TECHNICAL REPORT

APPROVED: 12 March 2018

doi:10.2903/sp.efsa.2018.EN-1397

Monitoring data on pesticide residues in food: results on organic versus conventionally produced food

European Food Safety Authority (EFSA)

Abstract

According to Regulation (EC) No 396/2005 on maximum residue levels of pesticides in or on food and feed, European Union Member States, Iceland and Norway monitor pesticide residue levels in food samples and submit the monitoring results to EFSA. This report provides the results of an ad-hoc data extraction and comparison of the monitoring results on organic and conventionally produced food samples. The data extraction focussed on samples taken in the framework of the EU-coordinated control programmes in the reference period 2013, 2014 and 2015 (for a total of 28,912 conventional and 1,940 organic food samples). Overall, 44% of the conventional produced food samples contained one or more quantifiable residues, while in organic food the frequency of samples with measurable pesticide residues was lower (6.5% of the organic samples). The MRL exceedance rate for conventional and organic food amounted to 1.2% and 0.2% of the samples tested, respectively. The calculated average number of pesticides analysed per food sample in organic and conventional food products was considered to be comparable.

Key words: pesticide residues, food, monitoring, control, organic production, conventional production

Requestor: European Parliament

Question number: EFSA-Q-2017-00506

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Suggested citation: EFSA (European Food Safety Authority) 2018. Monitoring data on pesticide residues in food: results on organic versus conventionally produced food. EFSA supporting publication 2018:EN-1397. 30 pp. doi:10.2903/sp.efsa.2018.EN-1397

ISSN: 2397-8325

Summary

According to Regulation (EC) No 396/2005 on maximum residue levels (MRL) of pesticides in or on food and feed of plant and animal origin European Union Member States, Iceland and Norway carry out official controls on pesticide residues in food. The results of the food analyses are submitted to EFSA. According to Article 32 of this regulation, EFSA prepares for each calendar year a report on pesticide residues on the basis of the results provided by the reporting countries. Thus, the 'European Union (EU) Annual Reports' provide both a summary of results of the pesticide occurrence in the most important food products consumed and the estimated dietary risk related to the exposure of European consumers to pesticide residues. Moreover, the data are analysed to identify food products whose pesticide residues exceeded the legal limits. Considering the large quantity of data received by EFSA each year, the EU Reports provide for a general overview on the official control activities carried out by EU Member States, Iceland and Norway. This document presents the results of an ad-hoc, refined data extraction and comparison, which was not conducted nor presented in the framework of the preparation of the EU Annual Reports above mentioned.

Taking into account the results for all unprocessed food items covered by the 2013, 2014 and 2015 EU-coordinated control programmes, this document shows the outcome of the comparison of the percentage of the occurrence of pesticide residues in food samples reported to have originated from two different production methods: organic and conventional. In particular, the pesticide residue monitoring results from 2013-2015 have been summarised in terms of number and percentage of the samples analysed, the samples with quantifiable residues at or above the limit of quantification and the samples for which the MRL was exceeded numerically; these summary statistics have been calculated for each food item and reported separately for organically produced and conventional food and derived without considering the different number of pesticides analysed for in each sample. The comparison of the detection and MRL exceedance rate between organic and conventional products in the present report is more reliable than the comparisons in the single EU Annual Reports, due to a larger number and more systematic inclusion of samples considered and a more uniform analytical scope.

The fresh, frozen or chilled food products (unprocessed in any other way) considered in the data comparison were the following: apples, aubergines, bananas, beans with pods, broccoli, carrots, chicken eggs, cow's milk, cucumbers, head cabbage, leek, lettuce, liver of ruminants/swine/poultry, mandarins, peaches (including nectarines), oats, oranges, pears, peas without pods, peppers (sweet), potatoes, poultry meat (fat and muscle), rice, rye, spinach, strawberries, swine meat, table grapes, tomatoes and wheat (grains).

Overall, considering all food items, the number of samples taken into account was 30,852. Out of these samples the largest majority (28,912 samples) were conventional food (94% of the samples). The pesticide residues analysed in food products of both plant and animal origin in the frame of the EU-coordinated programmes amounted to 209, 213 and 164 for the monitoring years 2013, 2014 and 2015, respectively. The total number of distinct pesticides that were actually analysed in the three years of control activities amounted to 213. Bromide ion and carbon disulphide that result from the dithiocarbamates can be naturally occurring substances and the presence of such residues is not necessarily resulting from the use of pesticides. Thus, these substances were not considered in the data analysis of this report in both organic and conventionally grown food samples.

Out of 1,940 organic food samples, 6.5% (126 samples) contained quantifiable residues of one or more pesticides. For conventionally grown food, 44.5% of the 28,912 samples analysed (12,857 samples) contained quantifiable residues of one or more pesticides.

The MRL exceedance rate for conventional and organic food amounted to 1.2% and 0.2% of the samples analysed, respectively. It is here recalled that MRLs are based on the maximum level of residues expected when the pesticide is applied according to the authorised good agricultural practices; MRLs breaches do not necessarily represent an exceedance of the toxicological reference values or a potential risk for the consumers' health. In addition, MRL exceedances mentioned in this report were already assessed, regarding the possible reasons for the exceedance and the potential risk for consumers, in the respective EU Annual Reports.

Considering all the food items addressed by the report, the average number of pesticides analysed for conventional and organic food samples was similar for both methods of production systems. Without discriminating between organic and conventional samples, a difference in the calculated means of the actual number of pesticides analysed per sample was noted at food item/group level. The highest averages have been calculated for food of plant origin (e.g. vegetables, fruit and cereals), while the lowest mean numbers of pesticide analysed per sample have been estimated for food of animal origin (e.g. milk and eggs). These results are not unexpected considering that the EU-coordinated control plans request the national control laboratories to analyse pesticide residues for a wider analytical scope in food of plant origin than in food of animal origin, as it is known that the majority of samples of animal origin are typically free of measurable residues.

It is important to consider that the limited number of results available for some organic food items is an uncertainty in the data analysis presented in this document. Nonetheless, this report provides the most comprehensive and systematic summary and comparison of the frequency of pesticide detection in organic and conventional products to date.

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1. Introduction

1.1. Background

The Science and Technology Options Assessment (EP Committee) (STOA) provides the European Parliament's Committees and other parliamentary bodies with independent, high-quality and scientifically impartial studies and information for the assessment of the impact of possibly introducing or promoting new technologies and identifying, from the technological point of view, the options for the best courses of action to take. In addition, STOA carries out the following tasks: 1) to organise forums in which politicians and representatives of scientific communities or organisations and of society as a whole discuss and compare scientific and technological developments of political relevance to civil society and 2) to support and coordinate initiatives to strengthen parliamentary technology assessment activities in the Member States of the European Union, including creating or enhancing parliamentary technology assessment capacities.

In 2017, a Member of the Committee on Agriculture and Rural Development of the European Parliament (EP) and committee's representative of the STOA proposed to the EP Panel to organise a hearing and draft a report on the topic 'Human health implications of organic food and organic agriculture', which was presented during a meeting of the Panel in Strasbourg late 2016.

It was recognised that for such a report reliable figures on the occurrence of pesticide residues in organic food compared with conventionally produced food were needed. Therefore, the STOA (in the following referred to as 'requestor') approached EFSA to provide a specific data extraction and analyses relating to pesticide residues on organic food in order to make a systematic comparison of the frequency of pesticide detection on organic and conventional productions.

According to Article 26 of Regulation (EC) No 396/2005[1] on maximum residue levels (MRL) of pesticides in or on food and feed of plant and animal origin Member States have to carry out official controls on pesticide residues in food. The results of these food analyses are submitted to EFSA and the European Commission and stored in a pesticide monitoring database held by EFSA. The data submitted by Member States are a comprehensive source of information on pesticide residues in food placed on the European market. According to Article 32 of this regulation, EFSA prepares for each calendar year a report on pesticide residues on the basis of the results provided by the reporting countries (the 'EU Report on Pesticide Residues in Food and Feed', in the following referred to as 'EU Report'), which provides for an overview of the results of the pesticide occurrence in the most important food products consumed and the dietary risk related to the exposure of European consumers to pesticide residues. Moreover, the data are analysed regarding the exceedance of the legal limits applicable for the individual pesticide/commodity combinations. The EU Report also contains specific analysis on different aspects, including comparing results for organic and conventional food products.

In the European Union (EU) two different pesticide residues control programmes are in place. The EU-coordinated control programmes (EUCP) aim at retrieving representative snapshots of the residue situation of food products available to consumers, while the samples taken under the national control programmes are rather risk based, focussing on products that are considered more likely to violate the legal limits established under Regulation EC No 396/2005.

Considering that the results of national control programmes may be biased due to a more targeted sampling strategy and differing analytical scopes according to national priorities, it is recognized that comparing the results on residues in organic and conventional products reported in the EU Reports should not be regarded a systematic comparison. Although narrower in scope, the EUCP provides for a basis for conducting a more systematic comparison, due to the sampling strategy and a defined set of analysed pesticides to be analysed by all countries throughout the Union. Therefore, a comparison of the monitoring results on organic and conventional products taken in the framework of the EUCP should provide additional insight on the residue situation reflecting the products available to European consumers. Thus, EFSA was asked by the requestor to perform an ad hoc data extraction and analysis from the pesticide monitoring database focussing on the EUCP data only.

[1] 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.

EU-harmonised MRL are set for more than 500 pesticides covering 370 food products/food groups. A default MRL of 0.01 mg/kg is applicable for pesticides not explicitly mentioned in the MRL legislation. Regulation (EC) No 396/2005 imposes on Member States the obligation to carry out controls to ensure that food placed on the market is compliant with the legal limits. For organic food items produced in accordance with Regulation (EC) No 834/2007[2], no specific MRLs are established. Thus, the MRL set in Regulation (EC) No 396/2005 apply equally to organic and to conventional food. According to Regulation (EC) No 834/2007, plant protection products should only be used if they are compatible with the objectives and principles of organic production in accordance with the provisions laid down in Article 16(3)(c). Regulation (EC) No 889/2008[3] lays down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products and defines the restricted list of plant protection products that may be used in organic farming. Most of these substances are exempted from the setting of legal limits under Regulation (EC) No 396/2005, as these substances are listed in Annex IV of the MRL regulation. It should be highlighted that the use of plant protection products listed in Regulation (EC) No 889/2008 must comply with the provisions of Article 16(1) of Regulation (EC) No 834/2007, hence these products may only be used as far as the corresponding use is authorised in general agriculture in the Member States concerned.

1.2. Terms of Reference as provided by the requestor

In 2017, EFSA was requested by Mr. Momchil Nekov – a member of the European Parliament (EP) and representative of the EP committee on Science and Technology Options Assessment (STOA) - to extract from the EFSA pesticide monitoring database results on pesticide residues in organic and conventionally produced food and prepare a Technical Report summarising them.

The data extraction should be based on the data submitted to EFSA in the framework of Article 31 of Regulation (EC) No 396/2005, focussing on samples taken under the EU-coordinated control programmes during the years 2013, 2014 and 2015.

More specifically, the requestor asked to extract the following subset of data from the EFSA database:

- Data on unprocessed agricultural products (including frozen or chilled food);
- Data on food samples originated from the EU and from Third Countries, without differentiation;
- All the pesticides covered by the EUCP programmes, excluding results concerning the following substances: bromide ion and the dithiocarbamates.

The technical report should present the following summary, comparative results:

- Total number of samples of organic and conventional food tested;
- Percentage of samples of organic and conventional food containing quantifiable residues above or equal to the Limit of Quantification[4] (LOQ);
- Percentage of samples of organic an conventional food exceeding the pesticide legal limits (MRLs);
- Average number of pesticides analysed per food sample in organic and conventional samples.

[2] Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91. OJ L 189, 20.7.2007, p. 139-161.

[3] Commission Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control. OJ L 250, 18.9.2008, p. 1–84.

[4] In the context of the present report, the terms samples without 'detectable', 'measurable' or 'quantifiable residues' are used as synonyms to describe results where the analytes/pesticide residues were not present in concentrations at or exceeding the limit of quantification (LOQ). The LOQ is considered the smallest concentration of an analyte that can be quantified.

2. Data and methodology

The EUCP control programmes laid down for the years 2013, 2014 and 2015 covered the following commodities:

- EUCP 2013: apples, head cabbage, leek, lettuce, peaches (including nectarines), rye or oats[5], strawberries, tomatoes, cow's milk and swine meat and wine.
- EUCP 2014: beans with pods, carrots, cucumbers, mandarins or oranges, pears, potatoes, spinach, rice, wheat flour, liver of ruminants/swine/poultry and poultry meat[6].
- EUCP 2015: aubergines, bananas, broccoli, table grapes, orange juice, peas without pods, peppers (sweet), virgin olive oil, wheat (grains), butter and chicken eggs.

According to the provisions of the EUCP Regulations[7],[8] the number of samples per food product to be analysed by each reporting country varied from 15 to 93, depending on the population of the reporting country. Member States, Iceland and Norway had to take at least one sample from organic production for each of the 11/12 food products in focus every year. Most of the food products tested in the reference period concerned unprocessed products, except butter, olive oil, orange juice, wheat flour and wine. As agreed with the requestor, the data enquiry shall not cover the processed food items; hence, the data on butter, orange juice, wheat flour and wine are not taken into account in the data comparison presented in this report.

The list of pesticides covered by the EUCP programmes of 2013, 2014 and 2015, including the specific residue definitions, is provided in Appendix A –.

In 2015, the number of approved pesticides for conventional production and with an established Acceptable daily Intake[9] (ADI) was 318[10] (nine of those were also approved for use in organic farming[11]). Out of the 318 substances, 132 were included in the total scope of 213 pesticides of the EUCP during 2013-2015 (four of those being approved for organic farming: pyrethrins, spinosad, deltamethrin and lambda-cyhalothrin).

With regard the pesticides which may exert acute toxicological effects (e.g. substances for which an ARfD[12] is set), a total of 205 pesticides were approved at the EU level in 2015 (four compounds are also applied in organic production); of these, 102 were part of the total scope of the EUCP during 2013-2015 (three of them are allowed in organic farming: pyrethrins, deltamethrin and lambda-cyhalothrin).

The analyses of bromide ion and the dithiocarbamates residues were encompassed by the EUCP provisions. Since bromide ion is naturally occurring, the presence of residues of bromide ion is not necessarily resulting from the use of pesticides. The same is true for carbon disulphide (CS_2), which is resulting from naturally occurring substances in certain food products that mimic the presence of

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[5] Rye and oats were alternative products to be analysed. EFSA assessed them separately since different MRLs are established for the two products.

[6] On 1 April 2013, with the entry into force of Commission Regulation (EU) No 212/2013 of 11 March 2013 replacing Annex I to Regulation (EC) No 396/2005 of the European Parliament and of the Council as regards additions and modifications with respect to the products covered by that Annex, OJ L 68, 12.3.2013, the description of the product to which the MRL applies has changed. At the time when the monitoring Regulation relevant for the calendar year 2014 was adopted (in 2013), the product description was poultry meat (whole product or the fat fraction only), whereas in 2014 the product was defined as muscle (meat after removal of trimmable fat). In the context of this report, both fractions of poultry (muscle and fat) were considered.

[7] Commission Implementing Regulation (EU) No 788/2012 of 31 August 2012 concerning a coordinated multiannual control programme of the Union for 2013, 2014 and 2015 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. OJ L 235, 1.9.2012, p. 8–27.

[8] Commission Implementing Regulation (EU) No 400/2014 of 22 April 2014 concerning a coordinated multiannual control programme of the Union for 2015, 2016 and 2017 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. OJ L119, 23.4.2014, p. 44–56.

[9] The chronic or long-term exposure assessment estimates the expected exposure of an individual consumer over a long period, predicting the lifetime exposure. the estimated short-term exposure for the pesticide/crop combination is compared with the relevant toxicological reference value, the Acceptable Daily Intake (ADI) value.

10 Number of substances according to the EU pesticides database: http://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=homepage&language=EN, including the substances whose approval expired in the course of 2015.

11 Azadirachtin, copper compounds, deltamethrin, ferric phosphate, lambda-cyhalothrin, plant oils (citronella oil and clove oil), pyrethrins, spinosad.

12 In order to perform the short-term (acute) risk assessment, the estimated short-term exposure for the pesticide/crop combination is compared with the relevant toxicological reference value, usually the Acute Reference Dose (ARfD) value.

dithiocarbamates. As indicated in the Term of Reference (see section 1.2) the monitoring results concerning these two compounds have not been addressed in the present technical report.

It should be noted that in the framework of the EUCP some substances that had to be analysed are no longer approved in the EU, however, due to their persistence in the environment, they may be detected in food products (e.g. DDT, dieldrin, hexachlorobenzene, heptachlor, hexachlorocyclohexane or lindane). For these compounds also a separate analysis would need to be performed to identify whether there are differences regarding the occurrence in organic and conventional products. However, this specific assessment was not performed by EFSA.

As regards the pesticides allowed in organic farming (Annex II of Regulation (EC) No 889/2008), only deltamethrin, lambda-cyhalothrin, pyrethrins and spinosad are covered by the EUCP of the reference period (Table 1:). However, deltamethrin and lambda-cyhalothrin are only allowed in pheromone traps so they should not be directly applied to organically produced crops.

Table 1: Pesticides allowed in organic farming according to Annex II of Regulation (EC) No 889/2008

Pesticide allowed in organic farming	Restrictions for the pesticide use	Substance included in the 2013-2015 EUCP	Substance for which no MRL are required
Aluminium silicate (aka kaolin)			Yes
Azadirachtin extracted from Azadirachta indica (Neem tree)			
Basic substances	Only those basic substances within the meaning of Article 23(1) of Regulation (EC) No 1107/2009 of the European Parliament and of the Council that are covered by the definition of 'foodstuff' in Article 2 of Regulation (EC) No 178/2002 of the European Parliament and of the Council and have plant or animal origin. Substances not to be used as herbicides, but only for the control of pests and diseases.		
Beeswax	Only as pruning agent/wound protectant.		
Calcium hydroxide	When used as fungicide, only in fruit trees, including nurseries, to control *Nectria galligena*.		Yes
Carbon dioxide			Yes
Copper compounds in the form of: copper hydroxide, copper oxychloride, copper oxide, Bordeaux mixture, and tribasic copper sulphate	Up to 6 kg copper per ha per year. For perennial crops, by way of derogation from the first paragraph, Member States may provide that the 6 kg copper limit can be exceeded in a given year provided that the average quantity actually used over a 5-year period consisting of that year and of the 4 preceding years does not exceed 6 kg.		
Deltamethrin	Only in traps with specific attractants; only against *Bactrocera oleae* and *Ceratitis capitata Wied.*	Yes	
Ethylene			Yes
Fatty acids	All uses authorised, except herbicide.		
Ferric phosphate (iron (III) orthophosphate)	Preparations to be surface-spread between cultivated plants.		
Hydrolysed proteins excluding gelatine			
Kieselguhr (aka diatomaceous earth)			Yes
Lambda-cyhalothrin	Only in traps with specific attractants; only against *Bactrocera oleae* and *Ceratitis capitata Wied.*	Yes	
Laminarin	Kelp shall be either grown or harvested in a sustainable way.		Yes
Lime sulphur (calcium polysulphide)			Yes
Micro-organisms	Not from GMO origin.		
Paraffin oil			Yes
Pheromones	Only in traps and dispensers.		
Plant oils	All uses authorised, except herbicide.		
Potassium hydrogen carbonate (aka potassium bicarbonate)			Yes
Pyrethrins extracted from *Chrysanthemum cinerariaefolium*		Yes	

Pesticide allowed in organic farming	Restrictions for the pesticide use	Substance included in the 2013-2015 EUCP	Substance for which no MRL are required
Quartz sand			Yes
Quassia extracted from *Quassia amara*	Only as insecticide, repellent.		
Repellents: Sheep fat	Only on non-edible parts of the crop and where crop material is not ingested by sheep or goats.		Yes
Spinosad		Yes	
Sulphur			Yes

The raw data (nearly four millions of records), which were used for this specific data analysis, were provided to the requestor in SAS tables. There, the results for pesticides for which different residue definitions are applicable according to the food products were aggregated under the same 'Pesticide name' (for more details see Appendix A –).

The EUCP results from 2013-2015 have been summarised as indicated by the requestor in terms of number and percentage of the samples with quantifiable residues at or above the LOQ and of the samples for which the MRL was numerically exceeded (see section 3). In case a sample resulted containing more than one quantifiable residue and/or more than one residue above the MRL (multiple residues or multiple MRL breaches), this sample was counted only once in totalling the number of samples with quantified residues above the LOQ or above the MRL; the same approach was used to derive the percentages of samples with quantifiable residue and samples above the MRL.

3. Results

3.1. Number of samples tested

Table 2: summarises the number of samples analysed in the framework of the EU-coordinated control programmes for the food items tested, by year and by the method of production reported for the sample (organic and conventional) in the reference time period 2013-2015[13]. Overall, considering all food types and both production methods (30,852 samples in total), it was observed that the calculated percentage of conventional samples out of the total samples represented almost the totality of the samples tested (93.7% of the total samples), while the organic food was tested only in a minor proportion of the samples tested (6.3% of the total samples).

The same pattern is observed in terms the percentages calculated for the single food items under consideration. The lowest percentages of organic food items tested are identified for poultry muscle (0.6% organic versus 99.4% of conventional samples), swine meat (0.7% versus 99.3%) and liver (1.2% versus 98.8%, considering together the results for all liver species). The highest percentages of organic samples tested compared to the conventionally grown food was observed for cereals (20.0%, 16.4% and 15.8% for rye, oats and wheat samples, respectively).

Furthermore, at food item level (see Table 2:), the lowest number of organic samples tested is recorded for swine meat, poultry muscle and liver samples (only five, six and 14 samples, respectively), while the highest number of organic samples analysed was found for bananas (162 samples), carrots (148) and wheat (134). No organic samples of poultry fat were analysed. Considering organic food only, more than 100 samples were only tested just for six distinct foods (bananas, carrots, wheat, milk, sweet pepper and eggs) out of the 31 food types considered.

Overall, it can be concluded that the data comparison presented in this report is affected by an uncertainty due to the often limited number of organic samples tested per food item in the framework of the EUCP programmes. Thus, the comparison of the results on conventional versus organic food are not always considered as reliable; this is particularly true for specific single food items.

[13] A slight deviation in the number of samples per food item tested in the frame of the 2015 EUCP indicated in the 2015 EU Report and the number of samples indicated in the present report may be observed. This apparent inconsistency is due to the fact that the 2015 EU Report (section 3.3) considered as 'EUCP samples' also the surveillance national samples for the same food commodities and pesticides covered by the 2015 EUCP (where available).

Table 2: Total number and percentage of samples tested in the framework of the EUCP programmes in the reference period 2013-2015 broken down by production method and food item (only unprocessed food samples).

Food item[(a)]	Total number of samples[(b)]	Conventionally produced food: No and % of samples out of the total number of samples	Organic farming food: No and % of samples out of the total number of samples
Apples	1,610	1,540/95.7%	70/4.3%
Aubergines	1,037	961/92.7%	76/7.3%
Bananas	1,164	1,002/86.1%	162/13.9%
Beans (with pods)	986	959/97.3%	27/2.7%
Broccoli	956	862/90.2%	94/9.8%
Carrots	1,255	1,107/88.2%	148/11.8%
Cucumbers	1,244	1161/93.3%	83/6.7%
Eggs (chicken)	842	735/87.3%	107/12.7%
Fat (poultry)	411	411/100%	-
Head cabbage	917	882/96.2%	35/3.8%
Leek	837	802/95.8%	35/4.2%
Lettuce	1,182	1,158/98.0%	24/2.0%
Liver (bovine)	307	299/97.4%	8/2.6%
Liver (poultry)	365	362/99.2%	3/0.8%
Liver (sheep)	83	81/97.6%	2/2.4%
Liver (swine)	364	363/99.7%	1/0.3%
Liver (pooled results)	*1,119*	*1,105/98.8%*	*14/1.2%*
Mandarins	493	478/97.0%	15/3.0%
Milk (cattle)	1,021	892/87.4%	129/12.6%
Muscle (poultry)	1,027	1,021/99.4%	6/0.6%
Oats	232	194/83.6%	38/16.4%
Oranges	1,096	1,045/95.3%	51/4.7%
Peaches	1,039	1,023/98.5%	16/1.5%
Pears	1,239	1,179/95.2%	60/4.8%
Peas (without pods)	796	747/93.82%	49/6.2%
Potatoes	1,431	1,343/93.82%	88/6.1%
Rice	763	679/89.0%	84/11.0%
Rye	424	339/80.0%	85/20.0%
Spinaches	935	870/93.0%	65/7.0%
Strawberries	1,139	1,119/98.2%	20/1.8%
Sweet peppers	1,360	1,252/92.1%	108/7.9%
Swine meat	753	748/99.3%	5/0.7%
Table grapes	1,243	1,202/96.7%	41/3.3%
Tomatoes	1,451	1,380/95.1%	71/4.9%
Wheat	850	716/84.2%	134/15.8%
Total	30,852	28,912/93.7%	1,940/6.3%

(a): The samples taken were all unprocessed (fresh, chilled or frozen).

(b): Total number of samples analysed among all the 30 reporting countries, without considering the samples analysed only for the naturally occurring substances (bromide ion and dithiocarbamates) that may also have been used as pesticides and that request a Single Residue analytical Method (SRM). A SRM aims to identify only one or a few compounds of the same family per sample (e.g. carbon disulphide for dithiocarbamates and glyphosate), whereas multi-residue methods (MRM) are intended to analyse simultaneously a large number of substances per sample.

3.2. Pesticides sought and found

Without differentiating between organic and conventional produces, the total number of distinct pesticides that were analysed in the framework of the EUCP in the years 2013-2015 amounted to 213; of those, 184 were quantified at or above the LOQ at least once in one of the food items tested.

In conventionally produced food, 184 pesticides were detected; eight of them can be considered as environmental contaminants (chlordane, DDT, dieldrin, heptachlor, hexachlorobenzene, alpha-hexachlorocyclohexane, beta-hexachlorocyclohexane and lindane).

In organic food samples 46 different pesticides were measured at or above the LOQ: two can be considered as environmental contaminants (DDT and hexachlorobenezene), while four are allowed in organic farming (deltamethrin, lambda-cyhalothrin, pyrethrins and spinosad); it is however noted that deltamethrin and lambda-cyhalothrin are only authorised for use in pheromone traps; thus, their residues may results from intentional uses directly on the crops that is against organic farming rules.

Among the potential naturally occurring substances that may also be used as pesticides, residues of bromide ion and the dithiocarbamates were found in both organic and conventionally grown food samples and were not taken into account for the present data examination[14]. Thus, the true frequency of pesticide residues detection is likely to be higher than this report shows.

3.3. Results by food item

Table 3: summarises the results by food products and by production method.

Out of 1,940 organic food samples, 6.5% (126 samples) contained quantifiable residues of one or more pesticide. For 0.2% of the organic samples analysed (three samples), the measured residues exceeded the legal limit: propargite in one sample of sweet peppers from Malta, fenazaquin in one potato sample from Romania and pemdimethalin in one leek sample from Portugal.

For conventionally grown food, 44.5% of the 28,912 samples analysed (12,857 samples) contained quantifiable residues of one or more pesticide. For 1.2% of the samples analysed (338 samples), MRL exceedances were identified related to about 100 different substances; these samples originated from 53 different countries from both within and outside the EU. The food items for which the highest number of samples exceeded the MRL were strawberries, beans with pods, carrots, lettuce and table grapes.

Figure 1 presents in from of a bar chart some of the results of Table 3, with the addition of the upper and lower confidence intervals to assess if there is a significant difference in the percentage of organic and conventional samples with quantifiable residues above the LOQ and above the MRL. Normally, a larger statistical sample size (i.e. the samples' population/number of samples tested per food item) would lead to a better estimate of the population parameter, e.g. for the percentage of the samples with quantified residues above the LOQ. The number of organic samples is sometimes limited (small size of the population/limited number); thus, the limited number of results available for some organic food items introduces uncertainties in the data analysis, which should not be ignored.

[14] Considering all the food types tested, the phytogenic sulphur mimicking residues of dithiocarbamates naturally occurs in broccoli, head cabbage and leek.

Table 3: Number and percentage of samples with quantified pesticide residues (at or above the limit of quantification, LOQ) and MRL exceedances (residues concentration numerically above the maximum residue levels, MRL) according to the production method and by food item.

	All type of production method	Conventional food production					Organic food production				
Food item	**Total No of samples analysed**	**No of samples analysed**	**No of samples with residue levels at or above LOQ**	**% samples with residue levels at or above LOQ**	**No of samples with levels above MRL**	**% samples with levels above MRL**	**No of samples analysed**	**No of samples with residues levels at or above LOQ**	**% samples with residue levels at or above LOQ**	**No of samples with levels above MRL**	**% samples with levels above MRL**
Apples	1,610	1,540	1,048	68.1%	16	1.0%	70	5	7.1%	-	-
Aubergines	1,037	961	319	33.2%	4	0.4%	76	1	1.3%	-	-
Bananas	1,164	1,002	840	83.8%	4	0.4%	162	32	19.8%	-	-
Beans (with pods)	986	959	410	42.8%	29	3.0%	27	1	3.7%	-	-
Broccoli	956	862	255	29.6%	10	1.2%1	94	9	9.6%	-	-
Carrots	1,255	1,107	525	47.4%	24	2.2%	148	5	3.4%	-	-
Cucumbers	1,244	1,161	605	52.1%	19	1.6%	83	4	4.8%	-	-
Eggs (chicken)	842	735	35	4.8%	2	0.3%	107	1	0.9%	-	-
Fat (poultry)	411	411	6	1.5%	-	-	-	-	-	-	-
Head cabbage	917	882	115	13.0%	8	0.9%	35	1	2.9%	-	-
Leek	837	802	237	29.6%	3	0.4%	35	2	5.7	1	2.9%
Lettuce	1,182	1,158	617	53.3%	25	2.2%	24	3	12.5%	-	-
Liver (bovine)	307	299	15	5.0%	-	-	8	-	-	-	-
Liver (poultry)	365	362	-	-	-	-	3	-	-	-	-
Liver (sheep)	83	81	5	6.2%	-	-	2	-	-	-	-
Liver (swine)	364	363	1	0.3%	-	-	1	-	-	-	-
Mandarins	493	478	387	81.0%	12	2.5%	15	2	13.3%	-	-
Milk (cattle)	1,021	892	77	8.6%	-	-	-	2	1.5%	-	-
Muscle (poultry)	1,027	1,021	31	3.0%	-	-	-			-	-
Oats	232	194	96	49.5%	3	1.5%	38	6	15.8%	-	-

	All type of production method	Conventional food production					Organic food production				
Oranges	1,096	1,045	867	83.0%	14	1.3%	51	4	7.8%	-	-
Peaches	1,039	1,023	767	75.0%	12	1.2%	16	1	6.2%	-	-
Pears	1,239	1,179	903	76.6%	20	1.7%	60	5	8.3%	-	-
Peas (without pods)	796	747	199	26.6%	5	0.7%	49			-	-
Potatoes	1,431	1,343	402	29.9%	14	1.0%	88	9	10.2%	1	1.1%
Rice	763	679	192	28.3%	16	2.4%	84	1	1.2%	-	-
Rye	424	339	137	40.4%	-	-	85	1	1.2%	-	-
Spinaches	935	870	344	39.5%	21	2.4%	65	8	12.3%	-	-
Strawberries	1,139	1,119	877	78.4%	29	2.6%	20	-		-	-
Sweet peppers	1,360	1,252	605	48.3%	10	0.8%	108	11	10.2%	1	
Swine meat	753	748	18	2.4%	-	-	5			-	-
Table grapes	1,243	1,202	966	80.4%	22	1.8%	41	4	9.8%	-	-
Tomatoes	1,451	1,380	636	46.1%	12	0.9%	71	6	8.4%	-	-
Wheat	850	716	320	44.7%	4	0.6%	134	2	1.5%	-	-
Total	**30,852**	**28,912**	**12,857**	**44.5%**	**338**	**1.2%**	**1,940**	**126**	**6.5%**	**3**	**0.2%**

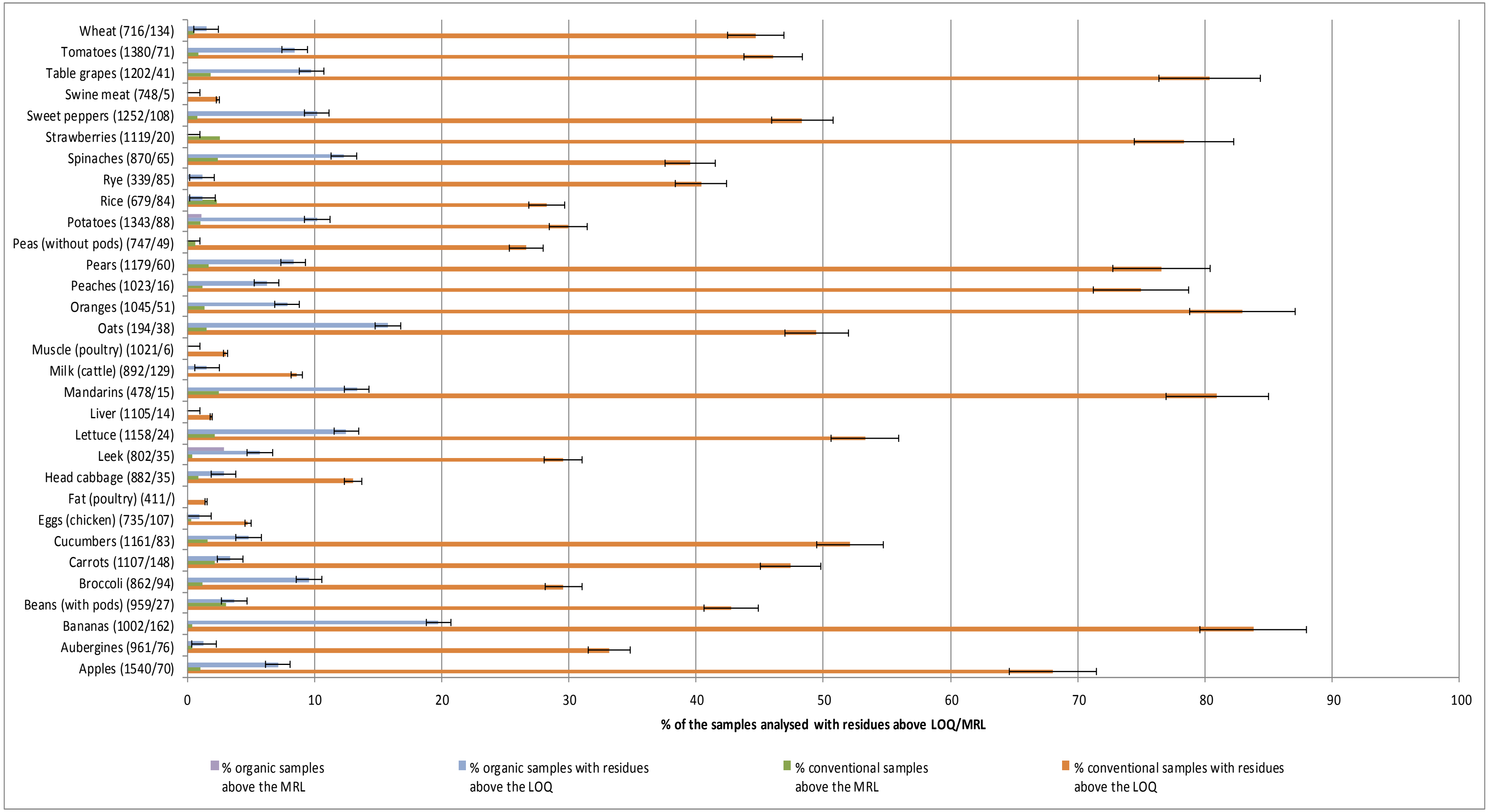

Figure 1: Percentage of organic and conventional samples with quantified residues at or above the LOQ and above the MRL according the food item tested (the number in brackets after the food label refers to the number of conventional and organic samples tested for the given food item).

3.4. Number of pesticides analysed per sample

Table 4: lists the average number of pesticides analysed per sample for each type of food product covered by the EUCP[15].

Table 4: Average number of pesticides analysed per sample according to the production method and by food item (only unprocessed food samples considered).

	Average number of pesticides tested per sample		
Food item	**All type of production method**	**Conventional food production**	**Organic food production**
Samples of plant origin			
Apples	139	137	161
Aubergines	124	126	106
Bananas	121	121	122
Beans (with pods)	146	146	144
Broccoli	128	130	114
Carrots	142	141	155
Cucumbers	143	142	161
Head cabbage	150	149	160
Leek	150	150	160
Lettuce	142	141	153
Mandarins	138	138	145
Oats	124	122	130
Oranges	133	133	149
Peaches	143	143	167
Pears	141	141	147
Peas (without pods)	127	127	140
Potatoes	137	136	152
Rice	137	137	144
Rye	141	142	139
Spinaches	144	143	158
Strawberries	149	149	152
Sweet peppers	123	123	115
Table grapes	124	123	134
Tomatoes	135	134	159
Wheat	111	109	122
Samples of animal origin			
Eggs (chicken)	15	15	16
Fat (poultry)	21	21	-
Liver (bovine)	25	24	34
Liver (poultry)	27	27	35
Liver (sheep)	30	30	34
Liver (swine)	35	35	40

[15] The mean values were calculated without considering the analysis of the dithiocarbamates and bromide ion residues.

	Average number of pesticides tested per sample		
Food item	**All type of production method**	**Conventional food production**	**Organic food production**
Milk (cattle)	29	29	27
Muscle (poultry)	26	26	34
Muscle (swine)	26	26	33

Without discriminating the method of food production, a difference in the calculated averages was noted at food group level. The highest averages have been estimated for food samples of plant origin (e.g. vegetables, fruit and cereals), while the lowest averages number of pesticide analysed per sample have been found for food of animal origin (e.g. milk and eggs). These results are not unexpected taking into consideration that the EUCP Regulations requested the national control laboratories to analyse pesticide residues for a wider analytical scope in food of plant origin than in food of animal origin. From the past monitoring programmes it is known that the majority of samples of animal origin were free of measurable residues, being the most frequently quantified pesticides persistent environmental pollutants or compounds resulting from sources other than pesticide use (EFSA, 2016). Moreover, it should be noted that the number of pesticides and the single distinct pesticides requested to be analysed in the different food items varied according to the monitoring year and according to the food groups, to which the single items belongs.

In addition, some pesticides require Single Residue Methods for their analysis, while the majority of the pesticides can be analysed by routine Multiple Residue Methods. Thus, should the average number of pesticides analysed per sample be compared, consideration should be also made on the year of monitoring, the specific food item and whether the pesticide had to be determined with a single residue method (SRM).

When the method of food production is taken into account, overall it is noted that the calculated averages at food group/item level are marginally higher in organically produced food. What it would appear from the available monitoring data is that organic food has been tested at least to the same extend than conventionally produces, if not more in terms of pesticides analysed. However, it is important to recall once again that the limited number of results available for some organic food items introduces an uncertainty in the data analysis.

4. Conclusions

Based on of the results generated in the framework of the 2013, 2014 and 2015 EU-coordinated control programmes and considering only raw samples (fresh, chilled and frozen samples) EFSA performed an ad-hoc data computation on the number and percentage of samples containing quantifiable residues of pesticides at or above the LOQ and above the MRL separately for conventional and organic food samples. The EUCP covers in a three-year's cycle the food products that are the major constituents of the European diets of both plant and animal origin. The pesticides that had to be analysed on a mandatory basis in the framework of the EU-coordinated programmes cover the most relevant compounds currently expected to contribute to the dietary exposure (EFSA, 2015).

The findings presented in the current report cannot be directly compared to the findings shown in the past annual EU Reports; this is because – among others - the results on organic produce presented in the annual EU Reports account for the results of both national control programs and EUCP sampling schemes, which together cover a wider range of food and pesticides and/or food tested for than the EUCP alone. The present report instead is aimed at providing a more systematic comparison of the prevalence of pesticide residues in organic relative to conventional products. The current report makes use of a more suitable datasets for this type of data analysis; thus, the comparative analysis presented in the current report can be considered as more reliable compared to the analysis previously published by EFSA.

Without considering the specific method of production, a difference in the calculated average of the number of distinct pesticides analysed per sample was noted at food group level; the highest averages have been estimated for food sample of plant origin samples (e.g. vegetables, fruit and cereals), while the lowest averages number of pesticide analysed per sample have been found for food of animal origin (e.g. milk and eggs). These results are not unexpected taking into consideration that the EUCP Regulations requested the national control laboratories to analyse pesticide residues for a wider analytical scope in food of plant origin than in food of animal origin.

Considering both all the food items and the single food items, the average number of single pesticides analysed in each sample was similar for the two methods of production. From the available monitoring data it appears that organic food has been tested at least to the same extend than conventionally production, if not marginally more, in terms of number of pesticides analysed. However, it is important to recall that the limited number of results available for some organic food items introduces an uncertainty in the data analysis.

In the reference period, 30,852 unprocessed samples were analysed. Out of the total number of samples, 1,940 samples were organically produced (6.3%).

Considering all food items covered by the present analysis, the data show that the percentages of conventionally grown food items containing at least one quantifiable pesticide residue was higher (44.5%) than the percentage calculated for organic food (6.5%). A similar residue pattern is observed when the percentages of samples containing quantifiable residues were derived for each individual food item considered in the data analysis. The lowest percentages of detection were reported for products of animal origin.

Pesticide residues may be expected on or in organic crops (but also on conventionally grown products) due to various reasons, mainly as a result of the permitted use in organic farming. However, residues may also occur due to contamination of organic fields by e.g. spray drift, residues due to natural substances mimicking the pesticide occurrence, environmental contamination with obsolete pesticides no longer approved, contamination of food lots during storage, labelling and transport, use of approved pesticides but not in accordance with the Good Agricultural Practices (e.g. use of plant protection products on crops for which no authorisation was granted or not respecting the application rate, the number of applications, or the method of application). Finally, the possible reasons explaining the occurrence of pesticide residues may also depend on the country of origin of the food tested (e.g. food imported from Third Countries in the EU territory may have been subjected to agricultural practice, which are not approved in the EU).

For 0.2% of the organic samples analysed (three samples), the measured residues exceeded the legal limit. For 1.2% of the conventionally grown food analysed (338 samples), MRL exceedances were identified related to about 100 different substances.

It is here recalled that MRLs are based on the maximum level of residues expected when the pesticide is applied according to the authorised good agricultural practices; MRLs breaches do not necessarily represent an exceedance of the toxicological reference values or a potential risk for the consumers' health[16]. In addition, MRL exceedances mentioned in this report were already assessed, regarding the possible reasons for the exceedance and regarding the potential risk for consumers, in the respective EU Reports (EFSA, 2015; EFSA, 2016; EFSA, 2017).

The MRL exceedance rate reported for conventional and organic food amounted to the 1.2% and 0.2% of the samples analysed, respectively.

Without considering the specific method of production, a difference in the calculated average was noted at food group level; the highest averages have been estimated for food sample of plant origin samples (e.g. vegetables, fruit and cereals), while the lowest averages number of pesticide analysed per sample have been found for food of animal origin (e.g. milk and eggs). These results are not unexpected taking into consideration that the EUCP Regulations requested the national control laboratories to analyse pesticide residues for a wider analytical scope in food of plant origin than in food of animal origin.

Considering both all the food items and the single food items, the average number of single pesticides analysed in each sample was similar for the two methods of production. From the available monitoring data it appears that organic food has been tested at least to the same extend than conventionally production, if not marginally more, in terms of number of pesticides analysed. However, it is important to recall that the limited number of results available for some organic food items introduces an uncertainty in the data analysis.

Finally, for both conventional and organic products, the true frequency of pesticide residue detection is likely to be higher than this report shows. This is because only a subset of existing and/or approved pesticides is addressed by the EUCP programmes and not all samples have been analysed for all pesticides. Furthermore, additional underestimation may occur considering that certain pesticides (methyl bromide, dithiocarbamates) have been excluded from this report's analysis. Nonetheless, this report provides the most comprehensive and systematic summary and comparison of the frequency of pesticide detection in organic and conventional products to date.

[16] A comparison of the estimated chronic and acute dietary exposure with the relevant toxicological reference values for long-term and short-term exposure (i.e. the acceptable daily intake (ADI) and the Acute Reference Dose (ARfD)), gives an indication of whether consumers are exposed to pesticide residues that may pose a health risk. As long as the dietary exposure is lower than or equal to the toxicological reference values, based on current scientific knowledge, a consumer health risk can be excluded with a high probability. However, possible negative health outcomes cannot be fully excluded if the exposure exceeds the toxicological reference values.

References

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Abbreviations

EC	European Commission
EEA	European Economic Area
EFSA	European Food Safety Authority
EU	European Union
EUCP	European Co-ordinated control programme for pesticide residues in food
EP	European Parliament
LOQ	Limit of Quantification
MS	Member States
MRL	Maximum Residue Level for pesticide residues in food
SSD	Standard Sample Description data model
STOA	Science and Technology Options Assessment (EP Committee)

Appendix A – Pesticides to be analysed according to the 2013, 2014 and 2015 EU-coordinated control programmes according to the provisions of the EUCP Regulations[17,18]

Pesticide name[(a)]	Residue definition according to Regulation (EC) No 396/2005 on EU MRLs[(b)]
2,4-D	2,4-D (sum of 2,4-D and its esters expressed as 2,4-D) or 2,4-D (sum of 2,4-D, its salts, its esters and its conjugates, expressed as 2,4-D) (P, A)
2-phenylphenol	
Abamectin	Abamectin (sum of avermectin B1a, avermectinB1b and delta-8,9 isomer of avermectin B1a)
Acephate	
Acetamiprid	Acetamiprid (P), Acetamiprid and IM-2-1 metabolite (A)
Acrinathrin	
Aldicarb	Aldicarb (sum of aldicarb, its sulfoxide and its sulfone, expressed as aldicarb)
Amitraz	Amitraz (amitraz including the metabolites containing the 2,4 -dimethylaniline moiety expressed as amitraz). According to Regulation (EU) No 788/2012 It is accepted if amitraz (parent) and its multi-residue-method-amendable metabolites 2,4-dimethyl formanilide (DMF) and N-(2,4-dimethyl-phenyl)-N'-methyl formamide (DMPF) are targeted and reported separately.
Amitrole	
Azinphos-ethyl	
Azinphos-methyl	
Azoxystrobin	
Benfuracarb	
Bifenthrin	
Biphenyl	
Bitertanol	
Bixafen	Bixafen (sum of bixafen and desmethyl-bixafen, expressed as bixafen) (A)
Boscalid	Boscalid (P), Boscalid (sum of boscalid and M 510F01(2-chloro-N-(4'-chloro-5-hydroxybiphenyl-2-yl)nicotinamide including its conjugates) (A)
Bromide ion	
Bromopropylate	
Bromuconazole	Bromuconazole (sum of diasteroisomers)
Bupirimate	
Buprofezin	
Captan	Captan, Captan/Folpet (sum) for beans, pome fruits, strawberries and tomatoes
Carbaryl	
Carbendazim	Carbendazim and benomyl (sum of benomyl and carbendazim expressed as carbendazim) (P), Carbendazim and thiophanate-methyl, expressed as carbendazim (A)
Carbofuran	Carbofuran (sum of carbofuran and 3-hydroxy-carbofuran expressed as carbofuran)
Carbosulfan	
Chlorantraniliprole	Chlorantraniliprole (DPX E-2Y45)
Chlordane	Chlordane (sum of cis- and trans-chlordane) (P), Chlordane (sum of cis- and trans-isomers and oxychlordane expressed as chlordane) (A)
Chlorfenapyr	
Chlorfenvinphos	

[17] Commission Implementing Regulation (EU) No 788/2012 of 31 August 2012 concerning a coordinated multiannual control programme of the Union for 2013, 2014 and 2015 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. OJ L 235, 1.9.2012, p. 8–27.

[18] Commission Implementing Regulation (EU) No 400/2014 of 22 April 2014 concerning a coordinated multiannual control programme of the Union for 2015, 2016 and 2017 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. OJ L119, 23.4.2014, p. 44–56.

Pesticide name[(a)]	Residue definition according to Regulation (EC) No 396/2005 on EU MRLs[(b)]
Chlormequat	
Chlorobenzilate	
Chlorothalonil	Chlorothalonil (P), Chlorothalonil expressed as SDS-3701 (4-hydroxy-2,5,6-trichloroisophthalonitrile) (A)
Chlorpropham	Chlorpropham (chlorpropham and 3-chloroaniline, expressed as chlorpropham) (P except potatoes), Chlorpropham (for potatoes), Chlorpropham and 4-hydroxychlorpropham-O-sulphonic acid (4-HSA),expressed as chlorpropham (A)
Chlorpyrifos	
Chlorpyrifos-methyl	
Clofentezine	Clofentezine (P), Clofentezine (sum of all compounds containing the 2-chlorobenzoyl moiety expressed as clofentezine) (C, A)
Clothianidin	
Cyfluthrin	Cyfluthrin (cyfluthrin including other mixtures of constituent isomers (sum of isomers))
Cymoxanil	
Cypermethrin	Cypermethrin (cypermethrin including other mixtures of constituent isomers (sum of isomers))
Cyproconazole	
Cyprodinil	Cyprodinil (P), Cyprodinil (sum cyprodinil and metabolite CGA 304075) (A)
Cyromazine	
DDT	DDT (sum of p,p'-DDT, o,p'-DDT, p,p'-DDE and p,p'-TDE (DDD) expressed as DDT)
Deltamethrin	Deltamethrin (cis-deltamethrin)
Diazinon	
Dichlofluanid	
Dichlorprop	Dichloprop (sum of dichlorprop (including dichlorprop-P) and its conjugates, expressed as dichlorprop)
Dichlorvos	
Dicloran	
Dicofol	Dicofol (sum of p, p' and o,p' isomers)
Dicrotophos	
Dieldrin	Aldrin and dieldrin (aldrin and dieldrin combined expressed as dieldrin)
Diethofencarb	
Difenoconazole	
Diflubenzuron	Diflubenzuron (P), Diflubenzuron (sum of diflubenzuron and 4-chlorophenylurea expressed as diflubenzuron) (A)
Dimethoate	Dimethoate (sum of dimethoate and omethoate expressed as dimethoate)
Dimethomorph	
Diniconazole	
Diphenylamine	
Dithianon	
Dithiocarbamates	Dithiocarbamates (dithiocarbamates expressed as carbon disulphide (CS_2), including maneb, mancozeb, metiram, propineb, thiram and ziram)
Dodine	
Endosulfan	Endosulfan (sum of alpha- and beta-isomers and endosulfan-sulfate expresses as endosulfan)
Endrin	
EPN	
Epoxiconazole	
Ethephon	
Ethion	
Ethirimol	

Pesticide name[a]	Residue definition according to Regulation (EC) No 396/2005 on EU MRLs[b]
Ethoprophos	
Etofenprox	
Famoxadone	
Fenamidone	
Fenamiphos	Fenamiphos (sum of fenamiphos and its sulphoxide and sulphone expressed as fenamiphos)
Fenarimol	
Fenazaquin	
Fenbuconazole	
Fenbutatin oxide	
Fenhexamid	
Fenitrothion	
Fenoxycarb	
Fenpropathrin	
Fenpropidin	Fenpropidin (sum of fenpropidin and its salts, expressed as fenpropidin)
Fenpropimorph	Fenpropimorph (P), Fenpropimorph carboxylic acid (BF 421-2) expressed as fenpropimorph (A)
Fenpyroximate	
Fenthion	Fenthion (fenthion and its oxigen analogue, their sulfoxides and sulfone expressed as parent)
Fenvalerate	Fenvalerate and esfenvalerate (sum of RR & SS isomers), Fenvalerate and esfenvalerate (sum of RS & SR isomers), Fenvalerate (sum of RR, SS, RS and SR isomers), Fenvalerate/Esfenvalerate (sum)
Fipronil	Fipronil (sum Fipronil and sulfone metabolite (MB46136) expressed as Fipronil)
Flonicamid	Flonicamid (sum of flonicamid, TNFG and TNFA) (P), Flonicamid and TFNA-AM, expressed as flonicamid (A)
Fluazifop-P-butyl	Fluazifop-P-butyl (fluazifop acid (free and conjugate))
Flubendiamide	
Fludioxonil	
Flufenoxuron	
Fluopyram	Fluopyram (P), Fluopyram (sum fluopyram and fluopyram-benzamide (M25) expressed as fluopyram) (A)
Fluquinconazole	
Flusilazole	Flusilazole (P), Flusilazole (sum of flusilazole and its metabolite IN-F7321 ([bis-(4-fluorophenyl)methyl]silanol) expressed as flusilazole) (A)
Flutriafol	
Folpet	Folpet, Captan/Folpet (sum) for beans, pome fruits, strawberries and tomatoes
Formetanate	Formetanate (sum of formetanate and its salts expressed as formetanate(hydrochloride))
Formothion	
Fosthiazate	
Glufosinate	Glufosinate-ammonium (sum of glufosinate, its salts, MPP and NAG expressed as glufosinate equivalents)
Glyphosate	
Haloxyfop-R	Haloxyfop including haloxyfop-R (haloxyfop-R methyl ester, haloxyfop-R and conjugates of haloxyfop-R expressed as haloxyfop-R) (P), Haloxyfop-R and conjugates of haloxyfop-R expressed as haloxyfop-R (A)
Heptachlor	Heptachlor (sum of heptachlor and heptachlor epoxide expressed as heptachlor)
Hexachlorobenzene	
Hexachlorocyclohexane (alpha)	Hexachlorocyclohexane (HCH), alpha-isomer
Hexachlorocyclohexane (beta)	Hexachlorocyclohexane (HCH), beta-isomer

Pesticide name[(a)]	Residue definition according to Regulation (EC) No 396/2005 on EU MRLs[(b)]
Hexaconazole	
Hexythiazox	
Imazalil	
Imidacloprid	
Indoxacarb	Indoxacarb (sum of indoxacarb and its R enantiomer)
Ioxynil	Ioxynil, including its esters expressed as ioxynil
Iprodione	Iprodione (P), Vinclozolin, iprodione, procymidone, sum of compounds and all metabolites containing the 3,5-dichloroaniline moiety expressed as 3,5 dichloroaniline (A)
Iprovalicarb	
Isocarbophos	
Isofenphos-methyl	
Isoprocarb	
Kresoxim-methyl	Kresoxim-methyl (P), 490M1 expressed as kresoxim-methyl (A: meat only), 490M9 expressed as kresoxim-methyl (A: milk only)
Lambda-cyhalothrin	Lambda-cyhalothrin (P), Lambda-cyhalothrin, including other mixed isomeric consituents (sum of isomers) (A)
Lindane	Lindane (gamma-isomer of hexachlorociclohexane (HCH))
Linuron	
Lufenuron	
Malathion	Malathion (sum of malathion and malaoxon expressed as malathion)
Maleic hydrazide	Maleic hydrazide (P), Maleic hydrazide and its conjugates expressed as maleic hydrazide (A: milk only)
Mandipropamid	
Mepanipyrim	Mepanipyrim (sum of mepanipyrim and its metabolite (2-anilino-4-(2-hydroxypropyl)-6-methylpyrimidine) expressed as mepanipyrim) (P)
Mepiquat	
Meptyldinocap	Meptyldinocap (sum of 2,4 DNOPC and 2,4 DNOP expressed as meptyldinocap)
Metaflumizone	Metaflumizone (sum of E- and Z- isomers)
Metalaxyl	Metalaxyl and metalaxyl-M (metalaxyl including other mixtures of constituent isomers including metalaxyl-M (sum of isomers))
Metazachlor	
Metconazole	
Methamidophos	
Methidathion	
Methiocarb	Methiocarb (sum of methiocarb and methiocarb sulfoxide and sulfone, expressed as methiocarb)
Methomyl	Methomyl and thiodicarb (sum of methomyl and thiodicarb expressed as methomyl)
Methoxychlor	
Methoxyfenozide	
Metobromuron	
Monocrotophos	
Myclobutanil	Myclobutanil (P), α-(3-hydroxybutyl)-α-(4-chloro-phenyl)-1H-1,2,4-triazole-1-propanenitrile (RH9090) expressed as myclobutanil (A)
Nitenpyram	
Oxadixyl	
Oxamyl	
Oxydemeton-methyl	Oxydemeton-methyl (sum of oxydemeton-methyl and demeton-S-methylsulfone expressed as oxydemeton-methyl)
Paclobutrazol	
Parathion	

Pesticide name[a]	Residue definition according to Regulation (EC) No 396/2005 on EU MRLs[b]
Parathion-methyl	Parathion-methyl (sum of parathion-methyl and paraoxon-methyl expressed as parathion-methyl)
Penconazole	
Pencycuron	
Pendimethalin	
Permethrin	Permethrin (sum of isomers)
Phenthoate	
Phosalone	
Phosmet	Phosmet (phosmet and phosmet oxon expressed as phosmet) (P), Phosmet (A)
Phoxim	
Pirimicarb	Pirimicarb (sum of pirimicarb and desmethyl pirimicarb expressed as pirimicarb)
Pirimiphos-methyl	
Prochloraz	Prochloraz (sum of prochloraz and its metabolites containing the 2,4,6-trichlorophenol moiety expressed as prochloraz)
Procymidone	Procymidone (P), see Iprodione (A)
Profenofos	
Propamocarb	Propamocarb (sum of propamocarb and its salt expressed as propamocarb)
Propargite	
Propiconazole	
Propoxur	
Propyzamide	Propyzamide (P), Propyzamide (sum of propyzamide and all metabolites containing the 3,5-dichlorobenzoic acid fraction expressed as propyzamide) (A)
Prothioconazole	Prothioconazole (prothioconazole-desthio) (P), Prothioconazole (sum of prothioconazole-desthio and its glucuronide conjugate, expressed as prothioconazoledesthio) (A)
Prothiofos	
Pymetrozine	
Pyraclostrobin	
Pyrazophos	
Pyrethrins	
Pyridaben	
Pyrimethanil	
Pyriproxyfen	
Quinoxyfen	
Resmethrin	Resmethrin (resmethrin including other mixtures of consituent isomers (sum of isomers))
Rotenone	
Spinosad	Spinosad (sum of spinosyn A and spinosyn D, expressed as spinosad)
Spirodiclofen	
Spiromesifen	
Spiroxamine	Spiroxamine (P), Spiroxamine carboxylic acid expressed as spiroxamine (A)
tau-Fluvalinate	
Tebuconazole	Tebuconazole (P), Tebuconazole (sum of tebuconazole, hydroxy-tebuconazole, and their conjugates, expressed as tebuconazole)
Tebufenozide	
Tebufenpyrad	
Teflubenzuron	
Tefluthrin	
Terbuthylazine	

Pesticide name[(a)]	Residue definition according to Regulation (EC) No 396/2005 on EU MRLs[(b)]
Tetraconazole	
Tetradifon	
Tetramethrin	
Thiabendazole	Thiabendazole (P), Thiabendazole (sum of thiabendazole and 5-hydroxythiabendazole) (A)
Thiacloprid	
Thiamethoxam	Thiamethoxam (sum of thiamethoxam and clothianidin expressed as thiamethoxam)
Thiophanate-methyl	
Tolclofos-methyl	
Tolylfluanid	Tolylfluanid (Sum of tolylfluanid and dimethylaminosulfotoluidide expressed as tolylfluanid)
Topramezone	
Triadimenol	Triadimefon and triadimenol (sum of triadimefon and triadimenol)
Triazophos	
Trichlorfon	
Trifloxystrobin	Trifloxystrobin (P), Trifloxystrobin (sum of trifloxystrobin and its metabolite (E,E)-methoxyimino-{2-[1-(3-trifluoromethyl-phenyl)-ethylideneamino-oxymethyl]-phenyl}-acetic acid (CGA 321113)) (A)
Triflumuron	
Trifluralin	
Triticonazole	
Vinclozolin	Vinclozolin (sum of vinclozolin and all metabolites containing the 3,5-dichloraniline moiety, expressed as vinclozolin) (P), see Iprodione (A)
Zoxamide	

(a): Pesticide name: if not specifically mentioned in the second column of the table, the legal residue definition comprises the parent compound only.
(b): If the legal residue definition contains more than one component (e.g. the metabolites of the parent compounds, breakdown products, etc.) or in case more than one residue definition is applicable for the same active substance depending on the food item tested, then the definition(s) of the residue analysed is reported in the second column of the table. The letters 'P', 'C' and 'A' are used to indicate the specific definition applicable to plant products (P), cereals (C) or animal products (A), respectively.