) were reported to EFSA. Probabilistic methodology expands the scope of the acute exposure assessment by introducing the likelihood of exposure events. Results of the probabilistic assessment refer to an exposure distribution, providing information both on the magnitude of exposure and on the probability of individuals being exposed at such a level.

The probability of exceeding the ARfD is to be understood as a characterisation of the overall risk for each population group under assessment for the given survey considered and based on the actual consumption of 40 food commodities (see Section 5.1.1.1) i.e. by real consumers. The occurrence data considered on those 40 food commodities were those reported over the last 3-year cycle (i.e. years 2021, 2022 and 2023), where 375 active substances were quantified. Of those, in 68 active substances the ARfD was deemed not necessary. Thus, an acute risk assessment calculation for these substances was considered unnecessary. In other 22 active substances (see Section 5.1.2.6), no ARfD was available so no assessment was carried out. The individual acute probabilistic exposure assessment was therefore conducted to 285 active substances for which an ARfD was derived. Out of the 285 active substances, 61 substances resulted in a probability equal or above 1 per million of individual consumer per day exceeding the ARfD (at the MB), in at least one survey.

The results of the acute probabilistic risk assessment are summarised in Table 5. It is reported as the middle bound (MB) (50th percentile) of the confidence interval for the percentage of individual consumer per day exceeding the ARfD. For each population class (adults, toddlers and other children), the minimum and the maximum value among different countries is presented in the table.

For example, for abamectin it is shown that among the 5 surveys on toddlers, the middle-bound value for the percentage of individual-days exceeding the ARfD varies from a minimum of 0.0000% (i.e. less than 1 individual-day out of 1,000,000) in one country to a maximum of 0.0020% (i.e. 20 individual consumers per day out of 1,000,000) in another country. The actual countries can be retrieved from Appendix B – Annex IV - Table 4.4, where the minimum is reached in The Netherlands and in Finland, while the maximum is found in Bulgaria. This means that in Bulgarian toddlers, the percentage of individual consumer per day exceeding the ARfD is estimated at 0.0020%. For the other toddler populations, the estimate is lower declining to 0.0000%.

**TABLE 5** Summary of the acute probabilistic risk assessment results.

| | Middle bound of the percentage of individual-days exceeding the ARfD[a] | | | | | |
|---|---|---|---|---|---|---|
| | Adults | | Other children | | Toddlers | |
| Active substance | Min[b] | Max[c] | Min[d] | Max[e] | Min[f] | Max[g] |
| Abamectin | 0.0000 | 0.0000 | 0.0000 | 0.0020 | 0.0000 | 0.0020 |
| Acetamiprid | 0.0080 | 0.0361 | 0.0630 | 0.1115 | 0.0585 | 0.1875 |
| Carbaryl | 0.0000 | 0.0071 | 0.0060 | 0.0160 | 0.0080 | 0.0395 |
| Carbendazim | 0.0000 | 0.0030 | 0.0000 | 0.0040 | 0.0000 | 0.0065 |
| Carbofuran | 0.0090 | 0.0506 | 0.0180 | 0.0550 | 0.0160 | 0.0550 |
| Carbosulfan | 0.0000 | 0.0000 | 0.0000 | 0.0040 | 0.0000 | 0.0020 |
| Chlorates | 0.0000 | 0.0000 | 0.0000 | 0.0060 | 0.0120 | 0.0160 |
| Chlormequat chloride | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0010 | 0.0020 |
| Chlorothalonil | 0.0000 | 0.0010 | 0.0000 | 0.0020 | 0.0000 | 0.0000 |
| Chlorpropham | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0010 |
| Cyhalothrin, lambda- | 0.0000 | 0.0060 | 0.0030 | 0.0145 | 0.0120 | 0.0295 |
| Cyhalothrin, gamma- | 0.0030 | 0.0160 | 0.0160 | 0.0600 | 0.0490 | 0.1030 |
| Cypermethrin, sum | 0.0080 | 0.0360 | 0.0305 | 0.0786 | 0.0285 | 0.1401 |
| Cypermethrin, alpha- | 0.0885 | 0.2025 | 0.2036 | 0.3922 | 0.2180 | 0.5147 |
| [70] | 0.0630 | 0.1510 | 0.1555 | 0.3082 | 0.1575 | 0.4270 |
| Deltamethrin, cis- | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0030 |
| Mancozeb | 0.0000 | 0.0000 | 0.0000 | 0.0030 | 0.0020 | 0.0045 |
| Maneb | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0010 | 0.0020 |

[70]Results on beta-cypermethrin are expected to be very similar to those of zeta-cypermethrin as both ARfD values are very similar (0.0016 mg/kg bw and 0.0015 mg/kg bw, respectively).

**TABLE 5** (Continued)

| Active substance | Middle bound of the percentage of individual-days exceeding the ARfD[a] | | | | | |
|---|---|---|---|---|---|---|
| | Adults | | Other children | | Toddlers | |
| | Min[b] | Max[c] | Min[d] | Max[e] | Min[f] | Max[g] |
| Metiram | 0.0090 | 0.0515 | 0.0625 | 0.1385 | 0.1050 | 0.1915 |
| Propineb | 0.0000 | 0.0020 | 0.0060 | 0.0140 | 0.0110 | 0.0325 |
| Thiram | 0.0070 | 0.0425 | 0.0545 | 0.1205 | 0.0945 | 0.1690 |
| Ziram | 0.0000 | 0.0050 | 0.0050 | 0.0220 | 0.0155 | 0.0295 |
| Ethephon | 0.0050 | 0.0206 | 0.0271 | 0.1020 | 0.0820 | 0.1415 |
| Fenamiphos | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0010 | 0.0030 |
| Flonicamid | 0.0000 | 0.0000 | 0.0000 | 0.0070 | 0.0010 | 0.0061 |
| Fluazifop-P | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0010 |
| Formetanate hydrochloride | 0.0000 | 0.0010 | 0.0010 | 0.0060 | 0.0020 | 0.0070 |
| Fosthiazate | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0020 |
| Glufosinate-ammonium | 0.0000 | 0.0040 | 0.0000 | 0.0040 | 0.0020 | 0.0120 |
| Imazalil | 0.0000 | 0.0350 | 0.0010 | 0.0155 | 0.0040 | 0.0590 |
| Indoxacarb | 0.0000 | 0.0030 | 0.0020 | 0.0100 | 0.0020 | 0.0110 |
| Methiocarb | 0.0005 | 0.0070 | 0.0010 | 0.0035 | 0.0000 | 0.0030 |
| Methomyl | 0.0000 | 0.0030 | 0.0000 | 0.0050 | 0.0000 | 0.0030 |
| Nicotine | 0.0000 | 0.0000 | 0.0000 | 0.0020 | 0.0010 | 0.0030 |
| Oxamyl | 0.0130 | 0.0410 | 0.0170 | 0.0700 | 0.0285 | 0.0600 |
| Phosmet | 0.0485 | 0.1735 | 0.1346 | 0.2315 | 0.1420 | 0.3081 |
| Pirimicarb | 0.0000 | 0.0010 | 0.0000 | 0.0040 | 0.0010 | 0.0150 |
| Prochloraz | 0.0000 | 0.0000 | 0.0000 | 0.0030 | 0.0000 | 0.0010 |
| Propiconazole | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0010 |
| Pyraclostrobin | 0.0000 | 0.0000 | 0.0000 | 0.0020 | 0.0000 | 0.0040 |
| Tebuconazole | 0.0000 | 0.0020 | 0.0000 | 0.0025 | 0.0010 | 0.0030 |
| Thiabendazole | 0.0000 | 0.0055 | 0.0000 | 0.0010 | 0.0010 | 0.0050 |
| Thiophanate-methyl | 0.0000 | 0.0030 | 0.0020 | 0.0110 | 0.0020 | 0.0120 |
| Acephate[h] | 0.0000 | 0.0030 | 0.0000 | 0.0135 | 0.0000 | 0.0060 |
| Aldicarb[h] | 0.0050 | 0.0205 | 0.0080 | 0.0270 | 0.0065 | 0.0275 |
| Amitraz[h] | 0.0000 | 0.0010 | 0.0000 | 0.0040 | 0.0000 | 0.0040 |
| Chlorpyrifos[h] | 0.0020 | 0.0080 | 0.0050 | 0.0110 | 0.0080 | 0.0160 |
| Dichlorvos[h] | 0.0000 | 0.0000 | 0.0000 | 0.0020 | 0.0000 | 0.0010 |
| Dimethoate[h] | 0.0210 | 0.0650 | 0.0600 | 0.1460 | 0.0655 | 0.1770 |
| Diniconazole[h] | 0.0000 | 0.0020 | 0.0000 | 0.0060 | 0.0000 | 0.0030 |
| Diniconazole-M[h] | 0.0000 | 0.0010 | 0.0000 | 0.0065 | 0.0000 | 0.0020 |
| Fenthion[h] | 0.0000 | 0.0010 | 0.0000 | 0.0040 | 0.0000 | 0.0040 |
| Furathiocarb[h] | 0.0000 | 0.0000 | 0.0000 | 0.0020 | 0.0000 | 0.0010 |
| Heptachlor[h] | 0.0000 | 0.0060 | 0.0000 | 0.0050 | 0.0000 | 0.0060 |
| Omethoate[h] | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0010 |
| Permethrin[h] | 0.0000 | 0.0050 | 0.0000 | 0.0040 | 0.0000 | 0.0050 |
| Propoxur[h] | 0.0000 | 0.0000 | 0.0000 | 0.0010 | 0.0000 | 0.0000 |
| Prothiofos[h] | 0.0000 | 0.0000 | 0.0000 | 0.0060 | 0.0010 | 0.0030 |
| Triazophos[h] | 0.0000 | 0.0030 | 0.0010 | 0.0030 | 0.0010 | 0.0040 |

[a]Even if the estimated probability is 0.0000% by the model, it does not mean the true probability on the real population is 0. Therefore, the probability should be considered close to zero.

[b]Lowest estimated probability of exceeding the ARfD among the 15 adult populations.

[c]Highest estimated probability of exceeding the ARfD among the 15 adult populations.

[d]Lowest estimated probability of exceeding the ARfD among the 10 child populations.

[e]Highest estimated probability of exceeding the ARfD among the 10 child populations.

[f]Lowest estimated probability of exceeding the ARfD among the 5 toddler populations.

[g]Highest estimated probability of exceeding the ARfD among the 5 toddler populations.

[h]Active substance with a *tentative* ARfD.

In Appendix B – Annex IV and Annex V, detailed information on the probabilistic acute risk assessment is reported. The annexes contain information on the set ARfD values and whether a primary or tentative value was selected; infographics by active substance, population group and countries are presented too.

Important to note that the assessment is affected by different types of uncertainties. On one hand, there are some considerations that might lead to an underestimation of the probabilities, such as: the restriction of the consumption data to 36 highly consumed RPCs[71] only instead of whole diets; and the use of the residue definition for enforcement and not for risk assessment (where additional metabolites may have contributed e.g. phosmet, methiocarb) in the calculations. On the other hand, the probabilities here presented could be overestimated mainly due to the lack of processing factors for processed food consumption and the unspecific residue definition measurands allocated to the different active substance in a given proportion.

To illustrate those uncertainties, the 10 pesticides with the highest estimated probability for an individual consumption-day to exceed the ARfD are discussed below, ordered by the maximum results for toddlers. A summary of the most contributing RPCs by substance is also discussed below but, the reader is referred to Appendix B – Annex IV and Annex V for detail information by country.

*Cypermethrins (sum of isomers), alpha-cypermethrin and beta-cypermethrin*

Cypermethrin as is a mixture of eight isomers, consisting of four diastereomeric pairs of enantiomers: alpha, beta, theta and zeta. Three of these enantiomers, alpha-, beta- and zeta-cypermethrin are active substances.

Cypermethrin (sum of isomers) was renewed for use in the EU in 2022.[72] Alpha-cypermethrin and zeta-cypermethrin are no longer approved in EU, having been withdrawn in 2021 and 2020, respectively. Beta-cypermethrin was never approved in the EU.

Since the four active substances share the same residue definition – *cypermethrin including other mixtures of constituent isomers (sum of isomers)*, different scenarios were built by assigning the concentrations reported in monitoring data to each active substance individually. This approach is conservative for alpha-cypermethrin being the scenario resulting in the most critical exposure estimations, as it is no longer approved in EU and represents roughly 20% of the content in cypermethrin (sum of isomers).

Despite beta-cypermethrin was never approved in EU, the ARfD value is very similar to zeta-cypermethrin. Thus, the outcome of the beta-cypermethrin scenario can be extrapolated to zeta-cypermethrin.

Regarding the approved *cypermethrins (sum of isomers)*, the exposure estimation is mainly driven by barley malt and wheat (in the form of semolina or flour semi-refined). There is also a clear contribution from unprocessed foods such as spinaches, lettuces, apple and table grape juice in a number of population groups (see Appendix B – Annex IV). In the EFSA comprehensive MRL review (EFSA, 2023b) of the authorised uses of cypermethrins, the lowering of the MRLs for barley and table grapes is proposed for risk managers' consideration. No safe uses were identified for apples, lettuces and spinaches, so EFSA recommended to lower their MRLs to the LOQ value.

To address the hindrance of a common residue definition for substances with varying potencies and approval status, EURLs[73] are currently developing non-chiral methods to quantify the alpha isomer individually. Additionally, EFSA has been mandated[74] to recalculate the MRL values based on cypermethrin (sum of isomers) and zeta-cypermethrin into the alpha isomer.

These approaches will enable risk managers to implement targeted measures to reduce the exposure to these substances.

*Phosmet*

For phosmet the exposure estimates are mainly driven by olive oil and apples followed by peaches, oranges and mandarins. Regarding these commodities, there is little room for refinements as apples and peaches may be consumed unpeeled. However, no processing factor is available for oranges and mandarins and since the active substance is not systemic, this may lead to an overestimation in the calculations.

The withdrawal of authorisations by Member States was due on the 1 November 2022.[75] Regulation (EU) 2023/1029,[76] applicable from 15 September 2023, lowered all MRLs to the LOQ, including those based on CODEX,[77] and the substance

[71] 36 in respect of the 40 taken, not being raw primary commodities those food for infants and young children.

[72] Commission Implementing Regulation (EU) 2021/2049 of 24 November 2021 renewing the approval of the active substance cypermethrin as a candidate for substitution in accordance with Regulation (EC) No 1107/2009 of the European Parliament and of the Council concerning the placing of plant protection products on the market and amending the Annex to Commission Implementing Regulation (EU) No 540/2011. OJ L 420, 25.11.2021, p. 6–13.

[73] https://www.eurl-pesticides.eu/library/docs/srm/EurlSrm_Observation_Cypermethrins_with_LC-MSMS.pdf.

[74] https://open.efsa.europa.eu/questions/EFSA-Q-2024-00651?search=cypermethrin.

[75] Commission Implementing Regulation (EU) 2022/94 of 24 January 2022 concerning the non-renewal of the approval of the active substance phosmet, in accordance with Regulation (EC) No 1107/2009 of the European Parliament and of the Council concerning the placing of plant protection products on the market and amending the Annex to Commission Implementing Regulation (EU) No 540/2011. OJ L 16, 25.1.2022, p. 33–35.

[76] Commission Regulation (EU) 2023/1029 of 25 May 2023 amending Annexes III and V to Regulation (EC) No 396/2005 of the European Parliament and of the Council as regards maximum residue levels for phosmet in or on certain products. OJ L 139, 26.5.2023, p. 15–27.

[77] https://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/pesticide-detail/en/?p_id=103.

was moved to Annex V of Regulation (EC) 395/2005. For apples and oranges, the LOQ was set at 0.005* mg/kg. The new MRLs in place are expected to lower the exposure estimation in upcoming years.

*Dithiocarbamates (maneb, mancozeb, metiram, propineb, thiram and ziram, expressed as CS2)*

The six active substances share a common unspecific residue definition 'dithiocarbamates (expressed as $CS_2$, including maneb, mancozeb, metiram, propineb, thiram and ziram)'. Lacking specific analytical methods for determining each precursor individually, $CS_2$ concentrations reported in the monitoring data were assigned to each active substance, resulting in six exposure scenarios. In 2023 only ziram and metiram were approved in the EU. According to the EFSA comprehensive MRL review of dithiocarbamates (EFSA, 2023d), import tolerances for mancozeb were also in place.

Focusing on the approved precursors, the highest exposure estimation was calculated for metiram. The results were mainly driven by apple and pears, head cabbages, lettuces, broccoli and cauliflowers. In the MRL review (EFSA, 2023d), uses on apples and pears were reported for ziram, not for metiram, meaning that these results might be an overestimation. In any case, a lowering of the MRL was proposed for these two commodities in the EFSA output. Lower MRLs are also proposed for head cabbage (based on naturally occurring $CS_2$ levels) and lettuces (based on metiram use). Broccoli and cauliflowers are known for containing $CS_2$ background levels. The outcome of the MRL review is still under discussion by risk managers and it is expected to reduce the exposure estimation in the upcoming years.

*Acetamiprid*

For acetamiprid, the exposure estimates are mainly driven by apple, pears and tomatoes and in less extend by raisins, mandarin juice and lettuces.

Among the five surveys on toddlers, the middle-bound value for the percentage of individual-days exceeding the ARfD varied from a minimum of 0.0585% in Finland to a maximum of 0.1875% in Germany. However, the calculations were conducted with the recently derived HBGV (EFSA, 2024f). If the previous values (legally in place in the monitoring period covered by this report, 2021–2023) would have been applied, the MB percentages would have ranged from 0.0000% to 0.0070%. Based on the new toxicological assessment, risk managers agreed on the lowering of the MRL on apples, pears, grapes, tomatoes and lettuce, among others. The lowered MRLs will enter into force on the 19/08/2025 under Regulation (EU) 2025/158.[78]

*Dimethoate*

For dimethoate, the exposure estimates are mainly driven by oranges and mandarins followed by peaches, cucumbers, peppers and olive oil for a number of population groups (see Appendix B – Annex IV). Dimethoate was not renewed since 2019[79] due to the fact that the genotoxic potential could not be ruled out (EFSA, 2017; EFSA, 2018e) and all MRLs were lowered to LOQ. Thus, any quantification[80] of this active substance can be considered due to a misuse. EFSA recommends risk managers to take the necessary measures[81] to assure that food containing this substance is either not placed or withdrawn from the market.

*Ethephon*

For ethephon, the exposure estimates are mainly driven by bananas (34 positive results reported only in 2022) followed by unprocessed tomatoes (132 positive results over the 3-year cycle), sweet/bell peppers (27 positive results over the 3-year cycle) and table grapes (234 positive results over the 3-year cycle). The main contributors were all unprocessed foods (except bananas for which no peeling factor is available). Therefore, the assessment is not impacted by the lack of refinement in the processing. In 2009, only uses on tomatoes and table grapes were authorised (EFSA, 2009). In a recent MRL review (EFSA, 2024d) using PRIMo 3.1, EFSA proposes lowering table grape MRL due to a lack of supporting data on this European GAP, while the MRL of 2 mg/kg for tomatoes remains. This MRL is based on JMPR supervised field trials, where the highest residue reported was 0.79 mg/kg.[82] Furthermore, EFSA recommends Competent Authorities to investigate the findings in bananas[83] and sweet peppers,[84] for which no authorisation is granted.

[78]Commission Regulation (EU) 2025/158 of 29 January 2025 amending Annex II to Regulation (EC) No 396/2005 of the European Parliament and of the Council as regards maximum residue levels for acetamiprid in or on certain products. OJ L 2025/158, 30.1.2025.

[79]SANTE/11494/2018. https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/backend/api/active_substance/download/112.

[80]Quantification numbers over the 3-year cycle were: 30 samples in 2023, 25 samples in 2022 and 44 samples in 2021.

[81]https://food.ec.europa.eu/system/files/2023-02/acn_working-instructions_2-2_pest-residues.pdf.

[82]This divergency is resulting from the methodology in place in the IESTI equation (EFSA, 2015c; FAO, 2017), and from the gap between the highest residue used in supervised field trials and the MRL derived.

[83]All 34 samples in bananas were reported in 2022 coming from France overseas territories.

[84]In 2023, the 2 samples reported on sweet pepper were coming from Germany and Türkiye, respectively. From the 15 samples reported in 2022 on sweet pepper, all had origin Poland. In 2021, the country of origin of the samples reporting ethephon were: 1 sample from The Netherland, 5 from Poland, 3 from Spain and 1 from Türkiye.

*Cyhalothrin, gamma*

Gamma-cyhalothrin and lambda-cyhalothrin share the same residue definition, *lambda-cyhalothrin (includes gamma-cyhalothrin) (sum of R,S and S,R)*. As for other active substances sharing an unspecific residue definition, EFSA has built two scenarios, one assigns the reported concentrations to gamma-cyhalothrin and the other to lambda-cyhalothrin. For gamma-cyhalothrin, the exposure estimates are mainly driven by bananas, apple juice, mandarin juice and peaches followed by spinaches and lettuce. However, in the MRL review of gamma-cyhalothrin (EFSA, 2024e) no uses on these commodities were notified to EFSA. EFSA decided to keep these results to cover unlikely cases of Member States granting an authorisation on gamma-cyhalothrin covered by the established MRL based on lambda-cyhalothrin.

*Oxamyl*

For oxamyl, the exposure estimation is mainly driven by cucumbers, beans (with pods) and carrots, followed by tomatoes, potatoes and strawberries. Overall, 22 positive results were reported over the 3-year cycle. Regulation (EU) 2019/552[85] setting MRLs for oxamyl at LOQ value for these commodities was in place during the reference period (years 2021–2023). Therefore, Competent Authorities are recommended to investigate further the findings in cucumber, beans (with pods), carrots, tomatoes, potatoes and strawberries.

The withdrawal of authorisations by Member States was due on the 30th of June 2023,[86] with a grace period expiring by 30th September 2023. Regulation (EU) 2024/331[87] (not yet applicable in 2023) lowers the MRLs even further than 0.01 mg/kg, default LOQ. This is expected to lower the exposure estimation of oxamyl (EFSA, 2023c; EFSA, 2024a) in the following years.

*Imazalil*

For imazalil, the exposure estimates are mainly driven by processed oranges, mandarins and grapefruits, followed by potatoes (9 positive results over the 3-year cycle). Occurrence data for orange juice and grapefruit juice was used for the estimation. Therefore, for these processed commodities no further refinement is possible. However, in some given occasions the concentrated juice contributed the most, for which no specific processing factor was available. In order to refine exposure, PFs or occurrence data reported on concentrated juice, are needed. Furthermore, in accordance with the PF database compendium (Kittelmann et al., 2024) processing techniques describing concentrated juices conclude that the preconcentration of pesticides is unlikely due to the overruling of other processing techniques, such as pasteurisation, that tend to degrade the pesticide. In order to elucidate the proper behaviour of the pesticides in concentrated juices, EFSA recommends Food Business Operators deriving PF on these.

Regarding the findings on potatoes, the current MRL is based on seed treatment, set at the LOQ of 0.01 mg/kg. However, during the MRL review (EFSA, 2018d), a post-harvest use was reported but could not be considered in deriving the MRL. Competent authorities are recommended to further investigate quantified residues in potatoes to determine whether they originate from post-harvest use.

*Carbofuran*

For carbofuran, the exposure estimates are driven by tomatoes (three positive results over 2021 and 2022), beans with pods (five positive results over 2022 and 2023) and sweet peppers (nine positive results over the 3-year cycle). All positive results were from samples coming from third countries. EFSA recommends Member States to monitor this substance on import control checks.

Regulation (EU) 2015/399[88] lowered the MRLs for this non-approved active substance to the lowest achievable analytical LOQ, which, for some commodities, was below the default MRL of 0.01* mg/kg. Thus, EFSA recommends risk managers to take the necessary measures to assure food containing this substance is either not placed or withdrawn from the market.

*Summary*

Among the 375 quantified active substances considered in this probabilistic acute risk assessment, in 22 no ARfD was available at the time of the assessment and in 68 substances an ARfD was deemed not necessary. For 224 active substances the probability of exceeding the ARfD was less than 1 individual consumer per day out of 1,000,000 based on the middle bound (median value) of the confidence interval. This indicates that for most of the substances (292 out of 375), the

[85]Commission Regulation (EU) 2019/552 of 4 April 2019 amending Annexes II and III to Regulation (EC) No 396/2005 of the European Parliament and of the Council as regards maximum residue levels for azoxystrobin, bicyclopyrone, chlormequat, cyprodinil, difenoconazole, fenpropimorph, fenpyroximate, fluopyram, fosetyl, isoprothiolane, isopyrazam, oxamyl, prothioconazole, spinetoram, trifloxystrobin and triflumezopyrim in or on certain products. OJ L 96, 5.4.2019, p. 6–49.

[86]Commission Implementing Regulation (EU) 2023/741 of 5 April 2023 concerning the non-renewal of the approval of the active substance oxamyl, in accordance with Regulation (EC) No 1107/2009 of the European Parliament and of the Council and amending Commission Implementing Regulation (EU) No 540/2011. OJ L 98, 11.4.2023, p. 1–3.

[87]Commission Regulation (EU) 2024/331 of 19 January 2024 amending Annexes II and V to Regulation (EC) No 396/2005 of the European Parliament and of the Council as regards maximum residue levels for oxamyl in or on certain products. OJ L, 2024/331, 22.1.2024.

[88]Commission Regulation (EU) 2015/399 of 25 February 2015 amending Annexes II, III and V to Regulation (EC) No 396/2005 of the European Parliament and of the Council as regards maximum residue levels for 1,4-dimethylnaphthalene, benfuracarb, carbofuran, carbosulfan, ethephon, fenamidone, fenvalerate, fenhexamid, furathiocarb, imazapyr, malathion, picoxystrobin, spirotetramat, tepraloxydim and trifloxystrobin in or on certain products. OJ L 71, 14.3.2015, p. 1–55.

probability of a consumer's intake exceeding the ARfD is extremely low. For the remaining 61 substances, aside from the cases handled above, the probability of exceedance the ARfD ranges from 0.001% to 0.040%.

The probabilistic approach is modelling sampling uncertainty to give a plausible confidence interval for the estimates analysed. The detail on the confidence interval is reported in Appendix B – Annexes IV and V.

It is important to note that the assessment still needs to account for additional uncertainties that may either overestimate or underestimate the exposure estimates provided above.

For cypermethrins and dithiocarbamates – substances among those with the highest estimated probability of an individual consumer per day to exceed the ARfD – some of the exposure scenarios presented might be overestimated as their isomers or precursors share a common unspecific residue definition and are under different approval status. EFSA still needs to improve the methodology to better account for these uncertainties. However, the availability of specific analytical methods to determine each of the isomers or precursors of these substances would particularly help to reflect exposure estimates more realistically. These substances are also under discussion by risk managers and the measures to be taken are expected to decrease the estimated exposure. On the other hand, recent withdrawal authorisations and lowering of MRLs beyond the default LOQ of 0.01 mg/kg is expected to decrease exposure estimates of phosmet and oxamyl. The availability of processing factors in concentrated juices can also contribute to reflect exposure estimates more realistically, for example for imazalil.

The sources of uncertainty that may lead to an underestimation of the exposure probabilities are those related to the retention of only 36 RPCs and 4 baby foods in the assessment, and the use of the residue definition for enforcement and not for risk assessment. The uncertainty related to the representativeness of the consumption data used in the model could either increase or decrease the calculated exposure estimates. Missing processing factors and the non-consideration of washing of commodities eaten raw may lead to overestimated results.

### 5.3.2 | Chronic results

In the chronic probabilistic modelling, the risk of real consumers is calculated based on their own individual dietary pattern. This allows capturing the distribution of the exposure, including the high end of the distribution for extreme levels of exposure within consumer population subgroups. The probability of exceeding the ADI is therefore to be understood as the percentage of high consumers in the population group under assessment exceeding the ADI in a long-term period (Section 5.2).

The assessment covered 375 active substances quantified in the 3-year cycle. Of those, in 22 active substances no ADI was available at the time of this assessment. Therefore, the individual chronic probabilistic exposure assessment was finally conducted to 353 active substances for which an ADI was derived (or any other HBGV for chronic intake assessment such as TDI). The only substances exceeding the ADI at the MB, in at least one population group were imazalil and pyrimethanil. For all the other substances the model did not show any consumer exposure exceeding the ADI at the MB.

Pirimiphos-methyl showed for some population groups a percentage of consumers exceeding the ADI above or equal to 1 subject out of 1,000,000 at the upper bound of the confident interval, i.e. 0.818% for toddlers in Bulgaria and 0.029% for adults in Germany.

To describe the magnitude of the exposure to those three active substances, Table 6 provides the exposure levels obtained from this analysis described by means of their 50th, 95th, 99th, 99.9th percentiles. The table has been extracted from Appendix B – Annex VI – Table 6.4. Only the three substances and the population groups exceeded, are reported. A value of 100% corresponds to an exposure equal to the ADI. The percentage of consumers exceeding ADI looking at the middle bound of the 95% confidence intervals is also reported (for both Middle Bound and Upper Bound scenarios; Section 5.2).

**TABLE 6** MB and UB exposure of median (50th Pctl) and high-end consumers (P95th Pctl, 99th Pctl, 99.9th Pctl) in terms of percentage of ADI and percentage of individuals exceeding the ADI for imazalil, pirimiphos-methyl and pyrimethanil; MB and UB describe the 50th and 99th percentile of the 95% confidence interval of the chronic exposure estimate.

| Substance | Population class | Country | 50th Pctl exposure (MB) (% of ADI) | 50th Pctl exposure (UB) (%of ADI) | 95th Pctl exposure (MB) (%of ADI) | 95th Pctl exposure (UB) (%of ADI) | 99th Pctl exposure (MB) (%of ADI) | 99th Pctl exposure (UB) (%of ADI) | 99.9th Pctl exposure (MB) (%of ADI) | 99.9th Pctl exposure (UB) (%of ADI) | Percentage of consumers exceeding ADI (MB) (%) | Percentage of consumers exceeding ADI (UB) (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Imazalil | Adults | FI | 0.1 | 0.2 | 1.2 | 1.4 | 4.3 | 8.0 | 90.6 | 253.0 | 0.155 | 0.386 |
| Imazalil | Adults | DE | 0.0 | 0.0 | 0.6 | 0.6 | 12.0 | 14.6 | 52.2 | 64.1 | 0.019 | 0.048 |
| Pirimiphos-methyl | Adults | DE | 0.7 | 0.9 | 2.8 | 4.2 | 4.8 | 7.4 | 8.5 | 13.7 | 0.000 | 0.029 |
| Pirimiphos-methyl | Toddlers | BG | 3.1 | 3.7 | 6.2 | 7.7 | 8.4 | 12.4 | 61.4 | 108.6 | 0.000 | 0.818 |

(Continues)

**TABLE 6** (Continued)

| Substance | Population class | Country | 50th Pctl exposure (MB) (% of ADI) | 50th Pctl exposure (UB) (%of ADI) | 95th Pctl exposure (MB) (%of ADI) | 95th Pctl exposure (UB) (%of ADI) | 99th Pctl exposure (MB) (%of ADI) | 99th Pctl exposure (UB) (%of ADI) | 99.9th Pctl exposure (MB) (%of ADI) | 99.9th Pctl exposure (UB) (%of ADI) | Percentage of consumers exceeding ADI (MB) (%) | Percentage of consumers exceeding ADI (UB) (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pyrimethanil | Adults | FI | 0.5 | 0.6 | 9.6 | 10.9 | 22.0 | 27.2 | 99.2 | 219.5 | 0.155 | 0.386 |
| Pyrimethanil | Adults | DE | 0.8 | 1.0 | 5.4 | 6.0 | 20.5 | 23.1 | 55.6 | 67.3 | 0.010 | 0.029 |
| Pyrimethanil | Other children | BE | 3.0 | 3.5 | 15.8 | 21.9 | 39.2 | 61.8 | 167.6 | 325.0 | 0.160 | 0.800 |
| Pyrimethanil | Other children | BG | 0.9 | 1.1 | 30.9 | 40.6 | 62.7 | 102.1 | 146.4 | 202.2 | 0.462 | 1.501 |
| Pyrimethanil | Other children | FI | 5.9 | 10.6 | 58.9 | 67.3 | 87.7 | 123.7 | 148.8 | 160.1 | 0.667 | 1.333 |
| Pyrimethanil | Other children | NL | 5.3 | 5.8 | 32.2 | 36.4 | 61.4 | 74.8 | 92.5 | 118.2 | 0.104 | 0.418 |
| Pyrimethanil | Toddlers | BG | 1.3 | 1.5 | 34.9 | 46.1 | 75.6 | 101.0 | 120.2 | 145.0 | 0.234 | 1.168 |
| Pyrimethanil | Toddlers | FI | 1.4 | 1.6 | 15.6 | 24.3 | 53.8 | 74.5 | 144.9 | 224.2 | 0.200 | 0.600 |
| Pyrimethanil | Toddlers | NL | 6.8 | 7.9 | 46.2 | 63.5 | 96.2 | 122.0 | 117.3 | 129.0 | 0.932 | 2.484 |

For the remaining active substances (i.e. 353–3 = 350), the percentage of consumers exceeding the ADI is estimated to be less than 1 subject out of 1,000,000 for every population group analysed.

However, as is the case in the acute exposure results (Section 5.3.1), these estimates are subject to multiple uncertainties that may either underestimate or overestimate the exposure.

*Imazalil*

The exposure estimates for imazalil are driven by orange juice concentrate, followed by the consumption of peeled orange and mandarin. In particular, the exceedances of the ADI are linked only to the consumption of orange juice concentrate with an average concentration of 0.895 mg/kg of imazalil in the orange, for which a processing factor was not available. Therefore, EFSA recommends not only deriving PF on juices but to do so on concentrated juices. Further, to investigate how the different processes involved in juicing (e.g. concentration, filtering, pasteurising) may affect the nature and quantities of the pesticide.

*Pyrimethanil*

The exposure estimates for pyrimethanil are driven by mandarin juice and orange juice concentrate, followed by the consumption of grapefruit juice, apple juice and cider. In particular, the exceedances of the ADI are only linked to the consumption of orange juice concentrate, with an average concentration of 0.400 mg/kg in orange, for which a processing factor is not available. A refinement of the exposure calculation (i.e. deriving processing factors for orange concentrated juice) should be explored. Therefore, EFSA recommends deriving PF on concentrated juices.

*Pirimiphos-methyl*

The exposure estimates for pirimiphos-methyl are driven by wheat flour and barley malt. The only two exceedances of the ADI are linked to wheat germ[89] (for which a processing factor was not applied) and its high consumption in the following surveys by one consumer:

- For adults in Germany the exceedance is linked to a high consumption of wheat germ for one consumer 180 g/day.
- For toddlers in Bulgaria the exceedance is linked to a high consumption of wheat germ for one consumer 30 g/day.

Even if the MB of percentage of consumers exceeding the ADI for this substance is less than 1 subject out of 1,000,000, the result is presented as the exceedance at the upper bound is only on two consumers, one in each of the two surveys.

[89]Wheat germ is converted to wheat by a factor of 50. Appendix B – Annex VI, Table 6.7 provides the amount consumed and the correspondent amount in the raw primary commodity conversion.

*Summary*

The occurrence data considered were on 375 active substances quantified on the 40 food commodities over the last 3-year cycle (i.e. years 2021, 2022 and 2023). In 22 active substances no ADI was available and thus, no assessment was carried out. The individual chronic probabilistic risk assessment was therefore conducted to the remaining 353 for which an ADI was derived (or TDI in some of the cases).

Based on the surveys used and their size, the probability to exceed the ADI was estimated to be less than 1 subject out of 1,000,000 for 350 out of 353 active substances.

For the remaining three substances, the estimated percentage of consumers to exceed the ADI ranged from 0.000% to 0.932%. In the case of pirimiphos-methyl, the estimate is linked to a high (or extreme) consumption event of a specific processed food (for which a processing factor is not available) by only two consumers, each one in a different survey. In the cases of imazalil and pyrimethanil, the estimates are linked to the consumption of orange juice concentrate for which a processing factor is not available. Should processing factors become available, the exposure could be refined. Therefore, these estimates are subject to high consumption events of processed commodities of extreme consumers present in the surveys.

*Overall*

In the samples analysed in the framework of 2021–2023 monitoring programmes, the estimated dietary exposure (i.e. for acute and chronic) to single pesticide residues for which HBGVs are available is very low for most of the EU subpopulation groups assessed. Previous assessments on cumulative exposure to pesticides affecting the nervous system (EFSA, 2020b), the thyroid (EFSA, 2020c) and the craniofacial alterations (EFSA, 2022) concluded that the threshold for regulatory consideration established by risk managers was not exceeded. Nevertheless, EFSA notes that among six of the active substances with the highest acute probability per individual consumer and day, their ARfDs were derived based on developmental neurotoxicity (DNT) toxicological endpoint, either as a result of the evaluation of DNT studies submitted during the peer-review process (i.e. alpha-cypermethrin, beta-cypermethrin, cypermethrin and dimethoate), or by applying an additional uncertainty factor due to the absence of those studies when required (i.e. phosmet and oxamyl). These results indicate the need to further progress in the consumer risk assessment of active substances with DNT potential, by reducing uncertainties, redefining data gaps, establishing cumulative assessment groups and performing cumulative risk assessments for DNT. In the last year, EFSA has engaged with stakeholders for the development and implementation of these activities contributing to the risk assessment of DNT.[90] EFSA notes that these active substances are either not approved at EU level or few of them are under risk managers' consideration.

The probabilistic approach analyses the average consumption of any single consumer. Therefore, it is more sensitive to extreme consumers and gives a clearer view on the probability that certain consumers within the population might be at risk. It has been found a precise model to estimate European consumers risk to single pesticide despite still some uncertainties remain. Future work will aim to include more commodities (e.g. animal commodities, minor crop commodities) and in the acute assessment to calculate the risk to only high exposure events.

## 6 | CONCLUSIONS AND RECOMMENDATIONS

The 2023 EU report on pesticide residues in food, prepared by EFSA in accordance with Article 32 of Regulation (EC) No 396/2005, provides an overview of the official control activities on pesticide residues carried out in the EU Member States,*[1] Iceland and Norway. Visuals of the results are presented in Appendix B – Annex I[2].

A total of 132,793 samples were analysed, representing a 19.8% increase compared with 2022 (110,829 samples). Of the total, 96.3% of the samples (127,816) fell within the legal limit, being the same figure as in previous years (96.3% in 2022; 96.1% in 2021); 76,962 samples (58.0%) did not contain quantifiable residues (results below the LOQ for each pesticide analysed), while 38.3% contained quantified residues not exceeding the legal limits (50,854 samples). The MRL exceedance rate remains the same as in 2022 (3.7%) (4977 samples). When considering measurement uncertainty, 2.0% (2694 samples) of all samples triggered legal sanctions or enforcement actions, the lowest rate over the last 3 years (2.5% in 2021; 2.2% in 2022).

Of the total 132,793 samples, 71,617 (53.9%) were reported as having origin in one of the reporting countries. Of these, 45,701 samples (63.8%) did not show quantifiable results (i.e. below the LOQ for each pesticide result analysed), while 24,614 samples (34.4%) contained residues at or above the LOQ but below or equal to the MRL. 1302 samples (1.8%) numerically exceeded the MRL and of these, 687 samples (1.0%) were non-compliant with the MRL (after taking into account the measurement uncertainty). The remaining 55,932 samples (42.1%) were imported from third countries, of which 28,457 samples (50.9%) were reported as without quantifiable residues, while in 24,014 samples (42.9%) contained quantifiable residues within the legal limits. The MRL exceedance rate (6.2%) and non-compliance rate (3.4%) were three times higher than in food products grown in one of the reporting countries. The remaining 5244 samples (4.0%) were reported as origin unknown of which, 115 samples (2.2%) led to non-compliances.

[90]Call for Tender: OC/EFSA/PREV/2023/01. https://www.efsa.europa.eu/en/events/webinar-environmental-neurotoxicants-advancing-understanding-impact-chemical-exposure-brain.

The random sampling of the 12 most consumed commodities by European citizens listed in the 2023 EU MACP (Regulation (EU) 2022/741) (i.e. carrots, cauliflowers, kiwi fruits -green, red and yellow-, onions, oranges, pears, potatoes, dried beans, brown rice, rye, bovine liver and poultry fat), provides a snapshot of the level of pesticide residues in those food products. These were compared with the same food products as sampled in 2020 and 2017 EU monitoring programmes.

A total of 13,246 samples were reported under the EU MACP and analysed for 197 pesticide residues. In 9253 of those samples (69.9%) no quantifiable residues were reported (residues were below the LOQ). The number of samples with pesticide residues within legally permitted levels (at or above the LOQ but below or at the MRL) was 3747 (28.3%). MRLs were exceeded in 1.9% (246) of samples, of which 1.0% (135) were found to be non-compliant after considering measurement uncertainty (very similar compliant rate for the same commodities sampled in 2020, which stood at 0.9%).

The overall MRL exceedance rate slightly decreased from 2.1% in 2020 to 1.9% in 2023. Among individual food commodities, MRL exceedance rates rose from 2017 to 2020 and to 2023 in dry beans (from 2.3% in 2017 to 6.9% in 2023). An increase in MRL exceedance was observed in carrots (from 1.2% in 2020 to 2.4% in 2023), onions (from 0.2% in 2020 to 0.8% in 2023), pears (from 2.3% in 2020 to 3.2% in 2023) and potatoes (from 0.8% in 2020 to 1.4% in 2023). In cauliflower, kiwi fruits (green, red and yellow), oranges and rice the rates were lower in 2017 and 2023 than in 2020. MRL exceedance rates decreased along the three-year cycles in rye (from 1.9% in 2017 to 0.8% in 2023). In bovine liver one MRL exceedance was reported in 2023, while in poultry fat a single exceedance was reported in 2020.

On average, out of the total EU MACP samples, 60.3% were domestic samples, 20.8% were from other reporting countries, 14.6% from third countries and 4.3% were of unknown origin. The percentages were very similar to 2020 results (60%, 22%, 14% and 4%, respectively) where the same food products were sampled.

By food products, quantification and MRL exceedance rates were lower in organic food compared to conventionally produced food (i.e. non-organic) for all food product categories except for foods for infants and young children (the quantification rate) and animal products (the exceedance rate). However, this was due to copper, a substance authorised in organic farming, having other uses such as food, food supplement in food for infants and young children, feed supplement and fertilisers. Regarding samples of food for infants and young children, in addition to copper, chlorates (resulting from sanitisation practices applied in the food chain), were responsible for most part of the exceedances.

The results from the monitoring programmes are a valuable source of information for estimating the dietary exposure of EU consumers. An analysis of the acute and chronic estimated intake of residues to consumers was performed using probabilistic exposure modelling. The results provide the probability of different subpopulation of European consumers to exceed the HBGV when exposed to pesticide residue dietary intake. Unlike deterministic calculations, probabilistic modelling reflects better the actual exposure resulting from consumption events. For this reason, it was chosen as the tool to estimate consumer exposure in this report. In 2023, the number of active substances included in the assessment was expanded to those having been quantified at least once in any of the 36 raw commodities of plant origin (along with four products on foods for infants and young children) included in the 2021–2023 monitoring programmes.

The probabilistic acute risk assessment revealed that for 292 active substances of the 353 assessed, the probability of exceeding the ARfD is estimated to be less than 1 individual consumer per day out of 1,000,000 for the 40 commodities and 30 surveys covering 30 European subpopulation groups and 17 EU MSs under assessment. The highest estimated probability of exceeding the ARfD was calculated for cypermethrins residue definition (when all quantifications were imputed to alpha- and zeta- isomers), phosmet and metiram (when all $CS_2$ quantifications were imputed to this precursor). Risk managers discussions are ongoing for cypermethrins and dithiocarbamates, while actions for phosmet have already been taken. To those active substances with DNT potential, further progress aiming at reducing uncertainties, redefining data gaps, establishing cumulative assessment groups and performing cumulative risk assessments for DNT, is ongoing engaging EFSA and stakeholders.

In the chronic probabilistic risk assessment based on the surveys used and their size, the probability to exceed the ADI was estimated to be less than 1 subject out of 1,000,000 for 350 out of 353 active substances. For the remaining three substances, only imazalil and pyrimethanil resulted in two and five populations, respectively, exceedances of the ADI equal or above 1 subject per million (at the middle-bound exposure).

Overall, in the samples analysed in the framework of 2021–2023 monitoring programmes, the estimated dietary exposure to single pesticide residues for which HBGVs are available is very low for most of the EU subpopulation groups assessed. Thus, the risk to EU consumer's health associated with pesticide individual substances is low. Previous assessments on cumulative exposure to pesticides affecting the nervous system, the thyroid and the craniofacial alterations concluded that the threshold for regulatory consideration established by risk managers, was not exceeded.

Based on the 2023 findings of the pesticide monitoring programmes, EFSA recommends the following:

- EFSA reiterates its previous years' recommendation to EU Member States to take the necessary measures to fulfil the minimum number of samples set in Annex II of the EU MACP Regulations regarding the 12 food commodities and the specific provisions on food for infants and young children and organic (as applicable).
- In the frame of the EU MACP, the following pesticide/crop combinations leading to non-compliances should be further investigated by Member States and monitored over the different years to confirm their decrease in frequency:

  From samples coming from the EU market:

  - chlorpyrifos (RD) and linuron (RD) in carrots,
  - imidacloprid (RD) in cauliflowers,

- chlorpyrifos (RD) in oranges,
- mepiquat chloride (RD) in pears.
- chlorpropham (RD) in potatoes,
- diflubenzuron (RD), imidacloprid (RD) and tricyclazole (RD) in rice.

From samples coming from outside the EU internal market leading to non-compliant results, the most frequent combinations were:

- fenamiphos (RD) and thiabendazole (RD) in carrots,
- glyphosate (RD), chlorpyrifos (RD), ethylene oxide (RD) and fosetyl (RD) in dried beans,
- buprofezin (RD) and chlorpyrifos (RD) in oranges,
- diflubenzuron (RD) in pears,
- thiamethoxam (RD), acetamiprid (RD), carbendazim (RD), chlormequat chloride (RD), chlorpyrifos (RD), imidacloprid (RD), propiconazole (RD) and tricyclazole (RD) in rice.

- Dried beans and rice are bulked products that represented the commodities with the highest MRL exceedance (6.9% and 5.1%, respectively) and non-compliance (3.5% and 3.4%, respectively) rates of those included in the EU MACP. Moreover, most of the pesticides leading to non-compliance in these commodities were quantified in samples coming from third countries, mainly Argentina, Madagascar and the United Kingdom in dried beans and India and Pakistan in rice. It is recommended to keep monitoring these two commodities and to elucidate which countries are using non-authorised active substances, namely: chlorpyrifos (RD), tricyclazole (RD), propiconazole (RD), imdacloprid (RD), carbendazim (RD) and ethylene oxide (RD) in crops intended to be imported in the EU.
- The number of pesticides listed in the EU MACP Regulation not meeting the minimum required number of analyses has decreased from 31 in 2022 to 16 in 2023. However, EFSA still recommends that MSs invest efforts to properly enforce the monitoring of mepiquat chloride (RD), haloxyfop (RD), ethylene oxide (RD), glufosinate equivalents (RD), bromide ion (RD), glyphosate (RD), 2,4-D (RD), dithianon (RD), fosetyl (RD), dithiocarbamates (RD), chlormequat chloride (RD), pencycuron (RD), 2-phenylphenol (RD), fluazifop (RD), ethephon (RD) and captan (RD). Notably, all of these substances, except for pencycuron (RD) and 2-phenylphenol (RD), require a single residue method (SRM) for their quantification.
- When considering the results of the overall monitoring programmes (EU MACP and MANCP), samples imported from third countries showed a 3-fold higher non-compliance rate (3.4%) compared with food produced within the EU (1%). The main third countries from which products leading to non-compliance intended to enter the EU market were Türkiye, India and Egypt. Most of these third country consignments were stopped at border. Although an improvement in the non-compliance rate of imported samples is observed in comparison with 2022 (4.5% vs. 3.4%), Member States' National authorities are still recommended to keep monitoring pesticide residues in samples imported from third countries with a wide analytical scope. Furthermore, 4% of the samples were still reported with origin unknown, out of which 2.2% were non-compliant. EFSA reiterates its past recommendation to report this piece of information, particularly on those samples leading to non-compliant results, together with the actions taken, to draw more solid conclusions.
- The active substances with the highest MRL exceedance rate for the overall monitoring programmes were the approved fumigant phosphane (RD), the naturally occurring and approved substance with uses other than as a pesticide - copper compounds (RD) and the substance that triggered a specific incident with strict measures in the past and not approved in the EU – ethylene oxide (RD). Remarkably, MRL exceedances decreased in copper (5.8% vs. 1.4%) and ethylene oxide (2.3% vs. 1.1%) in comparison to 2022, while phosphane was not leading to high MRL exceedances last year. Therefore, National Competent Authorities should consider the following pesticide/sample combinations in their monitoring programmes:

  - phosphane (RD) in rice, sunflower seeds, thyme and peas without pods, all from third countries,
  - copper compounds (RD) in wild terrestrial vertebrate animals, honey and bovine liver with particular origin from an EU MS,
  - ethylene oxide (RD) in samples coming from India and Türkiye.

- Focusing on animal commodities, copper and chlordecone (a banned persistent organic pollutant used in the past as pesticide in France overseas territories – known problem to this country), presented the highest quantification rates. Regarding non-compliance rate, bromide ion (RD) – a naturally occurring substance that can also be present in feed - presented the highest, mainly in bovine liver. Importantly, the number of quantified substances in honey has decreased from 32 to 23 over the last year, together with MRL exceedance (1.7% in 2023 vs. 3.6% in 2022) and non-compliance rates (1.2% in 2023 vs. 2.2% in 2022). Of these, acetamiprid, amitraz and boscalid were the most frequently quantified. Reporting countries are recommended to keep monitoring honey and other apicultural products in their national programmes, with a wide analytical scope and investigate the reasons for the presence of these substances.
- The MRL exceedance (5.6%) and non-compliance (3.1%) rates observed in processed food in 2023 were higher than those reported in 2022 (3.7% and 2.3%, respectively). The processed products presenting the highest non-compliance rate were grape leaves and similar species (39%), camomile flowers (18.2%), dried celery leaves (15.8%), dried basil and mint (15.8%), dried parsley (15.0%), processed dried beans (13.3%), dried liquorice (12.5%), coriander seed (12.5%), processed chards/beet leaves (11.8%), processed cumin seed (11.3%) and soyabeans oil (10.9%). Unprocessed food products showed

MRL exceedance (3.7%) and non-compliance (2.0%) rates lower than those processed, being grape leaves and similar species (20.2%), cumin seed (12.9%), pitahaya (dragon fruit) (12.1%) and chilli peppers (11.0%) those with the highest non-compliance rate. It is recommended to continue monitoring these food items, with an emphasis on the processed ones, in the national programmes designed by the different reporting countries.

- The number of samples with multiple pesticide residues (25.5%) was in the same range as in 2022 (23.0%). Unprocessed sweet peppers, citrus fruits (oranges, lemons, mandarins), apples, pears and strawberries were the commodities exhibiting the highest frequency of multiple residues. Among the processed products, raisins, red wine, wheat flour and processed apples were those with the highest multiple residues quantified. EFSA recommends reporting countries to continue monitoring these foodstuffs under their programmes.
- In organic farming, MRL exceedance and non-compliance rates decreased in 2023 compared to 2022 (exceedances: 0.9% in 2023 vs. 2.4% in 2022; non-compliance rate: 0.4% in 2023 vs. 1.4% in 2022). However, substances not authorised on organic farming were still reported sporadically: ethylene oxide (RD), imazethapyr (RD), chlorpyrifos (RD) and glyphosate (RD). Reporting countries are recommended to investigate the reasons for these findings and to widen the analytical scope in organic samples as much as possible.
- Competent authorities are recommended to follow-up on the following combinations exceeding the acute HBGV of an individual consumer per day:
    - ethephon in bananas and sweet peppers,
    - oxamyl in cucumber, beans (with pods), carrots, tomatoes, potatoes and strawberries,
    - imazalil in potatoes,
    - carbofuran in tomatoes, beans with pods and sweet peppers, all from third countries,
- The highest probabilities of exceeding the acute HBGV were estimated for some scenarios assigned to the active substances covered by the enforced residue definition *cypermethrins including other mixtures of constituent isomers (sum of isomers)* and *dithocarbamates (dithiocarbamates expressed as $CS_2$, including maneb, mancozeb, metiram, propineb, thiram and ziram)*. EFSA recommends continuing efforts to develop analytical methods specific to the isomers and precursors included in these residue definitions to enable more realistic exposure estimations. Additionally, EFSA advises remaining vigilant to $CS_2$ and cypermethrins (sum of isomers) quantifications in commodities where no uses were reported in the most recent comprehensive MRL reviews on these substances. An EU review process for the MRLs for both groups of substances is already ongoing.
- Dimethoate and carbofuran are no longer authorised in the EU and all MRLs were set to the lowest achievable LOQ years ago. EFSA recommends risk managers to take the necessary measures to assure that food containing these substances is either not placed or withdrawn from the market. Given the outcome of the exposure calculations where exceedances of the chronic HBGV were driven by food products consumed processed, i.e. imazalil and pyrimethanil in citrus fruits and pirimiphos-methyl in wheat, authorisation holders of these active substances are recommended to generate processing factors on concentrated juices to further refine the risk assessment. Furthermore, it is necessary to elucidate how other processing techniques (e.g. increasing of temperature, clarifying) may alter the nature and levels of residues in the concentrated juices.
- Reporting countries may consider strengthening the monitoring of pesticide residues in processed food commodities.

## ABBREVIATIONS: REPORTING COUNTRY CODES

| | |
|---|---|
| AT | Austria |
| BE | Belgium |
| BG | Bulgaria |
| CY | Cyprus |
| CZ | Czechia |
| DE | Germany |
| DK | Denmark |
| EE | Estonia |
| EL | Greece |
| ES | Spain |
| FI | Finland |
| FR | France |
| HR | Croatia |
| HU | Hungary |
| IE | Ireland |
| IS | Iceland |
| IT | Italy |
| LT | Lithuania |
| LU | Luxembourg |
| LV | Latvia |
| MT | Malta |

| | |
|---|---|
| XI | Northern Ireland |
| NL | The Netherlands |
| NO | Norway |
| PL | Poland |
| PT | Portugal |
| RO | Romania |
| SE | Sweden |
| SI | Slovenia |
| SK | Slovak Republic |

## OTHER ABBREVIATIONS

| | |
|---|---|
| ADI | acceptable daily intake |
| ARfD | acute reference dose |
| BAC | Benzalkonium Chloride |
| BCP | Border Control Posts |
| CAG | Cumulative Assessment Group |
| CP | Control Point |
| CRA | cumulative risk assessment |
| $CS_2$ | Carbon disulfide |
| DDAC | didecyldimethylammonium chloride |
| DNT | developmental neurotoxicity |
| DWH | EFSA's scientific Data Warehouse |
| EEA | European Economic Area |
| EFTA | European Free Trade Association |
| EU MACP | EU-coordinated multiannual control programme |
| EUPT | European Proficiency Test |
| EURL | European Union Reference Laboratory |
| FAO | Food and Agriculture Organization of the United Nations |
| GAP | Good Agricultural Practice |
| HBGV | health-based guidance value |
| HCH | Hexachlorocyclohexane |
| HQ | hazard quotient |
| HRM | highest residue measured |
| LOD | limit of detection |
| LOQ | limit of quantification |
| MANCP | Multiannual National Control Programme |
| MRL | maximum residue level |
| POP | persistent organic pollutants |
| pTDI | provisional tolerable daily intake |
| PRIMo | Pesticide Residue Intake Model |
| RD | Residue Definition |
| SSD | standard sample description |
| VMPR | Veterinary medicinal product residues |
| WHO | World Health Organization |

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## REQUESTOR

European Commission

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## REFERENCES


EFSA (European Food Safety Authority). (2009). Review of the existing maximum residue levels (MRLs) for ethephon on request of EFSA. *EFSA Journal*, *7*(10), 1347. https://doi.org/10.2903/j.efsa.2009.1347

EFSA (European Food Safety Authority). (2011). Guidance of EFSA on the use of the EFSA comprehensive European food consumption database in intakes assessment. *EFSA Journal*, *9*(3), 2097. https://doi.org/10.2903/j.efsa.2011.2097

EFSA (European Food Safety Authority). (2012a). Guidance on the use of probabilistic methodology for modelling dietary exposure to pesticide residues. *EFSA Journal*, *10*(10), 2839. https://doi.org/10.2903/j.efsa.2012.2839

EFSA (European Food Safety Authority). (2012b). A European tool for usual intake distribution estimation in relation to data collection by EFSA. *EFSA Supporting Publications*, EN-300. https://doi.org/10.2903/sp.efsa.2012.EN-300

EFSA (European Food Safety Authority). (2013). Guidance of EFSA on the standard sample description ver. 2.0. *EFSA Journal*, *11*(10), 3424. https://doi.org/10.2903/j.efsa.2013.3424

EFSA (European Food Safety Authority). (2014). Scientific Opinion on the essential composition of infant and follow-on formulae. *EFSA Journal*, *12*(7), 3760. https://doi.org/10.2903/j.efsa.2014.3760

EFSA (European Food Safety Authority). (2015a). Pesticide monitoring program: Design assessment. *EFSA Journal*, *13*(2), 4005. https://doi.org/10.2903/j.efsa.2015.4005

EFSA (European Food Safety Authority). (2015b). The food classification and description system FoodEx2 (revision 2). *EFSA Supporting Publications*, EN-804. https://doi.org/10.2903/sp.efsa.2015.en-804

EFSA (European Food Safety Authority). (2015c). EFSA scientific workshop, co-sponsored by FAO and WHO: Revisiting the international estimate of short-term intake (IESTI equations) used to estimate the acute exposure to pesticide residues via food. *EFSA Supporting Publications*, EN-907. https://doi.org/10.2903/sp.efsa.2015.en-907

EFSA (European Food Safety Authority). (2017). Scientific Opinion on the clarification of some aspects related to genotoxicity assessment. *EFSA Journal*, *15*(12), 5113. https://doi.org/10.2903/j.efsa.2017.5113

EFSA (European Food Safety Authority). (2018a). Guidance on use of EFSA pesticide residue intake model (EFSA PRIMo revision 3). *EFSA Journal*, *16*(1), 5147. https://doi.org/10.2903/j.efsa.2018.5147

EFSA (European Food Safety Authority). (2018b). Scientific opinion on pesticides in foods for infants and young children. *EFSA Journal*, *16*(6), 5286. https://doi.org/10.2903/j.efsa.2018.5286

EFSA (European Food Safety Authority). (2018c). Conclusion on the peer review of the pesticide risk assessment of the active substance fosetyl. *EFSA Journal*, *16*(7), 5307. https://doi.org/10.2903/j.efsa.2018.5307

EFSA (European Food Safety Authority). (2018d). Reasoned Opinion on the updated review of the existing maximum residue levels for imazalil according to article 12 of regulation (EC) No 396/2005 following new toxicological information. *EFSA Journal*, *16*(10), 5453. https://doi.org/10.2903/j.efsa.2018.5453

EFSA (European Food Safety Authority). (2018e). Conclusion on the peer review of the pesticide risk assessment of the active substance dimethoate. *EFSA Journal*, *16*(10), 5454. https://doi.org/10.2903/j.efsa.2018.5454

EFSA (European Food Safety Authority). (2019a). Technical report on the raw primary commodity (RPC) model: Strengthening EFSA's capacity to assess dietary exposure at different levels of the food chain, from raw primary commodities to foods as consumed. *EFSA Supporting Publications*, EN-1532. https://doi.org/10.2903/sp.efsa.2019.EN-1532

EFSA (European Food Safety Authority). (2019b). Review of the existing maximum residue levels for glyphosate according to article 12 of regulation (EC) No 396/2005 – Revised version to take into account omitted data. *EFSA Journal*, *17*(10), 5862. https://doi.org/10.2903/j.efsa.2019.5862

EFSA (European Food Safety Authority). (2020a). Statement on the dietary exposure assessment for the temporary maximum residue levels for chlordecone in certain products of animal origin. *EFSA Journal*, *18*(3), 6052. https://doi.org/10.2903/j.efsa.2020.6052

EFSA (European Food Safety Authority). (2020b). Cumulative dietary risk characterisation of pesticides that have acute effects on the nervous system. *EFSA Journal*, *18*(4), 6087. https://doi.org/10.2903/j.efsa.2020.6087

EFSA (European Food Safety Authority). (2020c). Cumulative dietary risk characterisation of pesticides that have chronic effects on the thyroid. *EFSA Journal*, *18*(4), 6088. https://doi.org/10.2903/j.efsa.2020.6088

EFSA (European Food Safety Authority). (2022). Scientific Report on retrospective cumulative dietary risk assessment of craniofacial alterations by residues of pesticides. *EFSA Journal*, *20*(10), 7550. https://doi.org/10.2903/j.efsa.2022.7550

EFSA (European Food Safety Authority). (2023a). Scientific Opinion on the re-evaluation of the existing health-based guidance values for copper and exposure assessment from all sources. *EFSA Journal*, *21*(1), 7728. https://doi.org/10.2903/j.efsa.2023.7728

EFSA (European Food Safety Authority). (2023b). Reasoned opinion on the review of the existing maximum residue levels for cypermethrins according to article 12 of regulation (EC) No 396/2005. *EFSA Journal*, *21*(3), 7800. https://doi.org/10.2903/j.efsa.2023.7800

EFSA (European Food Safety Authority). (2023c). Statement on the risk assessment of maximum residue levels (MRLs) for oxamyl in view of consumer protection. *EFSA Journal*, *21*(3), 7823. https://doi.org/10.2903/j.efsa.2023.7823

EFSA (European Food Safety Authority). (2023d). Reasoned opinion on the review of the existing maximum residue levels for dithiocarbamates according to article 12 of regulation (EC) No 396/2005. *EFSA Journal*, *21*(5), 7987. https://doi.org/10.2903/j.efsa.2023.7987

EFSA (European Food Safety Authority). (2023e). Statement on risk assessment related to the presence of benzalkonium chloride (BAC), didecyldimethyl ammonium chloride (DDAC) and chlorates in/on fish and fish products. *EFSA Journal*, *21*(5), 8019. https://doi.org/10.2903/j.efsa.2023.8019

EFSA (European Food Safety Authority). (2024a). Prioritisation of pesticides and target organ systems for dietary cumulative risk assessment based on the 2019–2021 monitoring cycle. *EFSA Journal*, *22*(2), 8554. https://doi.org/10.2903/j.efsa.2024.8554

EFSA (European Food Safety Authority). (2024b). Targeted review of the maximum residue levels (MRLs) for ethephon. *EFSA Journal*, *22*, 8757. https://doi.org/10.2903/j.efsa.2024.8757
EFSA (European Food Safety Authority). (2024c). Chemical monitoring reporting guidance: 2024 data collection. *EFSA Supporting Publications*, EN-8596. https://doi.org/10.2903/sp.efsa.2024.EN-8596
EFSA (European Food Safety Authority). (2024d). Review of the existing maximum residue levels for gamma-cyhalothrin according to article 12 of regulation (EC) No 396/2005. *EFSA Journal*, *22*, 8758. https://doi.org/10.2903/j.efsa.2024.8758
EFSA (European Food Safety Authority). (2024e). The 2022 European Union report on pesticide residues in food. *EFSA Journal*, *22*, 8753. https://doi.org/10.2903/j.efsa.2024.8753
EFSA (European Food Safety Authority). (2024f). Statement on the toxicological properties and maximum residue levels of acetamiprid and its metabolites. *EFSA Journal*, *22*, 8759. https://doi.org/10.2903/j.efsa.2024.8759
EFSA (European Food Safety Authority). (2024g). Harmonized terminology for scientific research [Data set], version v8. *Zenodo*. https://doi.org/10.5281/zenodo.10599860
EFSA (European Food Safety Authority). (2025a). Risks to human and animal health from the presence of bromide in food and feed. *EFSA Journal*, *23*, 9121. https://doi.org/10.2903/j.efsa.2025.9121
EFSA (European Food Safety Authority). (2025b). Statement on the update of maximum residue levels (MRLs) for copper compounds. *EFSA Journal*, *23*, 9271. https://doi.org/10.2903/j.efsa.2025.9271
EFSA (European Food Safety Authority). (2025c). Report for 2023 on the results from the monitoring of residues of veterinary medicinal products in live animals and animal products. *EFSA Supporting Publications*, EN-9297. https://doi.org/10.2903/sp.efsa.2025.EN-9297
EFSA (European Food Safety Authority). (2025d). National summary reports on pesticide residue analysis performed in 2023. *EFSA Supporting Publications*, EN-9320. https://doi.org/10.2903/sp.efsa.2025.EN-9320
European Commission. (2018). Working document on the summing up of LOQs in case of complex residue definitions. SANCO/12574/2015. Rev. 5(1). Application date: 1 January 2018. 30/11–01/12 2015.
European Commission. (2021). Analytical Quality Control and Method Validation Procedures for Pesticide Residues Analysis in Food and Feed. SANTE/11312/2021 V2 (implemented from 01.01.2024).
European Commission. (2024). The 2023 annual report alert and cooperation network. Luxembourg: Publications Office of the European Union, 2023. ISBN 978-92-68-04222-9. ISSN 2363-0965. https://food.ec.europa.eu/document/download/911d49f2-b3ef-4752-8ea3-5f20dbbe9945_en?filename=acn_annual-report_2023.pdf
FAO (Food and Agriculture Organization of the United Nations). (2003). Pesticide residues in food – 2005. Report of the Joint Meeting of the FAO Panel of Experts on Pesticide Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues. FAO Plant Production and Protection Paper 176.
FAO (Food and Agriculture Organization of the United Nations). (2017). *Submission and evaluation of pesticide residues data for the estimation of maximum residue levels in food and feed. Pesticide Residues. 3rd Edition* (p. 286). FAO Plant Production and Protection Paper 225.
Kittelmann, A., Scholz, R., Tietz, E., Zincke, F., & Michalski, B. (2024). Second update of the EU database of processing factors for pesticide residues. *EFSA Supporting Publications*, EN-8738. https://doi.org/10.2903/sp.efsa.2024.EN-8738
OECD (Organisation for Economic Co-operation and Development). (2014). *MRL calculator: Users guide and white paper, series on pesticides and biocides, No. 56*. OECD Publishing. https://doi.org/10.1787/9789264221567-en
UNEP. (2001). Stockholm Convention on Persistent Organic Pollutants, United Nation Environment Program, Stockholm Convention Secretariat. http://chm.pops.int/TheConvention/Overview/tabid/3351/
Zincke, F., Fischer, A., Kittelmann, A., Kraus, C., Scholz, R., & Michalski, B. (2022). First update of the EU database of processing factors for pesticide residues. *EFSA Supporting Publications*, EN-7453. https://doi.org/10.2903/sp.efsa.2022.EN-7453

## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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# APPENDIX A

## Authorities responsible for reporting pesticide residues by country

| Country | National competent authority | Web address for published national monitoring reports |
|---|---|---|
| **Austria** | Federal Ministry of Social Affairs, Health, Care and Consumer Protection | www.verbrauchergesundheit.gv.at/Lebensmittel/Pestizidruek_Kontami/pestizid.html |
| | Austrian Agency for Health and Food Safety | www.ages.at/pflanze/pflanzenschutzmittel/pflanzenschutzmittel-rueckstaende |
| **Belgium** | Federal Agency for the Safety of the food Chain (FASFC) | www.favv-afsca.be/fr/publications/brochures/pesticide-residue-monitoring-food-plant-origin-belgium-summary |
| **Bulgaria** | Risk Assessment Centre on Food Chain | www.babh.government.bg/en/ |
| **Croatia** | Ministry of Agriculture | www.mps.hr/ |
| **Cyprus** | Ministry of Health, Pesticides Residues Laboratory of the State General Laboratory | www.moh.gov.cy/sgl |
| | Ministry of Health, Department of Medical and Public Health Services (MPHS) | |
| **Czech Republic** | Czech Agriculture and Food Inspection Authority | www.szpi.gov.cz |
| | State Veterinary Administration | www.svscr.cz |
| **Denmark** | Danish Veterinary and Food Administration | foedevarestyrelsen.dk/publikationer |
| | National Food Institute, Technical University of Denmark | www.food.dtu.dk/publikationer/kemikaliepaavirkninger/pesticider-i-kosten |
| **Estonia** | Veterinary and Food Board | www.vet.agri.ee |
| **Finland** | Finnish Food Authority, Finnish Customs and National Supervisory Authority for Welfare and Health | www.ruokavirasto.fi/en/companies/food-sector/production/common-requirements-for-composition/residues-of-plant-protection-products/control-of-plant-protection-product-residues-in-food/ |
| **France** | Ministère de l'économie et des finances / Direction générale de la concurrence, de la consommation et de la répression des fraudes (DGCCRF) | www.economie.gouv.fr/dgccrf/securite/produits-alimentaires |
| | Ministère de l'Agriculture et de l'Alimentation, Direction générale de l'alimentation (DGAL) | agriculture.gouv.fr/plans-de-surveillance-et-de-controle |
| **Germany** | Federal Office of Consumer Protection and Food Safety (BVL) | www.bvl.bund.de/berichtpsm |
| **Greece** | Ministry of Rural Development and Food | www.minagric.gr/index.php/en/citizen-menu/foodsafety-menu |
| | | www.minagric.gr/index.php/el/for-farmer-2/crop-production/fytoprostasiamenu/ypoleimatafyto |
| **Hungary** | National Food Chain Safety Office | www.nebih.gov.hu |
| **Iceland** | MAST – The Icelandic Food and Veterinary Authority | www.mast.is |
| **Ireland** | Department of Agriculture Food and the Marine | www.pcs.agriculture.gov.ie |
| **Italy** | Ministero della Salute – Direzione Generale per l'Igiene e la Sicurezza degli Alimenti e la Nutrizione – Ufficio 7 | www.salute.gov.it/portale/fitosanitari/dettaglioContenutiFitosanitari.jsp?lingua=italiano&id=1105&area=fitosanitari&menu=vegetali |
| **Latvia** | Ministry of Agriculture | www.zm.gov.lv |
| | Food and Veterinary Service of Latvia | |
| **Lithuania** | National Food and Veterinary Service (SFVS) | www.nmvrvi.lt |
| **Luxembourg** | Ministry of Health, Directorate for public health, Division of Food Safety (Secualim) | www.securite-alimentaire.public.lu |
| | Ministry of Health, Administration of Veterinary Services (ASV) | |
| **Malta** | Malta Competition and Consumer Affairs Authority | www.mccaa.org.mt |
| **Netherlands** | Netherlands Food and Consumer Product Safety Authority (NVWA) | www.nvwa.nl |
| **Norway** | Norwegian Food Safety Authority | www.mattilsynet.no |
| | | www.mattilsynet.no/mat_og_vann/uonskede_stoffer_imaten/rester_av_plantevernmidler_i_mat/#overvakings_og_kartleggingsprogrammer |

(Continued)

| Country | National competent authority | Web address for published national monitoring reports |
|---|---|---|
| **Poland** | The State Sanitary Inspection | www.gis.gov.pl |
| **Portugal** | Direção-Geral de Alimentação e Veterinária (DGAV) | www.dgv.min-agricultura.pt/portal/page/portal/DGV/genericos?generico=4217393&cboui=4217393t |
| **Romania** | National Sanitary Veterinary and Food Safety Authority | www.ansvsa.ro |
| | Ministry of Agriculture and Rural Development | www.madr.ro |
| | Ministry of Health | |
| **Slovakia** | State Veterinary and Food Administration of the Slovakian Republic | www.svps.sk/ |
| | Public Health Authority of the Slovakian Republic | |
| **Slovenia** | Administration of the Republic of Slovenia for Food Safety, Veterinary Sector and Plant Protection | www.uvhvvr.gov.si/si/delovna_podrocja/ostanki_pesticidov |
| | Health Inspectorate of the Republic of Slovenia | www.gov.si/drzavni-organi/organi-v-sestavi/zdravstveni-inspektorat/ |
| **Spain** | Spanish Agency for Food Safety and Nutrition (AESAN) | www.aecosan.msssi.gob.es/AECOSAN/web/seguridad_alimentaria/subseccion/programa_control_residuos.htm |
| **Sweden** | Swedish Food Agency | www.livsmedelsverket.se |
| **Northern Ireland*[1]** | Department of Agriculture, Environment and Rural Affairs (DAERA). Sanitary and Phytosanitary Policy and Logistics Division | www.daera-ni.gov.uk/ |

## APPENDIX B

### Supporting information

Annex I The data visualisation (EU MACP and MANCP) of 2023 ARPR: https://multimedia.efsa.europa.eu/pesticides-report-2023/

***Annexes*** published in Zenodo: 10.5281/zenodo.14765085

Annex II – Supporting data for enforcement of the 2023 EU pesticide residues report on food
- Table 2.1 – The residue definitions under 2023 EU-coordinated multiannual programme of the Union.
- Table 2.2 – List of samples exceeding the MRLs, including information on the measured residue concentrations and the origin of the samples
- Table 2.3 – Scope of analysis of pesticides reported
- Table 2.4 – Regulation (EU) 2019/1793 on the temporary increase of official controls – extract of the controls to be performed of pesticides in food

Annex III – Supporting data of the probabilistic risk assessment
- Table 3.1 – List of residue definitions and active substances quantified in the last 3-year cycle: 2021–2023
- Table 3.2 – List of health-based guidance values (HBGV)
- Table 3.3 – Processing factors used
- Table 3.4 – List of authorisation status

Annex IV – Acute probabilistic exposure assessment to single substance, Primary of 2023 ARPR
- Figure 4.1: Histogram presenting the distribution of the hazard quotient per active substance and survey
- Figure 4.2: Box plot presenting the 95% confidence intervals of the hazard quotient at different percentiles per active substance and survey
- Figure 4.3: Pie chart presenting the average contributions of RPCs to the exposures exceeding the 99th percentile
- Table 4.4: Estimated 95% confidence intervals of the hazard quotient at different percentiles per active substance and survey
- Table 4.5: Distribution of the hazard quotient calculated per active substance, survey and bootstrap
- Table 4.6: Average contributions of RPCs to the exposures exceeding the 99th percentile per active substance and survey
- Table 4.7: Detailed records for consumers with exposures closer to the 99th percentile
- Table 4.8: Overview of RPCs and active substances with limited occurrence data

Annex V – Acute probabilistic exposure assessment to single substance, Tentative of 2023 ARPR
- Figure 5.1: Histogram presenting the distribution of the hazard quotient per active substance and survey
- Figure 5.2: Box plot presenting the 95% confidence intervals of the hazard quotient at different percentiles per active substance and survey
- Figure 5.3: Pie chart presenting the average contributions of RPCs to the exposures exceeding the 99th percentile
- Table 5.4: Estimated 95% confidence intervals of the hazard quotient at different percentiles per active substance and survey
- Table 5.5: Distribution of the hazard quotient calculated per active substance, survey and bootstrap
- Table 5.6: Average contributions of RPCs to the exposures exceeding the 99th percentile per active substance and survey
- Table 5.7: Detailed records for consumers with exposures closer to the 99th percentile
- Table 5.8: Overview of RPCs and active substances with limited occurrence data

Annex VI – Chronic probabilistic exposure assessment to single substance, Primary of 2023 ARPR
- Figure 6.1: Histogram presenting the distribution of the hazard quotient per active substance and survey
- Figure 6.2: Box plot presenting the 95% confidence intervals of the hazard quotient at different percentiles per active substance and survey
- Figure 6.3: Pie chart presenting the average contributions of RPCs to the exposures exceeding the 99th percentile
- Table 6.4: Estimated 95% confidence intervals of the hazard quotient at different percentiles per active substance and survey
- Table 6.5: Distribution of the hazard quotient calculated per active substance, survey and bootstrap
- Table 6.6: Average contributions of RPCs to the exposures exceeding the 99th percentile per active substance and survey
- Table 6.7: Detailed records for consumers with exposures closer to the 99th percentile
- Table 6.8: Overview of RPCs and active substances with limited occurrence data

## ANNEX A

### Outcome of the Member State,*[1] IS and NO consultation

Annex A is available under the Supporting Information section on the online version of the scientific output.