

Report

# TOXIC HARVEST

The rise of forever pesticides in fruit and vegetables in Europe

February 2024

# Summary

**Fruit and vegetables in Europe are increasingly contaminated with PFAS pesticide residues. This is shown in the analysis of official data from the national monitoring programmes of pesticide residues in food in Member States. The number of European fruit and vegetables with detected PFAS pesticide residues has nearly tripled between 2011 and 2021, with a growth rate of 220% for fruit and of 274% for vegetables. In some of the EU Member States studied individually, the growth rate has been even more dramatic: Austria (+698% for fruit, +3277% for vegetables) and Greece (+696% in fruit, +1974% in vegetables).**

A detailed analysis of the 2021 data, the most recent published to date, provides a more refined picture of the contamination. It shows that non-organic fruit, especially summer fruit, are the products most frequently contaminated with PFAS pesticide residues. Zooming in on fruits grown in Europe, 37% of strawberries, 35% of peaches and 31% of apricots are contaminated. Moreover, contaminated European-grown fruit (20%) often contain cocktails of PFAS pesticide residues, with up to four different PFAS pesticides detected in a single sample of strawberries and table grapes, and up to three in peaches and apricots. While, on average, a smaller percentage of European-grown vegetables (12%) is contaminated with PFAS pesticide residues compared to fruit, some vegetables are as frequently contaminated as the top-ranked fruit (chicories: 42%; cucumbers: 30%).

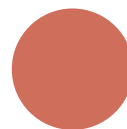
In 2021, the Member States that produced fruit and vegetables most frequently contaminated with PFAS pesticide residues were the Netherlands (27%), Belgium (27%), Austria (25%), Spain (22%) and Portugal (21%). Among imported fruit and vegetables, those most likely to contain residues of PFAS pesticides came from Costa Rica (41%), India (38%), South Africa (28%), Colombia (26%) and Morocco (24%).

In 2021, the most often detected PFAS active substances in contaminated European-grown products were the fungicide fluopyram, the insecticide flonicamid and the fungicide trifloxystrobin.

These findings indicate that the use of PFAS in pesticides results in fruit and vegetable contaminated with residues of these chemicals, leading to an increasingly frequent ingestion of PFAS pesticide residues by European consumers. This source of PFAS contamination should not be downplayed. The ongoing accumulation of PFAS in soils, waters and the food chain, along with other chemical substances or “chemical cocktails”, pose long-term risks to human health and the environment. A ban on the use of PFAS pesticides is urgent to curb European citizen exposure to PFAS pesticides and protect citizen health, including that of the most vulnerable groups, such as pregnant women, babies and children.



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# Key findings

## Surge in PFAS residues in food between 2011 and 2021

- In total, residues of 31 different PFAS pesticides were detected in EU fruit and vegetables between 2011 and 2021.
- The proportion of fruit and vegetables containing residues of PFAS pesticides in the EU has nearly tripled over the decade. It has risen by 220% for EU fruit and by 274% for EU vegetables. The most pronounced increase occurred for apricots (+333%), peaches (+362%) and strawberries (+534%).
- The most significant increases in PFAS contamination of domestic products (nationally grown products) were observed in Austria (fruit: +698%, vegetables: +3277%) and Greece (fruit: +696%, vegetables: +1974%).

## High Contamination of EU-grown products in 2021

- 20% of the EU-grown fruit contained residues of at least one PFAS pesticide. Summer fruit, namely strawberries (37%), peaches (35%) and apricots (31%) were particularly contaminated in comparison to imported fruit (12% of strawberries; 11% of peaches; 21% of apricots).
- While European-grown vegetables (12%) were on average less heavily contaminated with residues of PFAS pesticides than fruit (20%), some were particularly polluted: chicories (42%), cucumbers (30%), peppers (27%).
- Belgium (27%), the Netherlands (27%) and Austria (25%) stood as the Member States with the highest levels of PFAS contamination in their domestic fruit and vegetables.
- In European-grown products, the most often detected PFAS active substances in 2021 are the fungicide fluopyram, the insecticide flonicamid and the fungicide trifloxystrobin.

## No clear difference with imported products in 2021

- On average, 18% of imported fruit were contaminated with residues of PFAS pesticides in 2021, i.e. slightly less than European-grown fruit. However, some products like imported table grapes were way more frequently contaminated (37%) than European-grown ones (22%).

## Cocktail risks in 2021

- Residues of up to four different PFAS pesticides were detected in single samples of EU-grown strawberries and table grapes. Similarly, residues of up to three different PFAS pesticides were detected in single samples of peaches, apricots, pears and apples.



# Introduction

This report is about PFAS pesticides: the active substances used in pesticides in the EU that are per- and polyfluoroalkyl substances (PFAS). In particular, it provides some insight into the scale that the food sold in the EU has been contaminated with residues of PFAS pesticides, in the decade 2011-2021. This is a technical report, published together with a policy briefing.

The study focuses on fruit and vegetables grown in conventional agriculture (i.e. non-organic). It is based on official monitoring data from Member States, which were randomly sampled to accurately reflect a representative exposure of EU consumers to pesticides in food. The analysis was carried out at European level (following aggregation of all national data), but also at the level of 8 different Member States (Austria, Belgium, France, Germany, Greece, Hungary, the Netherlands, Spain). The report presents the study results. It is published in collaboration with Ecocity, Ecologistas en Acción, Friends of the Earth Hungary, Générations Futures, Global 2000, PAN Europe, PAN Germany, PAN Netherlands and Nature & Progrès Belgique.

## Methodology

The objective of the study was to analyse whether and how frequently residues of PFAS active substances were detected in fruit and vegetables and how this presence has evolved over the past ten-year period (2011-2021).

**PFAS list:** the analysis is based on the list of the 47 active substances used in pesticides listed as PFAS in the proposal for a universal PFAS restriction submitted to the European Chemical Agency (ECHA) in February 2023. This list stands as the only EU-wide official list of PFAS pesticide's active substances. Ten active substances on this list are no longer approved in the EU in January 2024. Nevertheless, they were included in the analysis as they were still in use during most of the period analysed. Co-formulants and metabolites, including the very persistent trifluoroacetic acid (TFA), could not be analysed because they are not monitored in food.

**Food products:** the main source of exposure to pesticides in the general population is the consumption of their residues in food products, particularly in conventionally grown fruit and vegetables<sup>1</sup>. Thus, the analysis specifically focuses on the most commonly sampled<sup>2</sup>, non-organically produced, fresh fruit and vegetables (refer to Annex 2). Samples were categorised into broader groups (e.g., black and red currants grouped as currants) for analysis purposes.

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<sup>1</sup> Ibid 6.

<sup>2</sup> Most commonly sampled products are referred to as the "most popular" products in the analysis.

**Time period:** the study analyses the data available for the years 2011 to 2021. The 2021 data are the most recent available online.

**Residue data:** under Regulation (EC) No 396/2005 on Maximum Residue Levels (MRL) of pesticides in or on food<sup>3</sup>, Member States are required to yearly control the presence of pesticide residues in food products. More specifically, Member States are required to examine whether the Maximum Residue Limits (MRLs) set by European regulators are exceeded by the collected samples. These data is collected by the European Food Safety Authority (EFSA), who carries an analysis and publishes a general EU report on pesticide residues in food after 2 years alongside the data received from each Member State<sup>4</sup>. Member States are required to perform both random and risk-based samplings. To ensure the analysis accurately reflects a representative consumer exposure to residues, only the official data, which have been randomly sampled by the Member States, were analysed in the study. This includes data that were collected under the official EU Multiannual Control Programme (EU MACP)<sup>5</sup> and under other control programmes set up by Member States on an individual and volunteer basis. All risk-based samples collected under the Multiannual National Control Programme (MANCP), the programme on import control in line with Regulation (EU) 2017/625 and any other national programme were excluded.

**Detection threshold:** only PFAS residues with a concentration level equal to or exceeding 0.01 mg/kg have been incorporated into the analysis. This threshold aligns with the default limit of detection (LOD) for pesticides specified in Regulation (EC) No 396/2005. The underlying rationale for choosing to focus on this specific detection threshold rather than on exceedance of maximum residue limits (MRLs) set in Regulation (EC) No 396/2005 is twofold:

1. Increasingly sophisticated detection methods allow for the identification of residues at ever-lower levels, potentially leading to the more frequent detection of residues over time. Setting a 0.01 mg/kg threshold, which already stood as the regulatory stand in 2011, enables to consider only genuine trends.
2. Contrary to EFSA, we decided to analyse how often PFAS pesticide residues were detected (above the regulatory threshold of 0.01 mg/kg), rather than how often MRLs (often set higher than 0.01 mg/kg) were exceeded. Our approach aims to unveil significant issues silenced by EFSA's selective and, in this respect, biased approach. These include the increasing presence of pesticides residues in European food products and the substantial proportion of samples containing multiple pesticide residues.

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<sup>3</sup> [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.

<sup>4</sup> Available in [EFSA Knowledge junction](#).

<sup>5</sup> [EU multi-annual control programmes - European Commission \(europa.eu\)](#)

Furthermore, in the case of PFAS, we consider any level of exposure as problematic. Indeed, maximum residue limits (MRL) are set:

- Based on the assessment of individual pesticide active substances, without taking into consideration cumulative and synergistic effects with other pesticides (i.e. combined exposure to the residues of several pesticide active substances used in agriculture) or other pollutants present in the environment.
- Without taking into account that the persistence and often bioaccumulative properties of pesticide active substances will result in exposure to higher levels (i.e. the fact that PFAS substances and their residues build up into bodies to levels that can cause adverse effects).

Failing to take these into consideration, we do not consider the current MRLs to sufficiently protect consumers.

**Analysis of the contamination evolution between 2011 and 2021:** Trends are calculated based on the average of the trends observed in all individual products within each respective product group. This method involves summing the trends for each product and then dividing that sum by the total number of products within the same product group. This approach ensures that products sampled more frequently are not disproportionately represented in the overall trend for the entire product group. For instance, within the fruit category, grapes

have been sampled significantly more often than strawberries. Therefore, the combined average of PFAS contamination for these two fruit is calculated by summing the average contamination per year per product and then dividing it by two.

The trendlines for the period 2011-2021 are calculated using the best fit model. An exponential model was used in all cases in the study, except for the Netherlands where the best fit was a linear trend. The percentage of increase or decrease of the detected residues is based on this trendline. Due to the differences in the number of national samples collected each year for each product, these trend lines provide a rough approximation of the trend but constitute the most common statistical approach in situations where year-to-year fluctuations can be observed as in the case of some studied Member States. Indeed, trendlines help in providing a more accurate representation of the long-term trend by smoothing out the anomalies or irregularities that can occur in individual years.

**Analysis of the 2021 samples:** For the year 2021, various key indicators have been calculated for each specific food category or Member State, including:

- The number of samples taken (n).
- The percentage of samples contaminated with residues of at least one PFAS pesticide.
- The sum of the different PFAS pesticides detected across all samples within each category (Sum).
- The maximum number of PFAS pesticides detected in a single sample (Max)

For the EU-wide results, only products and countries which have been sampled at least 50 times were considered, while for individual country-specific graphs, only products and countries which have been sampled at least 10 times were considered. This selective approach ensures consistency in the analysis across Member States and that only when there is a substantial number of samples, the findings are presented. It is important to take into consideration that the sampling and analysis of fruit and vegetables per country may vary over the years. This means that the number and type of fruit and vegetable samples collected was not the same across and within Member States or countries of origin each year, and that not all samples were consistently screened for all PFAS pesticides. However, the amount of data analysed over the years makes the present assessment and its conclusions the most representative analysis possible of real-world contamination rates.

## Limitations of the report

The results of this report are merely the tip of the iceberg. The true extent of PFAS pesticide contamination is far more extensive and, for the most part, remains unquantified and unknown.

- Firstly, the study is based on the EU's official monitoring program of pesticide residues in food and its scope is restricted to PFAS pesticide active substances. It does not include the notorious PFAS food contaminants such as perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorononanoic acid (PFNA) and perfluorohexane sulfonic acid (PFUx)<sup>6</sup> because they are not used in pesticides as active substances. Moreover, it does not include PFAS co-formulants, as there is no complete official list of co-formulants used in pesticides in Europe and no regulation of their presence in food products. Likewise, the analysis could not cover major pesticide metabolites, such as TFA, due to an absence of official monitoring data about their presence in food products.

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<sup>6</sup> Residue levels regulated by [Commission Regulation \(EU\) 2023/915](#) of 25 April 2023 on maximum levels for certain contaminants in food and repealing Regulation (EC) No 1881/2006.

<sup>7</sup> Examples of [Belgium](#), [France](#) and [Germany](#).



# Introduction

- Secondly, our study focuses on PFAS pesticide residues in food on fruit and vegetables only. Citizens also ingest PFAS through water, with drinking water monitoring studies and investigations revealing alarming levels of contamination<sup>7</sup>. Moreover, it was selected to analyse fruit and vegetables only. PFAS pesticide residues however, can possibly be detected in other categories of products than fresh fruit and vegetables, such as grains, pulses, herbs and teas as well as products of meat and fish origin, deriving from animals exposed to pesticide residues in feed and water.
- Then, our study focuses on just one facet of the complex exposure pathways to PFAS— ingestion. Additionally, citizens are exposed to PFAS through other pathways, including inhalation and dermal contact, which are particularly relevant for agricultural workers, their families, and residents in proximity to contaminated areas, or when pesticides are used in public spaces (e.g. parks and public gardens, sports grounds, golf courses etc).

Finally, the presence of these substances in food implies their presence in the environment to a much greater extent. PFAS pesticides sprayed in fields can contaminate soils and water sources ultimately finding their way into the crop plants. The transfer of PFAS pesticides occurs, albeit with a decreasing rate from plant roots to leaves and fruit. This means that the detection of "only" 31 of the 47 studied PFAS active substances listed by ECHA in fruit and vegetables does not equate to the absence of the others in the environment. For instance, while the PFAS herbicide flufenacet was not detected in the context of this analysis, it is known to represent the most important source of TFA emission in the environment in Germany<sup>8</sup>.



<sup>8</sup> Umwelt Bundesamt (UBA), [Reducing the input of chemicals into waters](#): TFA as a persistent and mobile substance with many concerns, September 2022., cf. p. 12.

# EU-wide results: PFAS residues in fruit and vegetables



## 2011-2021: a dramatic contamination increase in a decade

Between 2011 and 2021, a total of 278,516 fruit and vegetable samples met the study selection criteria<sup>9</sup>. During this period, on average 11.2% of the 140,022 fruit samples contained residues of at least one PFAS pesticide. The maximum number of PFAS pesticides detected in a single sample was five, while 30 different PFAS pesticides were detected across all samples. The rate of PFAS contamination was notably lower in vegetable samples, with 5.4% of the 138,494 samples containing residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single sample was four, while 31 different PFAS pesticides were detected across all samples. When considering both fruit and vegetables together, 31 different PFAS pesticides were detected across all samples (please refer to Annex 3).

**Table 1.** Samples per product category included in the trend analysis for 2011-2021.

Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	140,022	15,731	11.2%	5	30
<b>Vegetables</b>	138,494	7,527	5.4%	4	31
<b>Total</b>	278,516	23,256	8.40%	5	31

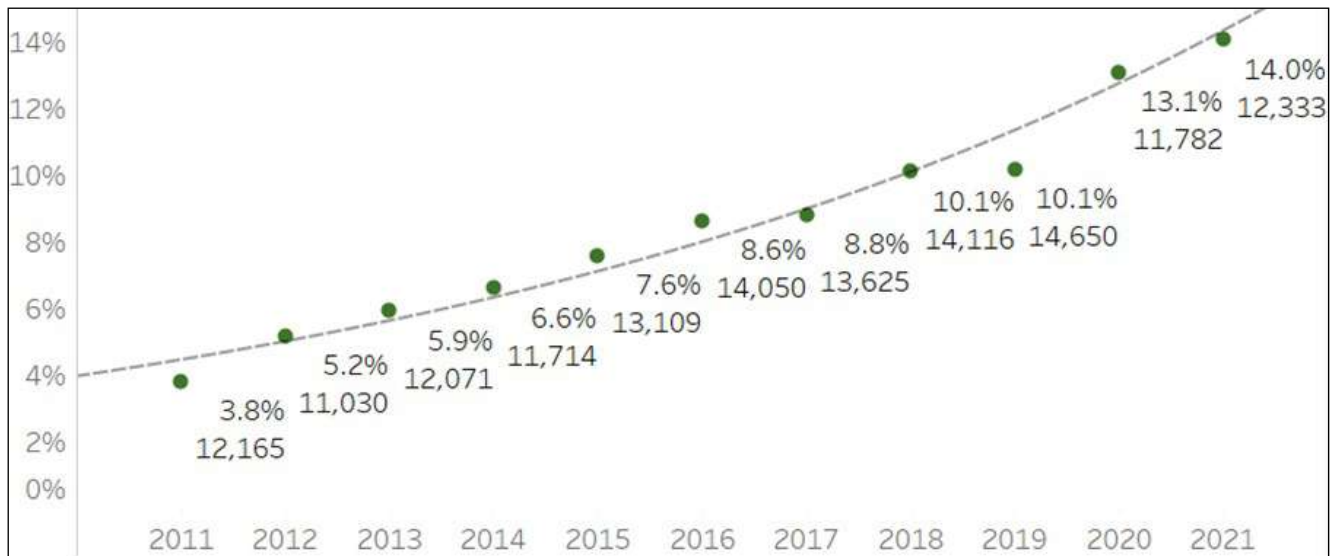
<sup>9</sup> Cf “Methodology, Scope of the study”.



## Fruit

The proportion of fruit sampled by EU Member States contaminated with residues of PFAS pesticides has risen from 3.8% in 2011 to 14% in 2021. According to the trendline, the average proportion of fruit samples containing PFAS pesticide residues has increased by 220% over a 10-year period.

**Figure 1.** Average PFAS contamination in fruit sampled in the EU in the period 2011-2021.

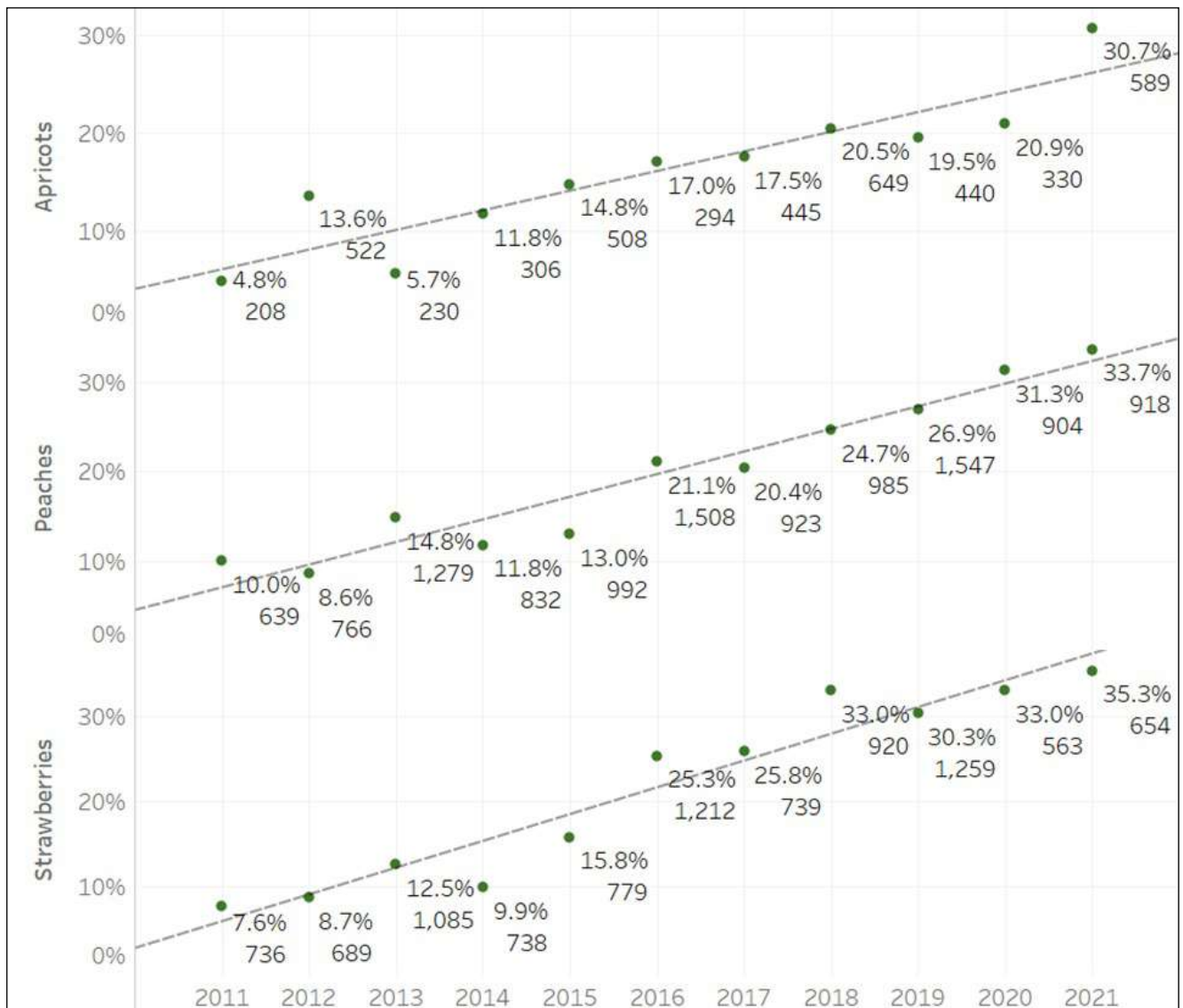




## Some notable upward PFAS contamination between 2011 and 2021

- **Apricots:** the proportion of contaminated samples has risen from 4.8% in 2011 to 30.7% in 2021. The trendline indicates an average contamination growth of +333% over the ten-year period.
- **Peaches:** the proportion of contaminated samples has risen from 10.0% in 2011 to 33.7% in 2021. The trendline indicates an average contamination growth of +362% over the ten-year period.
- **Strawberries:** the proportion of contaminated samples has risen from 7.6% in 2011 to 35.3% in 2021. The trendline indicates an average contamination growth of +534% over the ten-year period.

**Figure 2.** Average PFAS contamination in EU-sampled apricots, peaches and strawberries in the period 2011-2021.



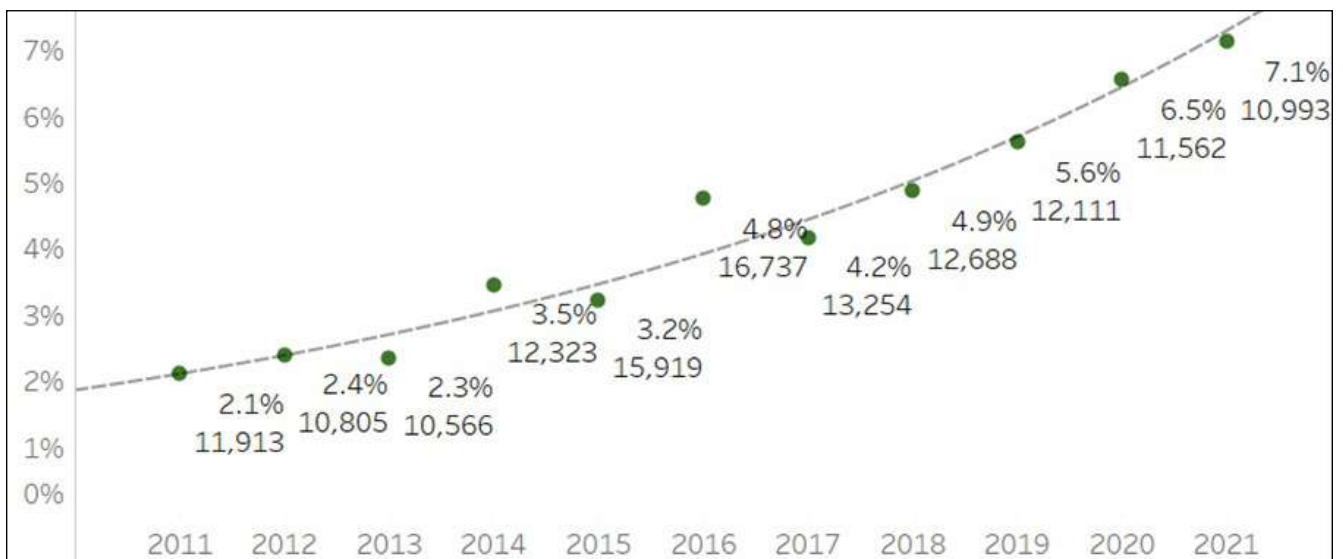




## Vegetables

The proportion of vegetables sampled by EU Member States contaminated with residues of PFAS pesticides has risen from 2.1% in 2011 to 7.1% in 2021. According to the trendline, the average proportion of vegetable samples containing PFAS pesticide residues has increased by 247% over a 10-year period.

**Figure 3.** Average PFAS contamination in vegetables sampled in the EU in the period 2011-2021.





## 2021: high average contamination and cocktail risks

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 50 times are presented in the graphs.

### EU-grown fruit

In 2021, residues of PFAS pesticides were present in 20% of all fruit samples.

Strawberries, peaches, and apricots stood as the most frequently contaminated EU-grown fruit:

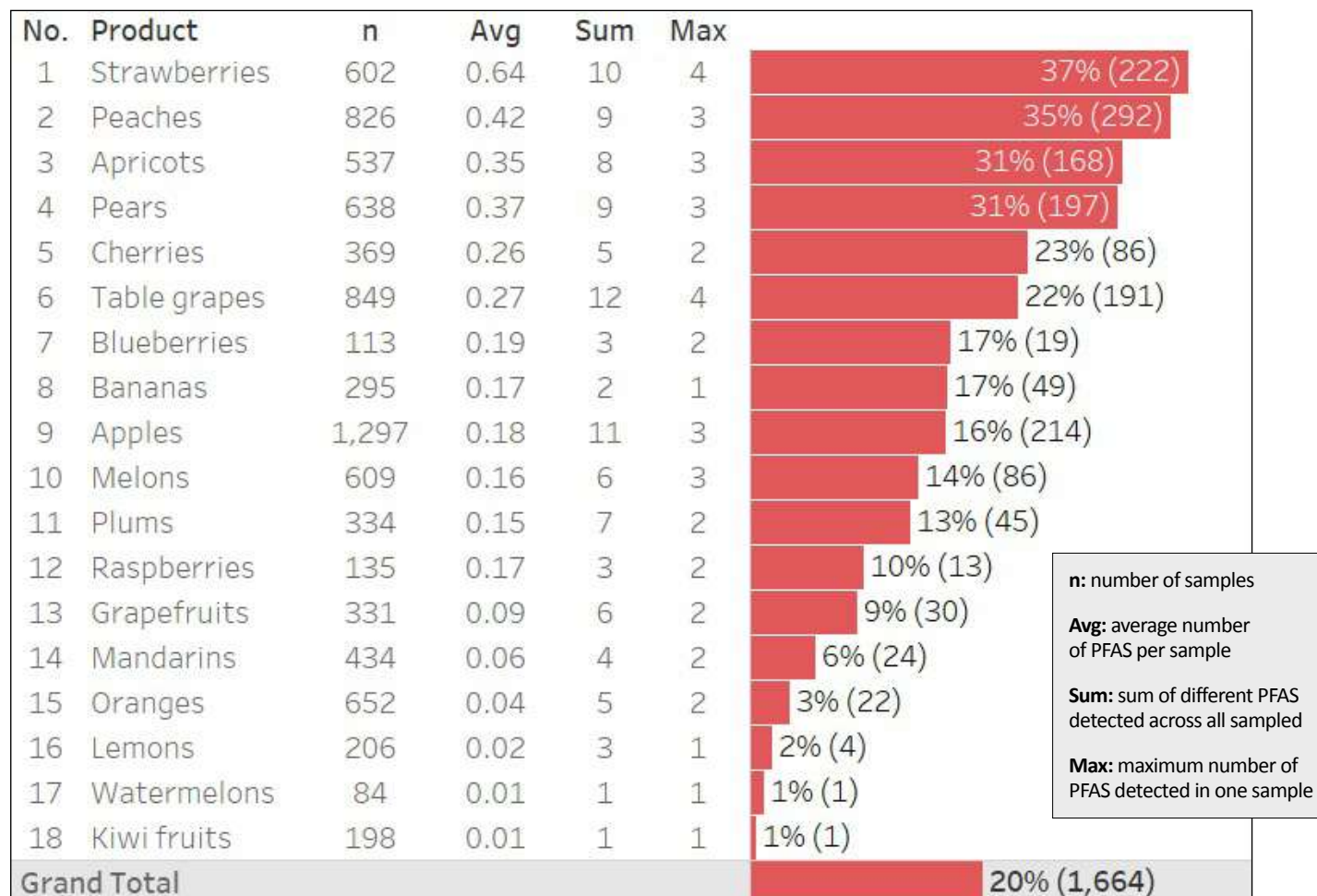
- 37% of the strawberry samples contained residues of at least one PFAS pesticide. In total, 10 different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to four different PFAS pesticides.
- 35% of the peach samples contained residues of at least one PFAS pesticide. In total, nine different PFAS pesticides were detected across samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 31% of the apricot samples contained residues of at least one PFAS pesticide. In total, eight different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to four different PFAS pesticides.

Overall, the maximum number of four different PFAS pesticides detected in a single sample was observed in strawberry samples. With a total of 12 different pesticides detected across all samples, table grape samples contained residues of the most diverse range of PFAS pesticides.

# EU-wide results: PFAS residues in fruit and vegetables



**Figure 4.** Most contaminated EU-grown fruit with PFAS in 2021.





## EU-imported fruit

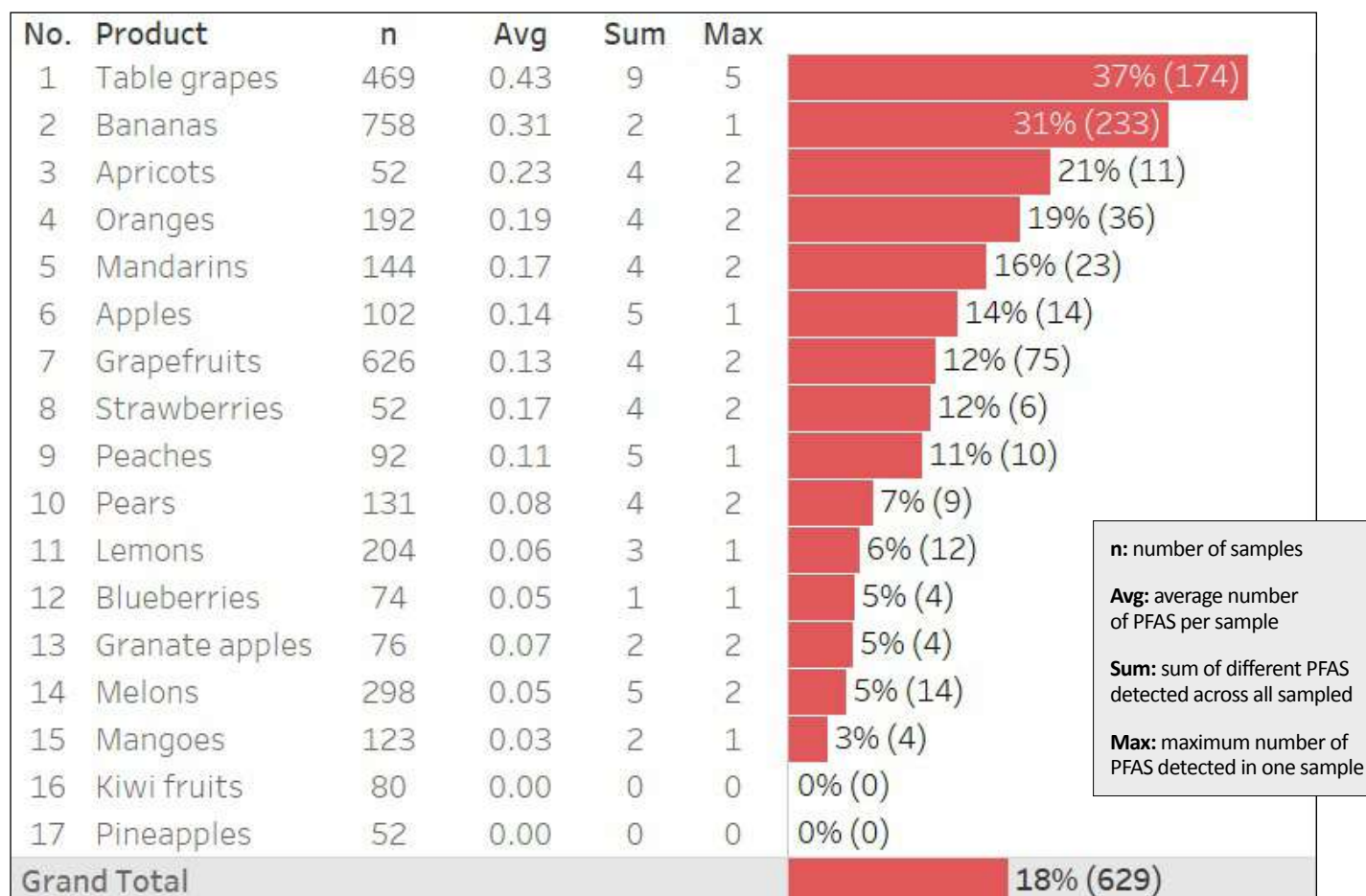
In 2021, residues of PFAS pesticides were present in 18% of all fruit samples.

Table grapes, bananas and apricots stood as the most frequently contaminated EU-imported fruit:

- 37% of the table grape samples contained residues of at least one PFAS pesticide. In total, nine different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to five different PFAS pesticides.
- 31% of the banana samples contained residues of at least one PFAS pesticides. In total, two different PFAS pesticides were detected across all samples, while in each sample, residues of no more than one PFAS pesticide were detected.
- 21% of the apricot samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to two different PFAS pesticides.

Overall, the maximum number of five different PFAS pesticides detected in a single sample was observed in table grape samples. With a total of 9 different pesticides detected across all samples, table grape samples also contained residues of the most diverse range of PFAS pesticides.

**Figure 5.** Most contaminated EU-imported fruit with PFAS in 2021







## EU-grown vegetables

In 2021, residues of PFAS pesticides were detected in 12% of all vegetable samples.

Chicories (witloofs), cucumbers and peppers stood as the most frequently contaminated EU-grown vegetables:

- 42% of the chicories (witloofs) samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- 30% of the cucumber samples contained residues of at least one PFAS pesticide. In total, 10 different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 27% of the pepper samples contained residues of at least one PFAS pesticide. In total, nine different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.

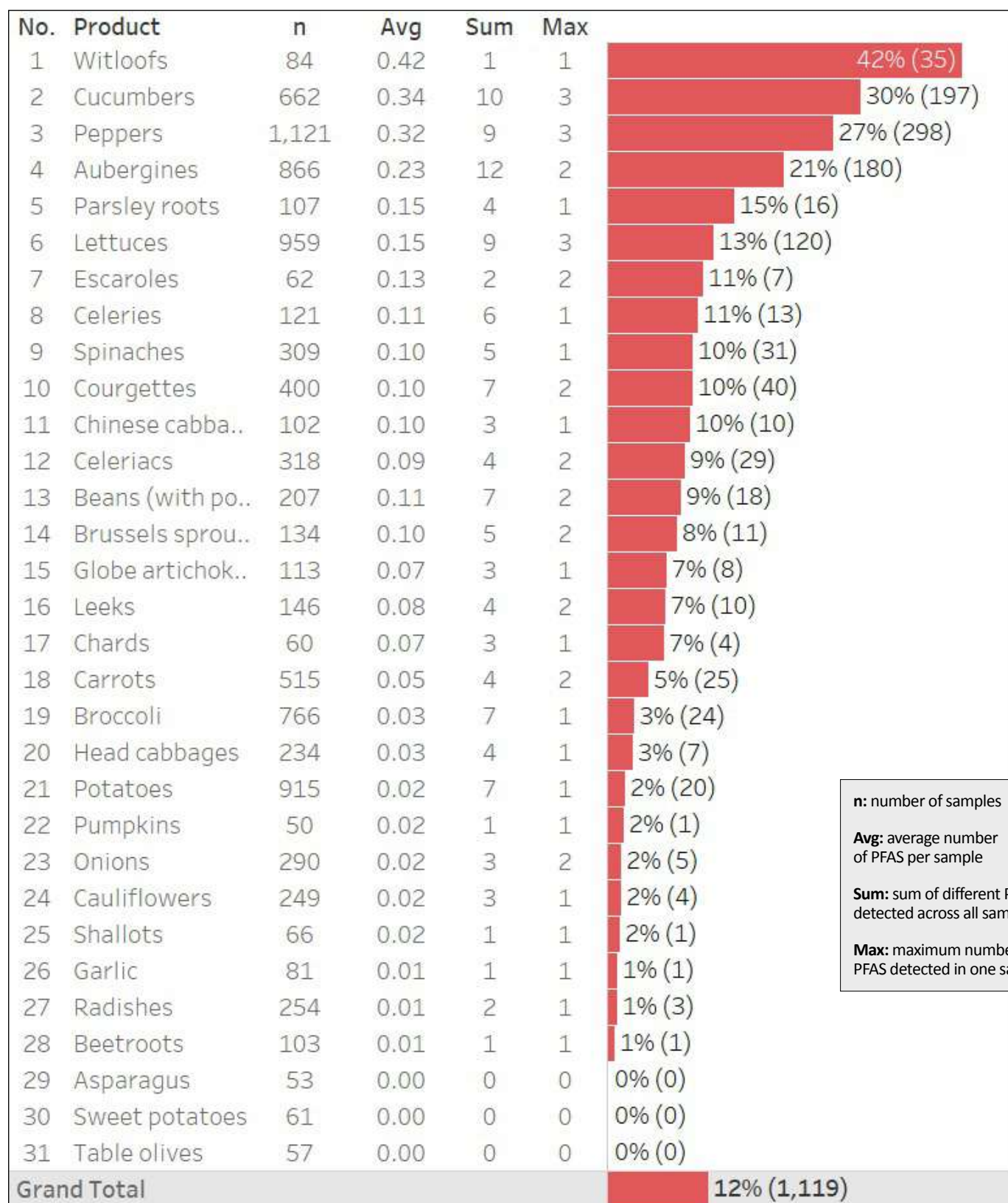
Overall, the maximum number of three different PFAS pesticides detected in a single sample was observed in pepper and cucumber samples. With a total of 12 different pesticides detected across all samples, aubergine samples contained residues of the most diverse range of PFAS pesticides.



# EU-wide results: PFAS residues in fruit and vegetables



Figure 6. Most EU-grown vegetables with PFAS in 2021





## EU-imported vegetables

In 2021, residues of PFAS pesticides were detected in 14% of all vegetable samples.

Cucumbers, aubergines and peppers stood as the most frequently contaminated EU-imported vegetables:

- 30% of the cucumber samples contained residues of at least one PFAS pesticide. In total, six different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 24% of the aubergine samples contained residues of at least one PFAS pesticide. In total, six different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 23% of the pepper samples contained residues of at least one PFAS pesticide. In total, 14 different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.

Overall, the maximum number of three different PFAS pesticides detected in a single sample was observed in pepper samples. With a total of 14 different pesticides detected across all samples, pepper samples also contained residues of the most diverse range of PFAS pesticides.

**Figure 7.** Most contaminated EU-imported vegetables with PFAS in 2021

No.	Product	n	Avg	Sum	Max	
1	Cucumbers	91	0.31	6	2	30% (27)
2	Aubergines	85	0.29	6	2	24% (20)
3	Peppers	338	0.28	14	3	23% (78)
4	Beans (with po..	88	0.16	4	2	15% (13)
5	Avocados	97	0.03	1	1	3% (3)
6	Courgettes	73	0.03	2	1	3% (2)
7	Carrots	60	0.02	1	1	2% (1)
8	Onions	83	0.00	0	1	0% (0)
9	Sweet potatoes	88	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>14% (144)</b>

**n:** number of samples      **Avg:** average number of PFAS per sample      **Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



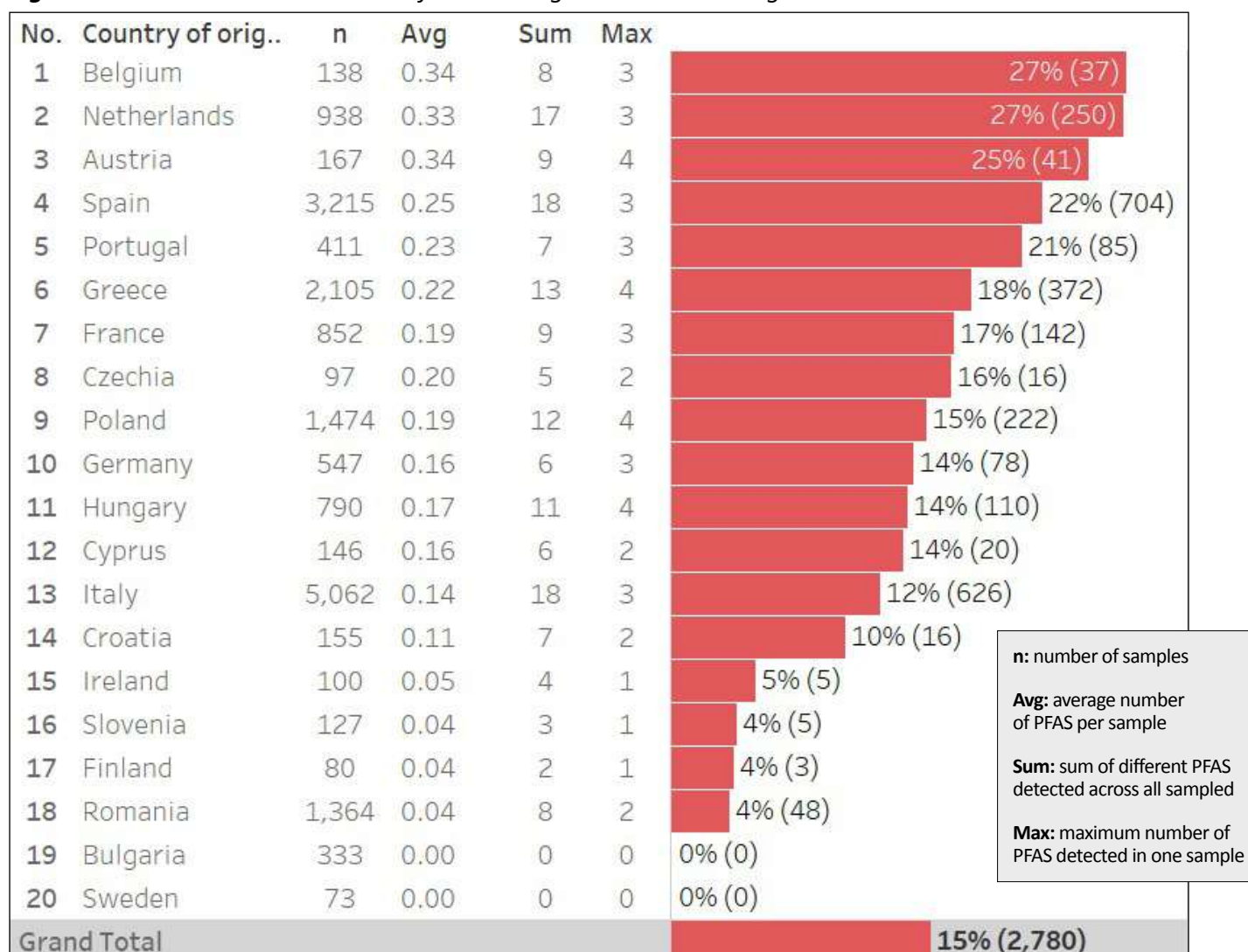


## Countries of origin of contaminated fruit and vegetables

### EU-grown products

In 2021, the samples of domestically grown fruit and vegetables with the highest rate of PFAS contamination came from Belgium (27%), the Netherlands (27%), and Austria (25%). Overall, 15% of all samples from EU-grown products contained residues of at least one PFAS pesticide. The maximum number of four different PFAS pesticides detected in a single sample was observed in fruit and vegetables grown in Austria, Greece, Hungary and Poland. With a total of 18 different pesticides detected across all their domestic samples, Italy and Spain stood as the countries of origin with the most diverse range of PFAS pesticides.

**Figure 8.** EU Member States whose fruit and vegetables had the highest PFAS contamination in 2021.



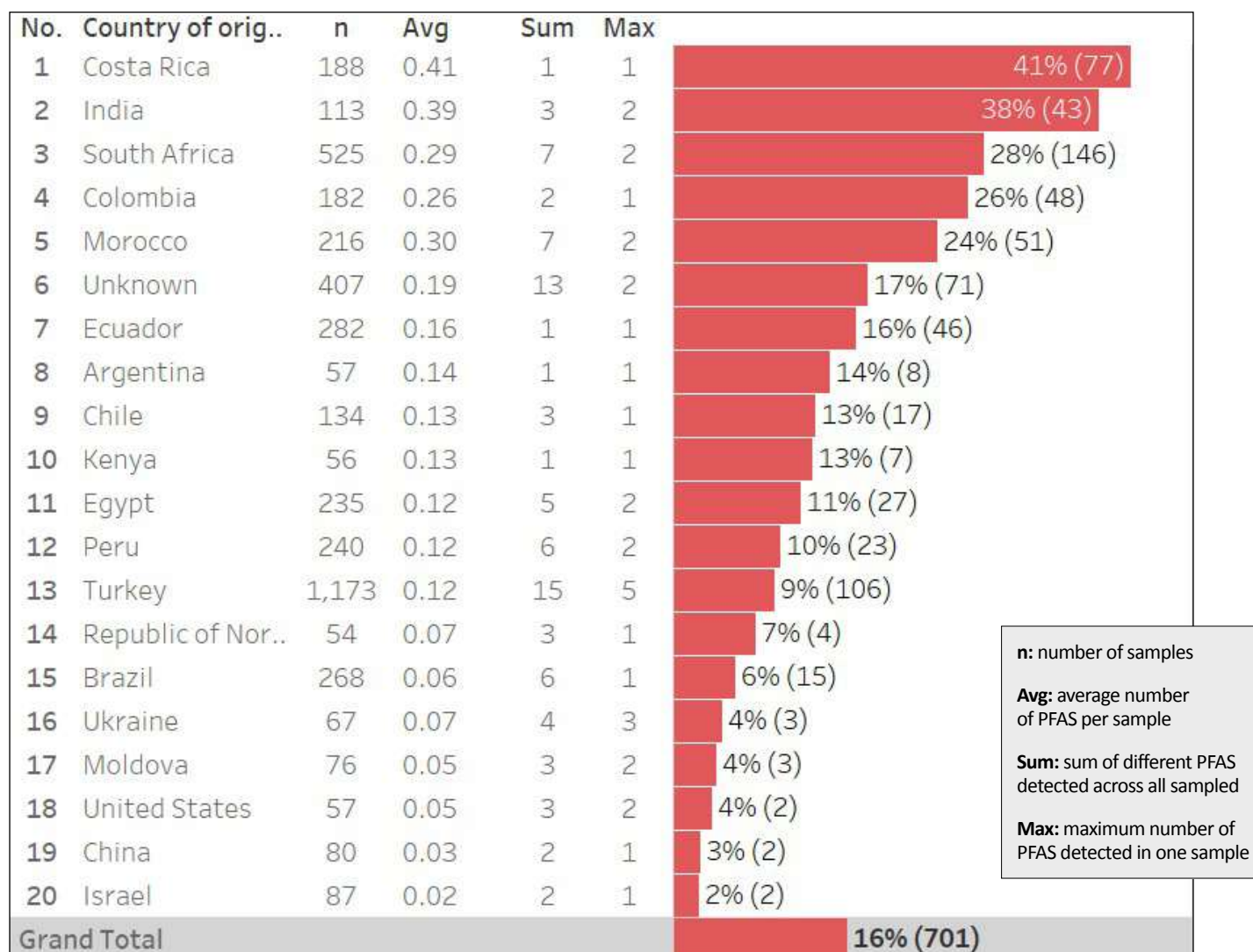




## EU-imported products

In 2021, the samples of EU-imported fruit and vegetables with the highest rate of PFAS contamination came from Costa Rica (41%), India (38%), and South Africa (28%). Overall, 16% of all samples from EU-imported products contained residues of at least one PFAS pesticide. Turkey stood as the country of origin with the maximum number of PFAS pesticides detected in a single sample, with certain individual Turkish samples containing residues of up to five different PFAS pesticides. Moreover, samples from Turkey contained the greatest diversity in terms of different PFAS pesticides detected across all samples (15).

**Figure 9.** Countries of origin of imported products with the highest PFAS contamination in 2021<sup>10</sup>.



<sup>10</sup> In 2021, in total, 407 of the 22,236 fruit and vegetables samples had an unknown country of origin (1.8%).



## Top 10 most contaminated products per country of origin

In 2021, the highest contamination levels across all fruit and vegetable samples were detected in samples of bananas from Panama (89%), table grapes from South Africa (75%), and strawberries from Spain (75%).

**Figure 10.** Top 10 products by country of origin with the highest % of PFAS<sup>11</sup>.

No.	Product & Country of origin	n	Avg	Sum	Max	
1	Bananas, Panama	28	0.89	1	1	89% (25)
2	Table grapes, South Africa	102	0.77	3	2	75% (77)
3	Strawberries, Spain	71	1.20	4	3	75% (53)
4	Strawberries, Netherlands	39	1.18	4	3	72% (28)
5	Strawberries, Austria	20	1.45	4	4	70% (14)
6	Cucumbers, Netherlands	41	0.78	5	2	63% (26)
7	Table grapes, Spain	134	0.69	8	3	61% (82)
8	Bananas, Costa Rica	128	0.60	1	1	60% (77)
9	Pears, Portugal	24	0.79	4	3	58% (14)
10	Bananas, Unknown	30	0.57	1	1	57% (17)
<b>Grand Total</b>						<b>19% (3,171)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



<sup>11</sup> In 2021, in total, 407 of the 22,236 fruit and vegetables samples had an unknown country of origin (1.8%). All these samples concerned EU-imported products (Figure 9).



## Top 10 detected PFAS pesticides in fruit and vegetables in 2021

### EU-grown products

In 2021, in the 2,812 samples of contaminated EU-grown fruit and vegetables collected across Member States, the three PFAS active substances most frequently detected were fluopyram, flonicamid, and trifloxystrobin.

No.	PFAS Pesticide	
1	Fluopyram	1,409
2	Flonicamid	420
3	Trifloxystrobin	381
4	Lambda Cyhalothrin	342
5	Triflumuron	207
6	Fluopicolide	140
7	Sulfoxaflor	84
8	tau-Fluvalinate	84
9	Tetraconazole	71
10	Cyflufenamid	30

**Table 2.** Top 10 PFAS pesticides detected in EU fruit and vegetables in 2021.

### EU-imported products

In 2021, in the 803 samples of contaminated EU-imported fruit and vegetables collected across Member States were fluopyram, bifenthrin, and trifloxystrobin.

No.	PFAS Pesticide	
1	Fluopyram	248
2	Bifenthrin	234
3	Trifloxystrobin	100
4	Lambda Cyhalothrin	97
5	Sulfoxaflor	72
6	Flonicamid	39
7	tau-Fluvalinate	24
8	Fluopicolide	18
9	Tetraconazole	11
10	Cyflufenamid	6

**Table 3.** Top 10 PFAS detected in fruit and vegetables imported by the EU in 2021.

# Austria: PFAS residues in fruit and vegetables



## 2011-2021: Evolution of PFAS contamination in fruit and vegetables in Austria

In Austria, between 2011 and 2021, a total of 7,686 fruit and vegetable samples met the study selection criteria. During this period, an average of 16.7% of the 4,096 fruit samples contained residues of at least one PFAS pesticide. The maximum number of PFAS pesticides detected in a single fruit sample was four, while 22 different PFAS pesticides were detected across all samples. The rate of PFAS contamination was significantly lower in vegetable samples, with 8.3% of the 3,590 samples containing residues of at least one PFAS pesticide. The maximum number of PFAS pesticides detected in a single vegetable sample was three, while 19 different PFAS pesticides were detected across all samples. When considering both fruit and vegetables together, 25 out of the selected 47 PFAS pesticides were detected across all samples.

*Table 4. Samples per product category included in the trend analysis for Austria in the period 2011-2021.*

Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	4,096	684	16.7%	4	22
<b>Vegetables</b>	3,590	297	8.3%	3	19
<b>Total</b>	7,686	981	12.8%	4	25





## PFAS contamination of fruit between 2011 and 2021 in Austria

The proportion of fruit samples contaminated with residues of PFAS pesticides has risen from 10.3% in 2011 to 37.5% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of fruit samples containing PFAS pesticide residues has increased by 698% over a 10-year period.

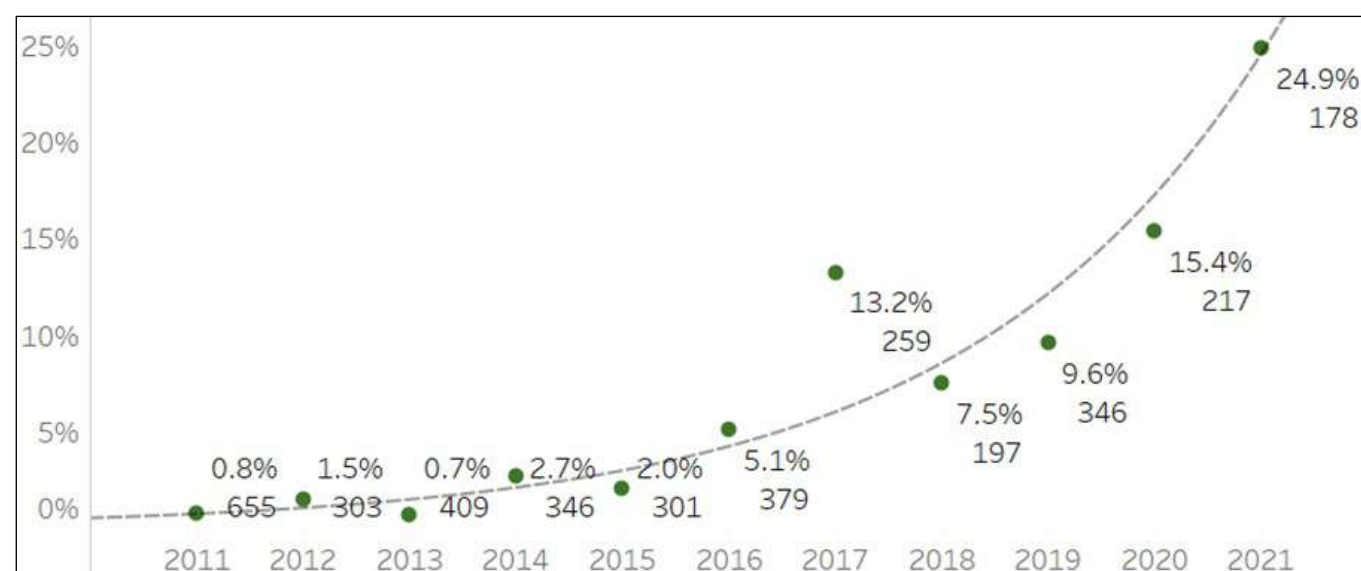
**Figure 11.** Average contamination of PFAS in popular fruit sampled in Austria in the period 2011-2021.



## PFAS contamination of vegetables between 2011 and 2021 in Austria

The proportion of vegetable samples contaminated with residues of PFAS pesticides has risen from 0.8% in 2011 to 24.9% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of vegetable samples containing PFAS pesticide residues has increased by 3277% over a 10-year period.

**Figure 12.** Average contamination of PFAS in popular vegetables sampled in Austria in the period 2011-2021.





## 2021: Overview of PFAS contamination of fruit and vegetables in Austria

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 10 times are presented in the graphs.

### PFAS contamination of fruit in 2021

#### Austrian fruit

In 2021, residues of PFAS pesticides were detected in 45% of all fruit samples.

Strawberries, apples, and pears emerged as the most frequently contaminated Austria-grown fruit:

- 70% of the strawberry samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to four different PFAS pesticides.
- 38% of the apple samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- 19% of the pear samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.

**Figure 13.** Most contaminated fruit grown in Austria in 2021.

No.	Product	n	Avg	Sum	Max	
1	Strawberries	20	1.45	4	4	70% (14)
2	Apples	13	0.38	3	1	38% (5)
3	Pears	16	0.19	2	1	19% (3)
<b>Grand Total</b>						<b>45% (22)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported fruit

In 2021, residues of PFAS pesticides were detected in 40% of all fruit samples.

Strawberries, table grapes and peaches stood as the most frequently contaminated imported fruit:

- 62% of the strawberry samples contained residues of at least one PFAS pesticide. In total, 10 different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to four different PFAS pesticides.
- 60% of the table grape samples contained residues of at least one PFAS pesticide. In total, seven different pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 48% of the peach samples contained residues of at least one PFAS pesticide. In total, eight different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.

**Figure 14.** Most contaminated fruit imported in Austria in 2021.

No.	Product	n	Avg	Sum	Max	
1	Strawberries	73	1.19	10	4	62% (45)
2	Table grapes	15	0.87	7	2	60% (9)
3	Peaches	85	0.65	8	3	48% (41)
4	Pears	76	0.47	7	3	34% (26)
5	Grapefruits	15	0.27	2	1	27% (4)
6	Melons	34	0.18	3	3	12% (4)
7	Figs	24	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>40% (129)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## PFAS contamination of vegetables in 2021

### Austrian vegetables

In 2021, residues of PFAS pesticides were detected in 20% of all vegetable samples.

The only vegetables grown in Austria sampled in sufficient amounts across Member States to generate meaningful statistics were cucumbers and potatoes.

- 39% of the cucumber samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 4% of the potato samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples. Each individual sample contained residues of no more than one PFAS pesticide.

**Figure 15.** Most contaminated fruit grown in Austria in 2021.

No.	Product	n	Avg	Sum	Max	
1	Cucumbers	41	0.41	3	2	39% (16)
2	Potatoes	47	0.04	2	1	4% (2)
<b>Grand Total</b>						<b>20% (18)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample







## Imported vegetables

In 2021, residues of PFAS pesticides were detected in 40% of all vegetable samples.

Peppers, aubergines, and cucumbers stood as the most frequently contaminated vegetables imported to Austria:

- 60% of the pepper samples contained residues of at least one PFAS pesticide. In total, seven different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 46% of the aubergine samples contained residues of at least one PFAS pesticide. In total, five different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 41% of the cucumber samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

**Figure 16.** Most contaminated vegetables imported in Austria in 2021.

No.	Product	n	Avg	Sum	Max	
1	Peppers	15	0.73	7	2	60% (9)
2	Aubergines	13	0.62	5	2	46% (6)
3	Cucumbers	34	0.44	4	2	41% (14)
4	Potatoes	16	0.13	1	1	13% (2)
<b>Grand Total</b>						<b>40% (31)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Countries of origin of contaminated fruit and vegetables

In 2021, imported fruit and vegetables with the highest contamination rate came from Germany (79%), Italy (47%), and Spain (41%). Overall, 39% of all samples from Austria-imported products contained residues of at least one PFAS pesticide.,

Italian, Spanish and Dutch samples contained the maximum number of different PFAS pesticides detected in a single sample (3). Spanish samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (12), closely followed by Turkish samples (11).

**Figure 17.** Most contaminated vegetables imported in Austria in 2021.

No.	Country of origin	n	Avg	Sum	Max	
1	Germany	14	1.43	5	3	79% (11)
2	Italy	89	0.74	8	3	47% (42)
3	Spain	131	0.56	12	3	41% (54)
4	Turkey	87	0.34	11	2	28% (24)
5	Netherlands	20	0.45	4	3	25% (5)
6	South Africa	21	0.24	3	1	24% (5)
<b>Grand Total</b>						<b>39% (141)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample





## Top 10 most detected PFAS in fruit and vegetables in 2021

### Austrian products

In 2021, in the 41 samples of contaminated Austria-grown fruit and vegetables collected across EU Member States, the three PFAS active substances most frequently detected were trifloxystrobin, flonicamid and fluopyram.

No.	PFAS Pesticide	
1	Trifloxystrobin	19
2	Flonicamid	16
3	Fluopyram	10
4	tau-Fluvalinate	5
5	Sulfoxaflor	3
6	Fluazifop-P	1
7	Flutolanil	1
8	Tetraconazole	1
9	Triflumuron	1

**Table 5.** Top 10 PFAS detected in Austrian fruit and vegetables in 2021.

### Imported products

In 2021, in the 167 samples of contaminated fruit and vegetables imported and collected in Austria, the three PFAS active substances most frequently were fluopyram, trifloxystrobin and flonicamid.

No.	PFAS Pesticide	
1	Fluopyram	92
2	Trifloxystrobin	43
3	Flonicamid	22
4	Lambda Cyhalothrin	21
5	Triflumuron	19
6	Sulfoxaflor	12
7	tau-Fluvalinate	6
8	Cyflufenamid	5
9	Fluopicolide	5
10	Tetraconazole	5

**Table 6.** Top 10 PFAS detected in fruit and vegetables imported to Austria in 2021.

# Belgium: PFAS residues in fruit and vegetables



## 2011-2021: Evolution of PFAS contamination in fruit and vegetables in Belgium

In Belgium, between 2011 and 2021, a total of 1,160 fruit and vegetable samples met the study selection criteria. During this period, on average 34% of the 656 fruit samples contained residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single fruit sample was three, while 12 different PFAS pesticides were detected across all samples. The rate of PFAS contamination was notably lower in vegetable samples, with 12.3% of the 504 vegetable samples containing residues of at least one PFAS pesticide. The maximum number of PFAS pesticides detected in a single vegetable sample was three, while nine different PFAS pesticides were detected across all samples. When considering both fruit and vegetables together, 14 different PFAS pesticides were detected across all samples.

*Table 7. Samples per product category included in the trend analysis for Belgium in the period 2011-2021.*

Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	656	223	34.0%	3	12
<b>Vegetables</b>	504	62	12.3%	3	9
<b>Total</b>	1,160	285	24.6%	3	14

In Belgium, it was not possible to calculate a trendline for PFAS contamination due to a limited dataset. This results from the sampling strategy of the Federal Agency for the Safety of the Food Chain (FASFC), which randomly samples very few products compared with other Member States (i.e. often less than 100-sample threshold of fruit or vegetable products per year)<sup>12</sup>.

Under the EU MACP programme, each Member State is required to randomly control a minimum number of samples of specific food products. This amount is proportional to the Member State's size.

<sup>12</sup> See tables 8 and 9.





In 2021 for instance, Belgium had to collect at least 15 conventionally-grown and 1 organically-grown samples of aubergines, broccolis, table grapes etc, while France had to collect 71 samples of each of these same commodities. The fact that the minimum number of samples is different from a Member State to another means that the threshold of 100 samples set in our analysis is more easily reachable in the largest Member States. Nevertheless, most Member States including smaller Member States like the Netherlands (18 samples per products), decide to collect more random samples than what is legally required from them under the EU MACP<sup>13</sup>. They have put in place additional other national control programmes in which they take random samples of residues. On the contrary, Belgium decided to stick to the legally required number of random samples under the EU MACP and to take the rest of its samples in a risk-based manner. While this approach is legal and valid, it limits the collection of comprehensive data and the assessment of consumer exposure to PFAS residues.

## PFAS contamination of fruit between 2011 and 2021 in Belgium

Based on the limited data from Belgium, the proportion of fruit samples contaminated with residues of PFAS pesticides has risen from 14.3% in 2011 to 25.5% in 2021. This represents a 1.8 fold increase between these years. No trendline could be calculated.

**Table 8.** Average contamination of PFAS in popular fruit sampled in Belgium in the period 2011-2021.

Year	Samples	%Samples with PFAS
2011	28	14.3%
2012	27	7.4%
2013	42	31%
2014	29	0%
2015	114	13.1%
2016	41	38.3%
2017	121	19.9%
2018	130	39.6%
2019	32	47.3%
2020	33	0%
2021	59	25.5%

<sup>13</sup> [The 2021 European Union report on pesticide residues in food \(europa.eu\)](https://eur.europa.eu/en/policies/pesticide-report). The Netherlands was required to randomly collect at least 18 samples of each product.



## PFAS contamination of vegetables between 2011 and 2021 in Belgium

Based on the limited data from Belgium, the proportion of vegetable samples contaminated with residues of PFAS pesticides has risen from 13.6% in 2011 to 35.6% in 2021. No trendline could be calculated.

**Table 9.** Average contamination of PFAS in popular vegetables sampled in Belgium in the period 2011-2021.

Year	Samples	%Samples with PFAS
2011	68	13.6%
2012	42	2.4%
2013	42	9.5%
2014	69	12.6%
2015	42	4.8%
2016	42	14.3%
2017	43	2.3%
2018	33	3%
2019	34	36.4%
2020	44	2.3%
2021	45	35.6%





## 2021: Overview of PFAS contamination of fruit and vegetables in Belgium

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 10 times are presented in the graphs, which in the case of Belgium a limited number of samples fulfilled these criteria in 2021.

### PFAS contamination of fruit in 2021

#### Belgium fruit

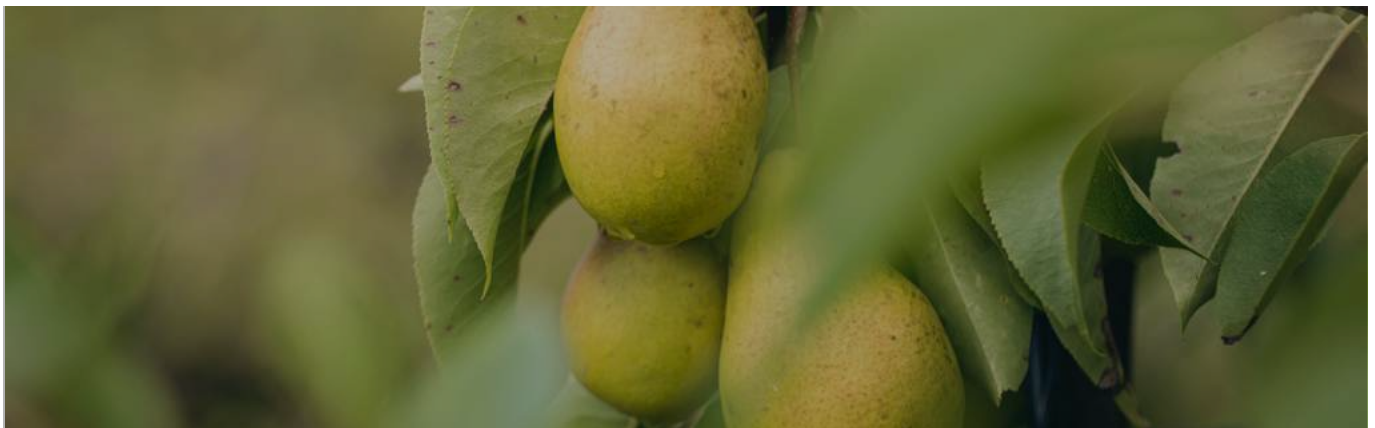
In 2021, the only fruit produced in Belgium sampled in sufficient amounts across Member States to generate meaningful statistics was pear.

15% of the pear samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, while residues of no more than one PFAS pesticide was detected in individual samples.

**Figure 18.** Most contaminated fruit grown in Belgium in 2021.

No.	Product	n	Avg	Sum	Max	
1	Pears	27	0.15	2	1	15% (4)
<b>Grand Total</b>						<b>15% (4)</b>

<b>n:</b> number of samples	<b>Avg:</b> average number of PFAS per sample	<b>Sum:</b> sum of different PFAS detected across all sampled
<b>Max:</b> maximum number of PFAS detected in one sample		





## Imported fruit

In 2021, residues of PFAS pesticides were detected in 25% of all fruit samples.

Bananas, grapefruit and melons stood as the most frequently contaminated fruit imported to Belgium:

- 40% of the banana samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- 29% of the grapefruit samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples.
- 20% of the melon samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples.

**Figure 19.** Most contaminated fruit imported in Belgium in 2021.

No.	Product	n	Avg	Sum	Max	
1	Bananas	15	0.40	1	1	40% (6)
2	Grapefruits	14	0.29	3	1	29% (4)
3	Melons	15	0.20	2	1	20% (3)
4	Table grapes	15	0.13	1	1	13% (2)
<b>Grand Total</b>						<b>25% (15)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample







## PFAS contamination of vegetables in 2021

### Belgium vegetables

In 2021, residues of PFAS pesticides were detected in 24% of all samples.

Samples of peppers, aubergines, brussels sprouts, and leeks grown in Belgium were collected across Member States including in Belgium.

- 56% of the pepper samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples. Certain individual samples contained residues of two different PFAS pesticides.
- 39% of aubergine samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples. Certain individual samples contained residues of two different PFAS residues.
- No residues of PFAS pesticide were detected in samples of brussels sprouts and leeks.

Pepper and aubergine samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (2). Certain individual samples of pepper and aubergine contained residues of two different PFAS pesticides.

**Figure 20.** Most contaminated vegetables grown in Belgium in 2021.

No.	Product	n	Avg	Sum	Max	
1	Peppers	16	0.63	2	2	56% (9)
2	Aubergines	18	0.44	2	2	39% (7)
3	Brussels sprouts	22	0.00	0	0	0% (0)
4	Leeks	10	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>24% (16)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported vegetables

In 2021, the only vegetable imported in Belgium sampled in sufficient amounts by Belgium to generate meaningful statistics was broccoli.

9% of the broccoli samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.

**Figure 21.** Most contaminated vegetables imported in Belgium in 2021.

No.	Product	n	Avg	Sum	Max	
1	Broccoli	11	0.09	1	1	9% (1)
<b>Grand Total</b>						<b>9% (1)</b>

<b>n:</b> number of samples	<b>Avg:</b> average number of PFAS per sample	<b>Sum:</b> sum of different PFAS detected across all sampled
<b>Max:</b> maximum number of PFAS detected in one sample		

## Countries of origin of contaminated fruit and vegetables

In 2021, residues of PFAS pesticides were detected in 18% of all samples.

The countries of origin of imported fruit and vegetables with the highest presence of PFAS were Spain and Italy.

- 19% of the Spanish samples contained residues of at least one PFAS pesticide. In total, five different PFAS pesticides were detected across all samples.
- 15% of the Italian samples contained residues of a single pesticide, which was detected across all contaminated samples.

**Figure 22.** Countries of origin of imported products in Belgium with the highest PFAS contamination in 2021

No.	Country of origin	n	Avg	Sum	Max	
1	Spain	27	0.19	5	1	19% (5)
2	Italy	13	0.15	1	1	15% (2)
<b>Grand Total</b>						<b>18% (7)</b>

<b>n:</b> number of samples	<b>Avg:</b> average number of PFAS per sample	<b>Sum:</b> sum of different PFAS detected across all sampled
<b>Max:</b> maximum number of PFAS detected in one sample		



## Most detected PFAS in fruit and vegetables in 2021

### Belgium products

In 2021, in the 38 samples of contaminated Belgium fruit and vegetables collected across Member States, the three most frequently detected PFAS active substances were trifloxystrobin, flonicamid and fluopyram.

No.	PFAS Pesticide	
1	Flonicamid	22
2	Fluopyram	15
3	Trifloxystrobin	6
4	Fluopicolide	2
5	Lambda Cyhalothrin	1
6	Pyridalil	1
7	Sulfoxaflor	1
8	Tetraconazole	1

**Table 10.** Eight PFAS detected in Belgium fruit and vegetables in 2021.

### Imported products

In 2021, in the 17 samples of contaminated fruit and vegetables imported in Belgium, the three most frequently detected PFAS active substances were bifenthrin, trifloxystrobin and flonicamid.

No.	PFAS Pesticide	
1	Bifenthrin	6
2	Trifloxystrobin	3
3	Flonicamid	2
4	Fluopicolide	2
5	Sulfoxaflor	2
6	Fluopyram	1
7	Lambda Cyhalothrin	1

**Table 11.** Seven PFAS detected in fruit and vegetables imported to Belgium in 2021.

# France: PFAS residues in fruit and vegetables



## 2011-2021: Evolution of PFAS contamination in fruit and vegetables in France

In France, between 2011 and 2021, a total of 22,168 fruit and vegetable samples met the study selection criteria. During this period, an average of 12.2% of the 9,637 fruit samples contained residues of at least one PFAS pesticides. The maximum number of PFAS detected in a single fruit sample was three, while 19 different PFAS pesticides were detected across all samples. The rate of PFAS contamination in vegetables was significantly lower with 8% of the 12,531 vegetable samples containing residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single vegetable sample was three, while 20 different PFAS pesticides were detected across all samples. When considering both fruit and vegetables together, 23 different PFAS pesticides were detected across all samples.

*Table 12. Samples per product category included in the trend analysis for France in the period 2011-2021.2021.*

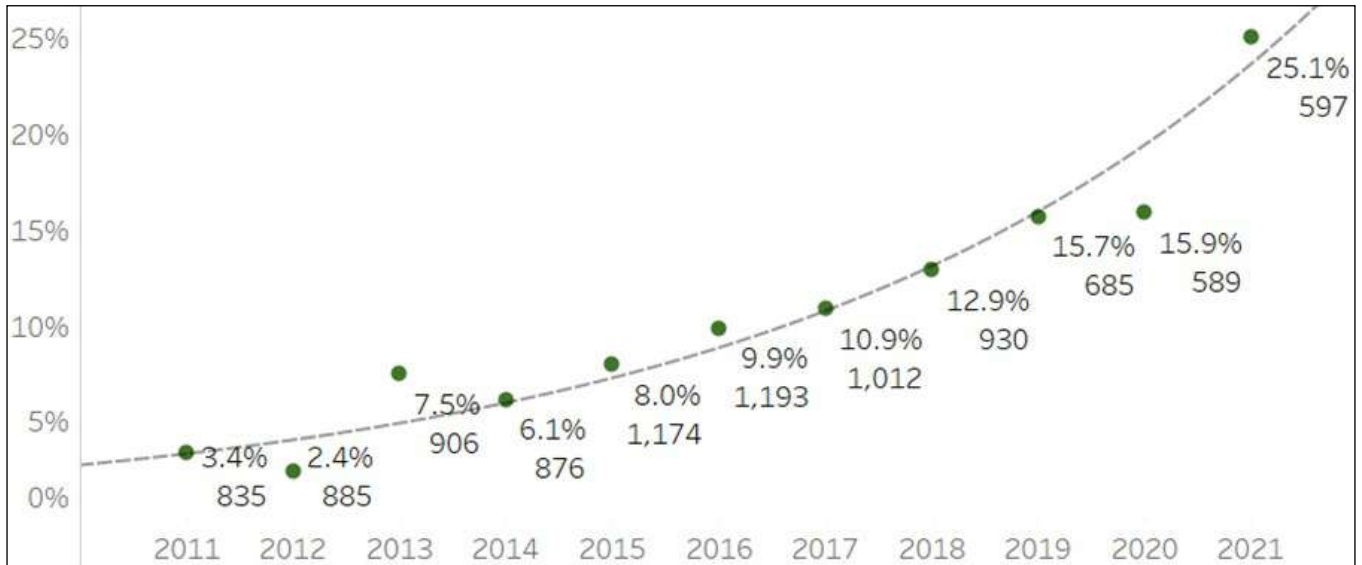
Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	9,637	1,176	12.2%	3	19
<b>Vegetables</b>	12,531	999	8.0%	3	20
<b>Total</b>	22,168	2,175	9.8%	3	23



## PFAS contamination of fruit between 2011 and 2021 in France

The proportion of fruit samples contaminated with residues of PFAS pesticides has gradually risen from 3.4% in 2011 to 25.1% in 2021. According to the trendline, the average proportion of fruit samples containing PFAS pesticide residues has increased by 617% over a 10-year period.

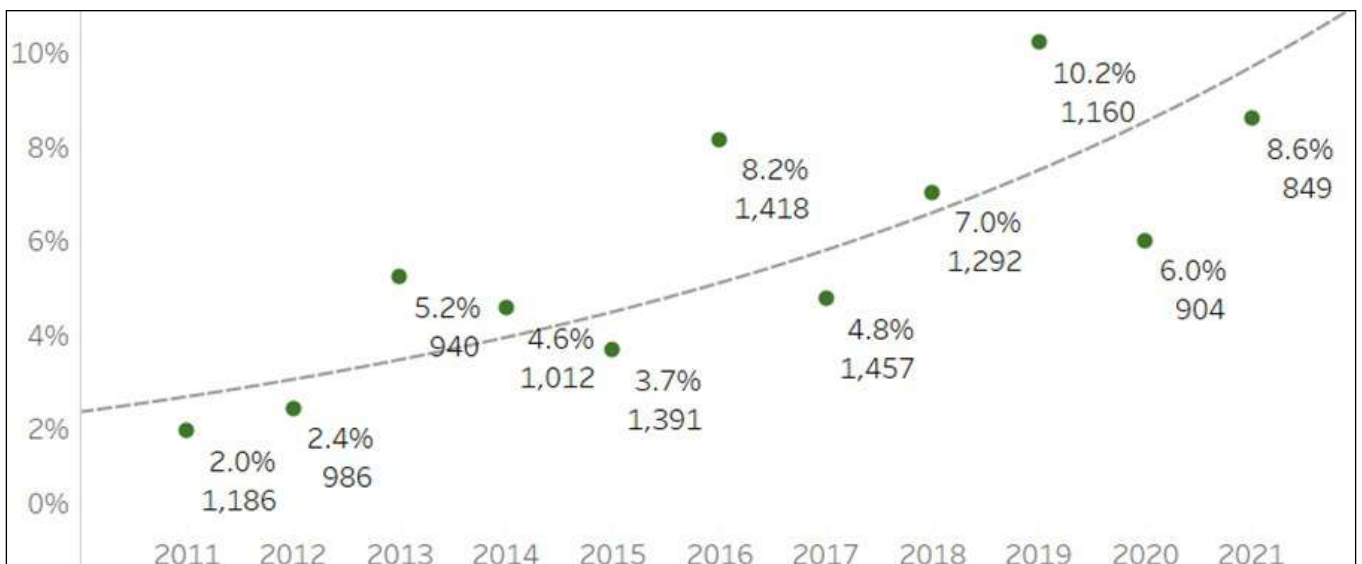
**Figure 23.** Average contamination of PFAS in popular fruit sampled in France in the period 2011-2021.



## PFAS contamination of vegetables between 2011 and 2021 in France

The proportion of vegetable samples contaminated with residues of PFAS pesticides has risen from 2.0% in 2011 to 8.6% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of vegetable samples containing PFAS pesticide residues has increased by 262% over a 10-year period.

**Figure 24.** Average contamination of PFAS in popular vegetables sampled in France in the period 2011-2021.







## 2021: Overview of PFAS contamination of fruit and vegetables in France

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 10 times are presented in the graphs.

### PFAS contamination of fruit in 2021

#### French fruit

In 2021, residues of PFAS pesticides were detected in 29% of all France-grown samples.

Table grapes, apricots and melons stood as the most frequently contaminated France-grown fruit:

- 48% of the table grape samples contained residues of at least one PFAS pesticide. In total, five PFAS different pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 39% of the apricot samples contained residues of at least one PFAS pesticide. In total, three PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 37% of the melon samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

**Figure 25.** Most contaminated fruit grown in France in 2021.

No.	Product	n	Avg	Sum	Max	
1	Table grapes	23	0.87	5	3	48% (11)
2	Apricots	64	0.44	3	2	39% (25)
3	Melons	46	0.41	3	2	37% (17)
4	Apples	37	0.14	3	1	14% (5)
5	Bananas	13	0.00	0	0	0% (0)
6	Figs	15	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>29% (58)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported fruit

In 2021, residues of PFAS pesticides were detected in 11% of all imported fruit samples.

Apricots, table grapes and raspberries stood as the most frequently contaminated imported fruit:

- 54% of the apricot samples contained at least one PFAS residue. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 27% of the table grape samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, while in individual samples, no more than one PFAS pesticide was detected.
- 18% of the strawberry samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

Overall, table grape samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (4).

**Figure 26.** Most contaminated fruit imported in France in 2021.

No.	Product	n	Avg	Sum	Max	
1	Apricots	13	0.62	3	2	54% (7)
2	Table grapes	51	0.27	4	1	27% (14)
3	Raspberries	17	0.35	2	2	18% (3)
4	Grapefruits	65	0.12	2	2	11% (7)
5	Bananas	95	0.11	2	1	11% (10)
6	Melons	30	0.07	2	1	7% (2)
7	Oranges	53	0.06	3	1	6% (3)
8	Blueberries	10	0.00	0	0	0% (0)
9	Figs	26	0.00	0	0	0% (0)
10	Mangoes	55	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>11% (46)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample





## PFAS contamination of vegetables in 2021

### French vegetables

In 2021, residues of PFAS pesticides were detected in 14% of all France-grown vegetable samples.

Chicories (witloof), aubergines and peppers stood as the most frequently contaminated French vegetables:

- 52% of the chicory (witloof) samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- 29% of the aubergine samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 23% of the pepper samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, while in individual samples, no more than one PFAS pesticide was detected.

Overall, lettuce samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (4).

**Figure 27.** Most contaminated vegetables grown in France in 2021.

No.	Product	n	Avg	Sum	Max	
1	Witloofs	58	0.52	1	1	52% (30)
2	Aubergines	24	0.38	2	2	29% (7)
3	Peppers	22	0.23	2	1	23% (5)
4	Cucumbers	50	0.20	2	2	18% (9)
5	Courgettes	34	0.15	2	1	15% (5)
6	Lettuces	60	0.20	4	3	13% (8)
7	Globe artichokes	38	0.08	1	1	8% (3)
8	Beans (with pods)	17	0.06	1	1	6% (1)
9	Brussels sprouts	34	0.03	1	1	3% (1)
10	Shallots	51	0.02	1	1	2% (1)
<b>Grand Total</b>						<b>14% (71)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported vegetables

In 2021, residues of PFAS pesticides were detected in 16% of all imported vegetable samples.

Cucumbers, peppers and beans stood as the most frequently contaminated imported vegetables:

- 43% of the cucumber samples contained residues of at least one PFAS pesticide. In total, seven different PFAS pesticides were detected across samples, while in individual samples, no more than one PFAS pesticide was detected.
- 28% of the pepper samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to 5 different PFAS pesticides.
- 20% of the bean (with pods) samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, while in individual samples, no more than one PFAS pesticide was detected.

Overall, cucumber samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (7).

**Figure 28.** Most contaminated vegetables imported in France in 2021.

No.	Product	n	Avg	Sum	Max	
1	Cucumbers	35	0.43	7	1	43% (15)
2	Peppers	47	0.32	4	3	28% (13)
3	Beans (with pods)	20	0.20	2	1	20% (4)
4	Aubergines	47	0.19	3	1	19% (9)
5	Globe artichokes	17	0.18	2	1	18% (3)
6	Broccoli	43	0.02	1	1	2% (1)
7	Brussels sprouts	25	0.00	0	0	0% (0)
8	Sweet potatoes	53	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>16% (45)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Countries of origin of contaminated fruit and vegetables

In 2021, South Africa, the Netherlands, and Colombia stood out as the countries of origin where PFAS residue presence was most notable in fruit and vegetables imported into France.

- 31% of the South African samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all the samples, while in each sample, no more than one PFAS pesticide was detected.
- 22% of the Dutch samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 20% of all the Columbian samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all the samples, while in each, no more than one PFAS pesticide was detected.

Overall, residues of PFAS pesticides were detected in 13% of all vegetable-imported samples. Samples from Guadeloupe (France) contained the maximum number of different PFAS pesticides detected in a single sample (4). Spanish samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (7).

**Figure 29.** Countries of origin of imported products in France with the highest PFAS contamination in 2021.



**n:** number of samples      **Avg:** average number of PFAS per sample      **Sum:** sum of different PFAS detected across all sampled  
**Max:** maximum number of PFAS detected in one sample





## Top 10 most detected PFAS in fruit and vegetables in 2021

### French products

In 2021, in the 143 samples of contaminated French fruit and vegetables collected across Member States, the three most frequently detected PFAS active substances were fluopyram, flonicamid and lambda-cyhalothrin.

No.	PFAS Pesticide	
1	Fluopyram	68
2	Flonicamid	45
3	Lambda Cyhalothr..	23
4	Fluopicolide	15
5	Trifloxystrobin	5
6	tau-Fluvalinate	4
7	Cyflufenamid	3
8	Flubendiamide	1
9	Triflumuron	1

**Table 13.** Top 10 PFAS detected in French fruit and vegetable in 2021.

### Imported products

In 2021, in the 96 samples of contaminated fruit and vegetables imported in France, the three most frequently detected PFAS active substances were fluopyram, lambda-cyhalothrin and trifloxystrobin.

No.	PFAS Pesticide	
1	Fluopyram	43
2	Lambda Cyhalothr..	13
3	Trifloxystrobin	13
4	Bifenthrin	9
5	Sulfoxaflor	7
6	Flonicamid	6
7	tau-Fluvalinate	4
8	Fluopicolide	3
9	Cyflufenamid	2
10	Penthiopyrad	2

**Table 14.** Top PFAS detected in fruit and vegetables imported to France in 2021.

# Germany: PFAS residues in fruit and vegetables



## 2011-2021: Evolution of PFAS contamination in fruit and vegetables in Germany

In Germany, between 2011 and 2021, a total of 28,288 fruit and vegetable samples met the study selection criteria. During this period, an average of 15.5% of the 12,393 fruit samples contained residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single fruit sample was five, while 21 different PFAS pesticides were detected across all samples. The rate of PFAS contamination was significantly lower in vegetables, with 6.8% of the 15,895 vegetable samples containing residues of at least one PFAS pesticide. The maximum number of PFAS pesticides detected in a single vegetable sample was three, while 22 different PFAS pesticides were detected. When considering both fruit and vegetables together, 26 different PFAS pesticides were detected across all samples.

**Table 15.** Samples per product category included in the trend analysis for Germany in the period 2011-2021.

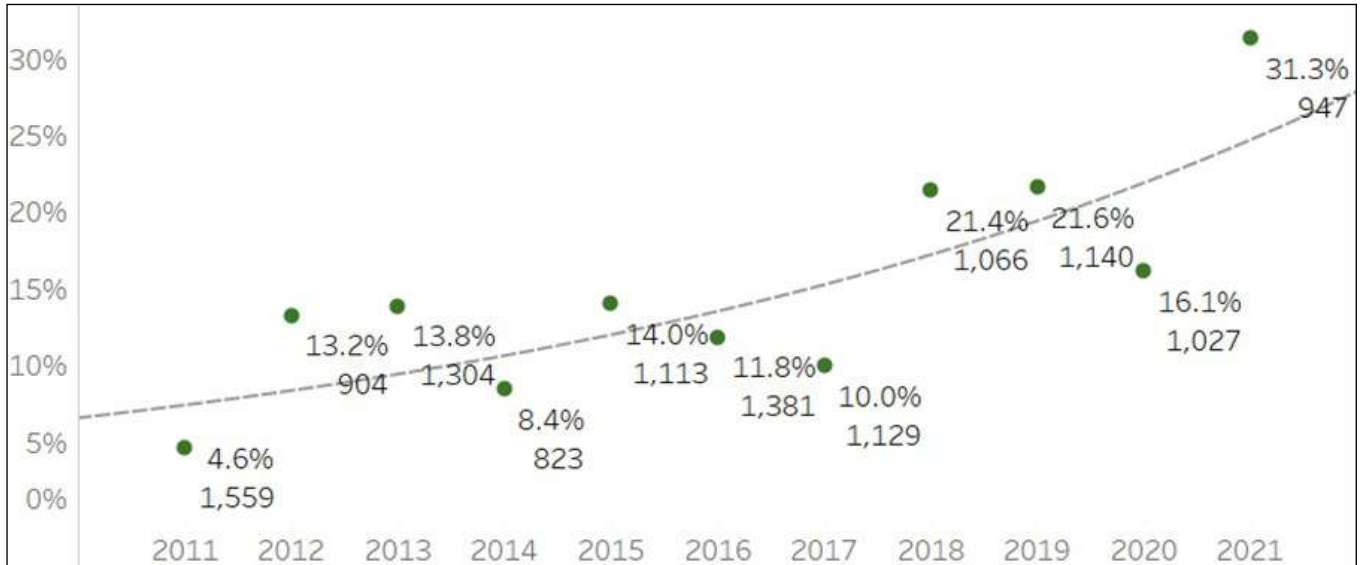
Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	12,393	1,924	15.5%	5	21
<b>Vegetables</b>	15,895	1,082	6.8%	3	22
<b>Total</b>	28,288	3,006	10.6%	5	26



## PFAS contamination of fruit between 2011 and 2021 in Germany

The proportion of fruit samples contaminated with residues of PFAS pesticides has risen from 4.6% in 2011 to 31.3% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of fruit samples containing PFAS pesticide residues has increased by 234% over a 10-year period.

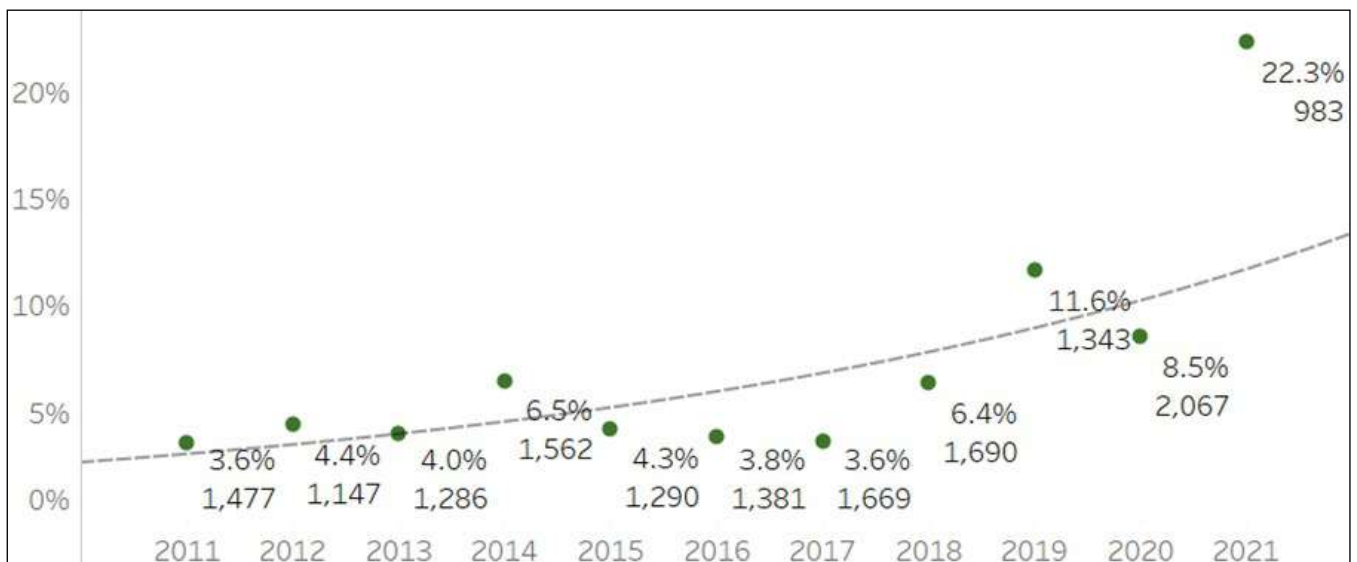
**Figure 30.** Average contamination of PFAS in popular fruit sampled in Germany in the period 2011-2021.



## PFAS contamination of vegetables between 2011 and 2021 in Germany

The proportion of vegetable samples contaminated with residues of PFAS pesticides has risen from 3.6% in 2011 to 22.3% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of vegetable samples containing PFAS pesticide residues has increased by 284% over a 10-year period.

**Figure 31.** Average contamination of PFAS in popular vegetables sampled in Germany in the period 2011-2021.





## 2021: Overview of PFAS contamination of fruit and vegetables in Germany

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 10 times are presented in the graphs.

### PFAS contamination of fruit in 2021

#### German fruit

In 2021, the only fruit grown in Germany sampled in sufficient amounts across Member States to generate meaningful statistics was strawberries.

60% of strawberry samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.

**Figure 32.** Most contaminated fruit grown in Germany in 2021.

No.	Product	n	Avg	Sum	Max	
1	Strawberries	15	1.20	4	3	60% (9)
Grand Total						60% (9)

<b>n:</b> number of samples	<b>Avg:</b> average number of PFAS per sample	<b>Sum:</b> sum of different PFAS detected across all sampled
<b>Max:</b> maximum number of PFAS detected in one sample		





## Imported fruit

In 2021, residues of PFAS pesticides were detected in 29% of all fruit samples.

Bananas, apricots, and table grapes stood as the most frequently contaminated fruit imported into Germany:

- 48% of the banana samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- 44% of the apricot samples contained residues of at least one PFAS pesticide. In total, seven different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 37% of the table grape samples contained residues of at least one PFAS pesticide. In total, seven PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to five different PFAS pesticides.

Overall, apricot and table grape samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (7).

**Figure 33.** Most contaminated fruit imported in Germany in 2021.

No.	Product	n	Avg	Sum	Max	
1	Bananas	141	0.48	1	1	48% (68)
2	Apricots	174	0.49	7	2	44% (76)
3	Table grapes	202	0.40	7	5	37% (75)
4	Grapefruits	213	0.15	5	1	15% (32)
5	Melons	210	0.15	5	2	12% (26)
<b>Grand Total</b>						<b>29% (277)</b>

**n:** number of samples      **Avg:** average number of PFAS per sample      **Sum:** sum of different PFAS detected across all sampled  
**Max:** maximum number of PFAS detected in one sample





## PFAS contamination of vegetables in 2021

### German vegetables

In 2021, residues of PFAS pesticides were detected in 14% of all France-grown vegetable samples.

Lettuces, aubergines and peppers stood as the most frequently contaminated vegetables grown in Germany.

- 39% of the lettuce samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, while in each sample, no more than one PFAS pesticide was detected.
- 33% of the aubergine samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, while in each sample, no more than one PFAS pesticide was detected.
- 33% of the pepper samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, while in each sample, no more than one PFAS pesticide was detected.

Overall, celeriac samples contained the maximum number of PFAS pesticides detected in a single sample (2). Lettuce, broccoli, and celeriac samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (3).

**Figure 34.** Most contaminated vegetables grown in Germany in 2021.

No.	Product	n	Avg	Sum	Max	
1	Lettuces	93	0.39	3	1	39% (36)
2	Aubergines	12	0.33	2	1	33% (4)
3	Peppers	15	0.33	2	1	33% (5)
4	Potatoes	15	0.07	1	1	7% (1)
5	Broccoli	51	0.06	3	1	6% (3)
6	Celeriacs	187	0.06	3	2	6% (11)
7	Radishes	122	0.01	1	1	1% (1)
<b>Grand Total</b>						<b>12% (61)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported vegetables

In 2021, residues of PFAS pesticides were detected in 31% of all vegetable samples.

Peppers, aubergines and lettuces stood as the most frequently contaminated vegetables imported to Germany:

- 49 % of the peppers sample contained residues of at least one PFAS pesticide. In total, seven different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 42% of the aubergine samples contained residues of at least one PFAS pesticide. In total, seven different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 18% of the lettuce samples contained residues of at least one PFAS pesticide. In total, five different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

Overall, pepper and aubergines samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (7).

**Figure 35.** Most contaminated vegetables imported in Germany in 2021.

No.	Product	n	Avg	Sum	Max	
1	Peppers	162	0.62	7	2	49% (79)
2	Aubergines	144	0.48	7	2	42% (60)
3	Lettuces	68	0.19	5	2	18% (12)
4	Celeriacs	37	0.11	1	1	11% (4)
5	Broccoli	65	0.09	3	1	9% (6)
6	Radishes	39	0.03	1	1	3% (1)
<b>Grand Total</b>						<b>31% (162)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



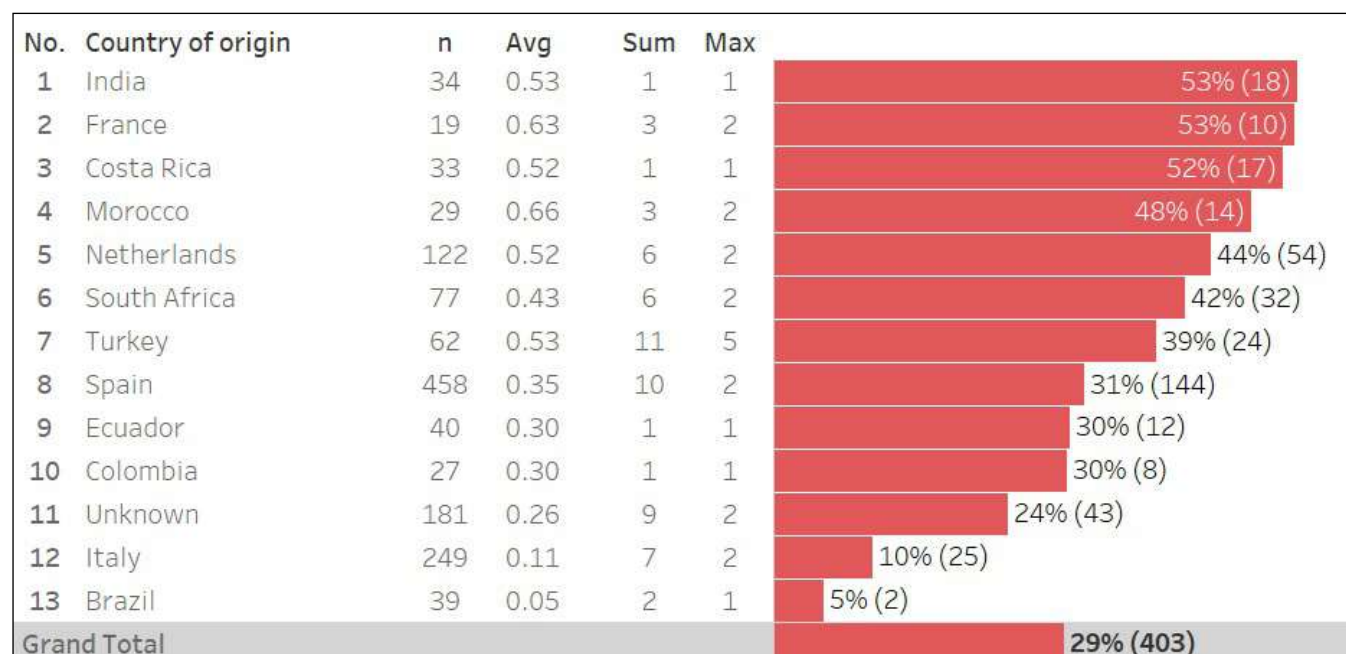
## Countries of origin of contaminated fruit and vegetables

In 2021, the countries of origin of imported fruit and vegetables with the highest presence of PFAS were India, France and Costa Rica.

- 53% of the Indian samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- 53% of the French samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 52% of the Costa Rican samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.

Overall, residues of PFAS pesticides were detected in 29% of all samples. Turkish samples contained the maximum number of different PFAS pesticides detected in the same sample, with certain individual samples containing residues of up to five different PFAS pesticides. Turkish samples also contained the greatest diversity in terms of different PFAS residues detected across samples (11).

**Figure 36.** Countries of origin of imported products in Germany with the highest PFAS contamination in 2021.



**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Most detected PFAS in fruit and vegetables in 2021

### German products

In 2021, in the 78 samples of contaminated German fruit and vegetables collected across Member States, the three most frequently detected PFAS active substances were lambda cyhalothrin, fluopyram and trifloxystrobin.

No.	PFAS Pesticide	
1	Lambda Cyhalothrin	37
2	Fluopyram	23
3	Trifloxystrobin	11
4	Fonicamid	10
5	tau-Fluvalinate	5
6	Fluazifop-P	2

**Table 16.** Six PFAS detected in German fruit and vegetables in 2021.

### Imported products

In 2021, in the 439 samples of contaminated fruit and vegetables imported to Germany, the three most frequently detected PFAS active substances were fluopyram, bifenthrin and fonicamid.

No.	PFAS Pesticide	
1	Fluopyram	204
2	Bifenthrin	68
3	Fonicamid	66
4	Trifloxystrobin	42
5	Lambda Cyhalothrin	37
6	Sulfoxaflor	22
7	Pyridalil	14
8	Fluopicolide	9
9	tau-Fluvalinate	7
10	Fluazifop-P	5

**Table 17.** Top PFAS detected in fruit and vegetables imported to Germany in 2021.

# Greece: PFAS residues in fruit and vegetables



## 2011-2021: Evolution of PFAS contamination in fruit and vegetables in Greece

In Greece, between 2011 and 2021, a total of 18,607 fruit and vegetables samples met the study selection criteria. During this period, 14.8% of the 9,360 tested fruit samples contained residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single fruit sample was four. Five different PFAS pesticides were detected across all samples. The rate of PFAS contamination was significantly lower in vegetable samples, with 6.2% of the 9,247 samples containing residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single vegetable sample was four, while 18 different PFAS pesticides were detected across all samples. When considering both fruit and vegetables, 20 different PFAS pesticides were detected across all samples.

*Table 18. Samples per product category included in the trend analysis for Greece in the period 2011-2021.*

Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	9,360	1,383	14.8%	4	15
<b>Vegetables</b>	9,247	574	6.2%	4	18
<b>Total</b>	18,607	1,957	10.5%	4	20

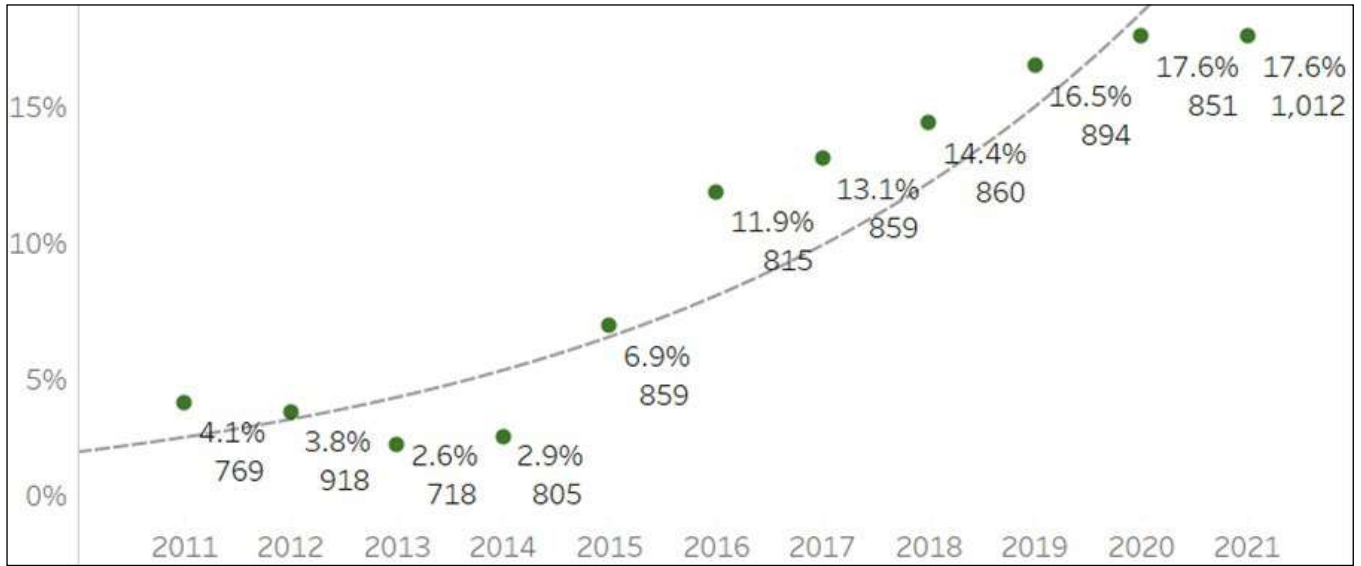




## PFAS contamination of fruit between 2011 and 2021

The proportion of fruit samples contaminated with residues of PFAS pesticides has risen from 4.1% in 2011 to 17.6% in 2021. According to the trendline, which averages out the fluctuations in different years, the percentage of fruit samples containing PFAS pesticides represents a substantial increase of 696% over a 10-year period.

**Figure 37.** Average contamination of PFAS in popular fruit sampled in Greece in the period 2011-2021.



## PFAS contamination of vegetables between 2011 and 2021

The proportion of vegetable samples contaminated with residues of PFAS pesticides has risen from 0.7% in 2011 to 6.1% in 2021. According to the trendline, which averages out the fluctuations in different years, the percentage of vegetable samples containing PFAS pesticides represents a substantial increase of 1974% over a 10-year period.

**Figure 38.** Average contamination of PFAS in popular vegetables sampled in Greece in the period 2011-2021.





## 2021: Overview of PFAS contamination of fruit and vegetables in Greece

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 10 times are presented in the graphs.

### PFAS contamination of fruit in 2021

#### Greek fruit

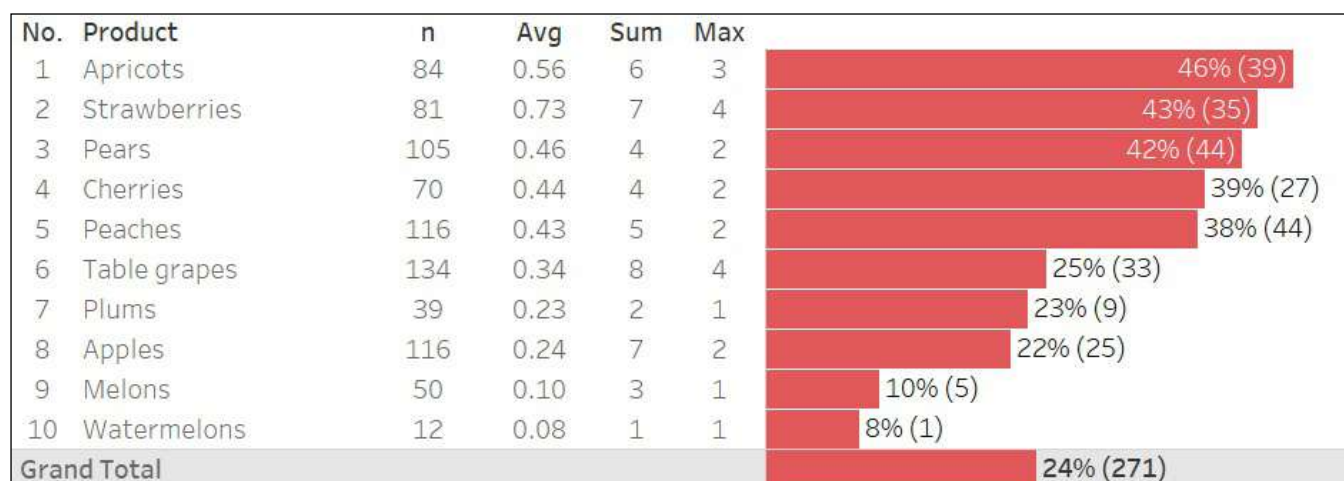
In 2021, residues of PFAS pesticides were detected in 24% of all fruit samples.

Apricots, strawberries and pears stood as the most frequently contaminated Greek fruit:

- 46% of the apricot samples contained residues of at least one PFAS pesticide. In total, six different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 43% of the strawberry samples contained residues of at least one PFAS pesticide. In total, seven different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to four different PFAS pesticides.
- 42% of the pear samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of different PFAS pesticides.

Overall, strawberry and table grape samples had the maximum number of different PFAS pesticides detected in a single sample (4). Table grape samples also contained the greatest diversity in terms of different PFAS pesticides detected across samples (8).

**Figure 39.** Most contaminated fruit grown in Greece in 2021.



**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported fruit

In 2021, residues of PFAS pesticides were detected in 6% of all fruit samples.

Mangoes and bananas stood as the most frequently contaminated fruit imported into Greece:

- 10% of the mango samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- 5% of the banana samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.

Overall, apricot and table grape samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (7).

**Figure 40.** Most contaminated fruit imported in Greece in 2021.

No.	Product	n	Avg	Sum	Max	
1	Mangoes	10	0.10	1	1	10% (1)
2	Bananas	37	0.05	1	1	5% (2)
<b>Grand Total</b>						<b>6% (3)</b>

**n:** number of samples      **Avg:** average number of PFAS per sample      **Sum:** sum of different PFAS detected across all sampled  
**Max:** maximum number of PFAS detected in one sample





## PFAS contamination of vegetables in 2021

### Greek vegetables

In 2021, residues of PFAS pesticides were detected in 11% of all vegetable samples.

Cucumbers, peppers and lettuces stood as the most frequently contaminated Greek vegetables:

- 33% of the cucumber samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 30% of the pepper samples contained residues of at least one PFAS pesticide. In total, six different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 16% of the lettuce samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

Overall, cucumber and pepper samples contained the maximum number of different PFAS pesticides detected in a single sample (3). Pepper samples also contained the greatest diversity in terms of different PFAS pesticides detected across samples (6).

**Figure 41.** Most contaminated vegetables grown in Greece in 2021

No.	Product	n	Avg	Sum	Max	
1	Cucumbers	115	0.41	4	3	33% (38)
2	Peppers	97	0.40	6	3	30% (29)
3	Lettuces	85	0.22	3	2	16% (14)
4	Spinaches	64	0.13	2	1	13% (8)
5	Beans (with pods)	42	0.10	2	2	7% (3)
6	Beetroots	19	0.05	1	1	5% (1)
7	Aubergines	66	0.05	2	1	5% (3)
8	Potatoes	144	0.03	2	1	3% (4)
9	Courgettes	57	0.02	1	1	2% (1)
10	Asparagus	20	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>11% (101)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample

### Imported vegetables

In 2021, the only vegetable imported in Greece that was sampled in sufficient amounts by the Greek authorities to generate meaningful statistics was the potatoes. None of these samples contained residues of PFAS pesticides.





## Countries of origin of contaminated fruit and vegetables

In 2021, the countries of origin of imported fruit and vegetables (mangoes, bananas and potatoes) with the highest presence of PFAS were Brazil and Ecuador:

- 12% of the Brazilian samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples.
- 5% of the Ecuadorian samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- No residues of PFAS pesticides were detected in Peruvian samples.

Overall, residues of PFAS pesticides were detected in 6% of all samples. Brazil samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (2).

**Figure 42.** Countries of origin of imported products in Greece with the highest PFAS contamination in 2021.

No.	Country of origin	n	Avg	Sum	Max	
1	Brazil	17	0.12	2	1	12% (2)
2	Ecuador	37	0.05	1	1	5% (2)
3	Peru	11	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>6% (4)</b>

<b>n:</b> number of samples	<b>Avg:</b> average number of PFAS per sample	<b>Sum:</b> sum of different PFAS detected across all sampled
<b>Max:</b> maximum number of PFAS detected in one sample		





## Top 10 most detected PFAS in fruit and vegetables in 2021

### Greek products

In 2021, in the 375 samples of contaminated Greek fruit and vegetables collected across Member States, the three most frequently detected PFAS active substances were fluopyram, trifloxystrobin, and fluopicolide

No.	PFAS Pesticide	
1	Fluopyram	215
2	Trifloxystrobin	59
3	Fluopicolide	35
4	Flonicamid	34
5	Sulfoxaflor	34
6	tau-Fluvalinate	27
7	Lambda Cyhalothrin	20
8	Cyflumetofen	16
9	Cyflufenamid	11
10	Metaflumizone	3

**Table 19.** Top 10 PFAS detected in Greek fruit and vegetables in 2021.

### Imported products

In 2021, in the 10 samples of contaminated fruit and vegetables imported in Greece, the three most frequently detected PFAS active substances were fluopyram, bifenthrin and fluopicolide.

No.	PFAS Pesticide	
1	Fluopyram	3
2	Bifenthrin	2
3	Fluopicolide	2
4	Flonicamid	1
5	Lambda Cyhalothrin	1
6	Tetraconazole	1
7	Trifloxystrobin	1

**Table 20.** Seven PFAS substances detected in fruit and vegetables imported to Greece in 2021.

# Hungary: PFAS residues in fruit and vegetables



## 2011-2021: Evolution of PFAS contamination in fruit and vegetables in Hungary

In Hungary, between 2011 and 2021, a total of 17,397 fruit and vegetable samples met the study selection criteria. During this period, 12.7% of the 8,801 fruit samples contained residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single fruit sample was three, while overall, 19 different PFAS pesticides were detected across all samples. The rate of PFAS contamination in vegetable samples was lower, with 7.5% of the 8,596 vegetable samples containing residues of at least one PFAS pesticide. The maximum number of PFAS in a single vegetable sample was three while 16 different PFAS pesticides were detected across all samples. When considering both fruit and vegetables together, 22 different PFAS pesticides were detected across all samples.

*Table 21. Samples per product category included in the trend analysis for Hungary in the period 2011-2021.*

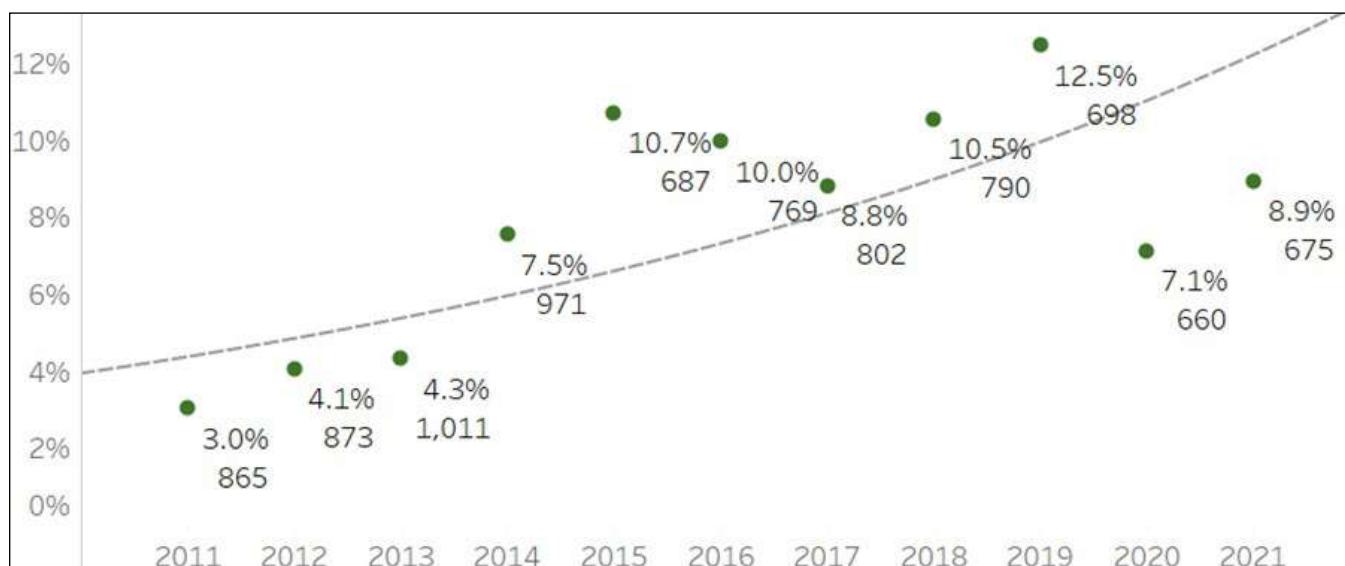
Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	8,801	1,122	12.7%	3	19
<b>Vegetables</b>	8,596	645	7.5%	3	16
<b>Total</b>	17,397	1,767	10.2%	3	22



## PFAS contamination of fruit between 2011 and 2021

The proportion of fruit samples contaminated with residues of PFAS pesticides has risen from 3.0% in 2011 to 8.9% in 2021. According to the trendline, which averages out the fluctuations in different years, the percentage of fruit samples containing PFAS pesticides represents a substantial increase of 182% over a 10-year period.

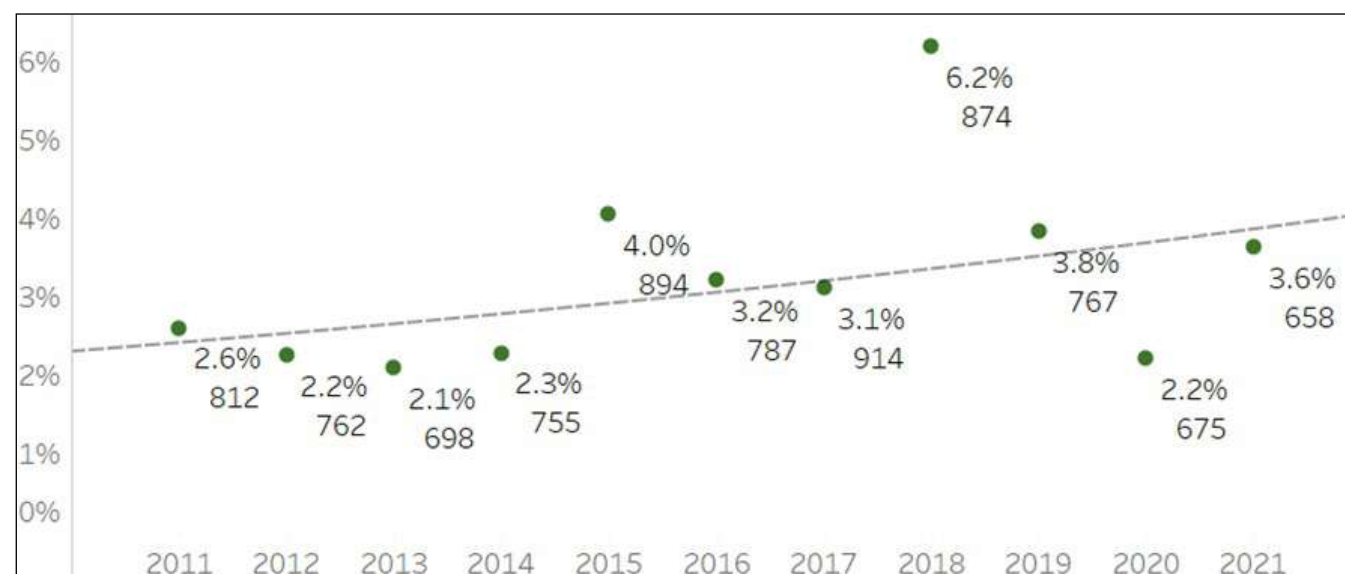
**Figure 43.** Average contamination of PFAS in popular fruit sampled in Hungary in the period 2011-2021.



## PFAS contamination of vegetables between 2011 and 2021

The growth of PFAS presence in vegetables sampled in Hungary has remained fairly stable according to the trendline and when compared with that of other studied EU Member States. Nevertheless, the proportion of vegetable samples contaminated with residues of PFAS pesticides has slightly risen from 2.6% in 2011 to 3.6% in 2021. According to the trendline, which averages out the fluctuations in different years, the percentage of vegetable samples containing PFAS pesticides represents an increase of 63% over a 10-year period.

**Figure 44.** Average contamination of PFAS in popular vegetables sampled in Hungary in the period 2011-2021.





## 2021: Overview of PFAS contamination of fruit and vegetables in Hungary

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 10 times are presented in the graphs.

### PFAS contamination of fruit in 2021

#### Hungarian fruit

In 2021, residues of PFAS pesticides were detected in 22% of all fruit samples.

Peaches, cherries and strawberries stood as the most frequently contaminated Hungarian fruit:

- 47% of the peach samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 43% of the cherry samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, while no more than one PFAS pesticide was detected in a single sample.
- 26% of the strawberry samples contained residues of at least one PFAS pesticide. In total, four PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to four different PFAS pesticides.

Overall, strawberry samples contained the maximum number of different PFAS pesticides detected in a single sample (4). Apple samples contained the greatest diversity in terms of different PFAS pesticides detected across all samples (5).

**Figure 45.** Most contaminated fruit grown in Hungary in 2021.

No.	Product	n	Avg	Sum	Max	
1	Peaches	30	0.50	3	2	47% (14)
2	Cherries	14	0.43	2	1	43% (6)
3	Strawberries	19	0.63	4	4	26% (5)
4	Plums	23	0.26	1	1	26% (6)
5	Apples	130	0.27	5	3	23% (30)
6	Apricots	23	0.13	2	1	13% (3)
7	Table grapes	21	0.14	3	2	10% (2)
8	Pears	37	0.11	3	2	8% (3)
9	Watermelons	12	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>22% (69)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported fruit

In 2021, residues of PFAS pesticides were detected in 12% of all fruit samples.

Apricots, strawberries, and table grapes stood as the most frequently contaminated fruit imported to Hungary:

- 44% of the apricot samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, while no more than one PFAS pesticide was detected in single samples.
- 40% of the strawberry samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 30% of the table grape samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

Overall, strawberry samples contained the maximum number of different PFAS pesticides detected in a single sample (3). Apricot, strawberry and apple samples contained the greatest diversity of different PFAS pesticides detected across samples (3).

**Figure 46.** Most contaminated fruit imported in Hungary in 2021.

No.	Product	n	Avg	Sum	Max	
1	Apricots	16	0.44	3	1	44% (7)
2	Strawberries	10	0.80	3	3	40% (4)
3	Table grapes	46	0.33	3	2	30% (14)
4	Peaches	46	0.20	2	2	17% (8)
5	Apples	36	0.17	3	1	17% (6)
6	Bananas	24	0.00	0	0	0% (0)
7	Granate apples	11	0.00	0	0	0% (0)
8	Grapefruits	22	0.00	0	0	0% (0)
9	Kiwi fruits	12	0.00	0	0	0% (0)
10	Lemons	45	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>12% (39)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample





## PFAS contamination of vegetables in 2021

### Hungarian vegetables

In 2021, residues of PFAS pesticides were detected in 10% of all vegetable samples.

Cucumbers, lettuces and peppers stood as the most frequently contaminated Hungarian vegetables:

- 24% of the cucumber samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 17% of the lettuce samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 11% of the pepper samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing up to two different PFAS pesticides.

Overall, lettuce samples contaminated the maximum number of different PFAS pesticides detected in a single sample (3). Lettuce samples also contained the greatest diversity in terms of PFAS pesticides, detected across samples (4).

**Figure 47.** Most contaminated vegetables grown in Hungary in 2021.

No.	Product	n	Avg	Sum	Max	
1	Cucumbers	80	0.25	3	2	24% (19)
2	Lettuces	66	0.24	4	3	17% (11)
3	Peppers	85	0.14	3	2	11% (9)
4	Parsley roots	17	0.06	1	1	6% (1)
5	Carrots	26	0.04	1	1	4% (1)
6	Asparagus	13	0.00	0	0	0% (0)
7	Courgettes	11	0.00	0	0	0% (0)
8	Head cabbages	19	0.00	0	0	0% (0)
9	Kohlrabies	16	0.00	0	0	0% (0)
10	Potatoes	59	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>10% (41)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported vegetables

In 2021, residues of PFAS pesticides were detected in 17% of all vegetable samples.

Cucumbers, peppers and potatoes stood as the most frequently contaminated vegetables imported to Hungary:

- 41% of the cucumber samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 32% of the pepper samples contained residues of at least one PFAS pesticide. In total, seven different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 7% of the potato samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.

Overall, pepper samples contained the greatest diversity of different PFAS pesticides detected across samples (7).

**Figure 48.** Most contaminated vegetables imported in Hungary in 2021.

No.	Product	n	Avg	Sum	Max	
1	Cucumbers	39	0.44	3	2	41% (16)
2	Peppers	47	0.36	7	2	32% (15)
3	Potatoes	14	0.07	1	1	7% (1)
4	Broccoli	30	0.00	0	0	0% (0)
5	Cauliflowers	11	0.00	0	0	0% (0)
6	Lettuces	19	0.00	0	0	0% (0)
7	Radishes	10	0.00	0	0	0% (0)
8	Sweet potatoes	13	0.00	0	0	0% (0)
<b>Grand Total</b>						<b>17% (32)</b>

**n:** number of samples      **Avg:** average number of PFAS per sample      **Sum:** sum of different PFAS detected across all sampled  
**Max:** maximum number of PFAS detected in one sample





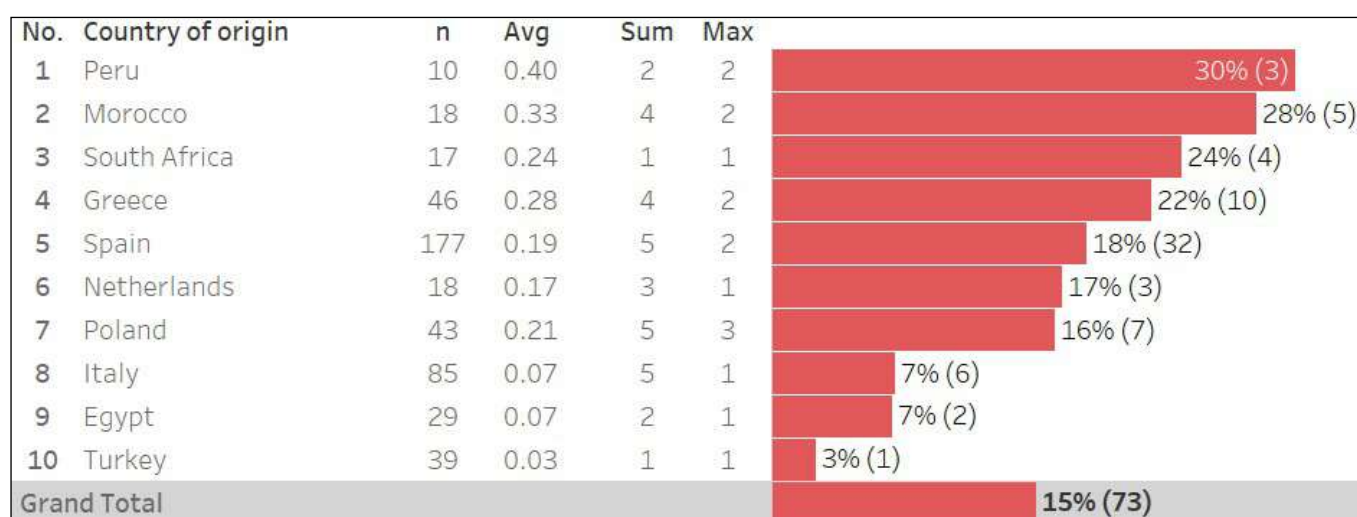
## Countries of origin of contaminated fruit and vegetables

In 2021, the countries of origin of imported fruit and vegetables with the highest presence of PFAS were Peru, Morocco, and South Africa:

- 30% of the Peruvian samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 28% of the Moroccan samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 24% of the South African samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.

Overall, residues of PFAS pesticides were detected in 15% of all samples. Polish samples contained the maximum number of different PFAS pesticides detected in a single sample (3). Spanish and Italian samples contained the greatest diversity in terms of different PFAS pesticides detected across all samples (5).

**Figure 49.** Countries of origin of imported products in Hungary with the highest PFAS contamination in 2021.



**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Top 10 most detected PFAS in fruit and vegetables in 2021

### Hungarian products

In 2021, in the 110 samples of contaminated Hungarian fruit and vegetables collected across Member States, the three most frequently detected PFAS active substances were fluopyram, fluopicolide and flonicamid.

No.	PFAS Pesticide	
1	Fluopyram	63
2	Fluopicolide	19
3	Flonicamid	18
4	Triflumuron	11
5	Trifloxystrobin	9
6	Lambda Cyhalothrin	7
7	Tetraconazole	3
8	Cyflufenamid	1
9	Fluazinam	1
10	tau-Fluvalinate	1

**Table 22.** Top 10 PFAS detected in Hungarian fruit and vegetables in 2021.

### Imported products

In 2021, in the 80 samples of contaminated fruit and vegetables imported in Greece, the three most frequently detected PFAS active substances were fluopyram, flonicamid and trifloxystrobin.

No.	PFAS Pesticide	
1	Fluopyram	52
2	Flonicamid	14
3	Trifloxystrobin	10
4	Tetraconazole	4
5	Fluopicolide	3
6	Fluazinam	2
7	Flubendiamide	1
8	Metaflumizone	1
9	Tefluthrin	1
10	Triflumuron	1

**Table 23.** Top PFAS detected in fruit and vegetables imported to Hungary in 2021.

# The Netherlands: PFAS residues in fruit and vegetables



## 2011-2021: Evolution of PFAS contamination in fruit and vegetables in the Netherlands

In the Netherlands, between 2011 and 2021, a total of 12,228 fruit and vegetable samples met the study selection criteria. During this period, 16.8% of the 5,255 fruit samples contained residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single sample was three, while 18 different PFAS pesticides were detected across all samples. The rate of PFAS contamination was lower in vegetable samples, with 10.4% of the 6,973 vegetable samples containing residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single sample was three, while 26 different PFAS pesticides were detected across all samples. When considering both fruit and vegetables, 26 different pesticides were detected across all samples.

*Table 24. Samples per product category included in the trend analysis for The Netherlands in the period 2011-2021.*

Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	5,255	882	16.8%	3	18
<b>Vegetables</b>	6,973	726	10.4%	3	23
<b>Total</b>	12,228	1,608	13.2%	3	26

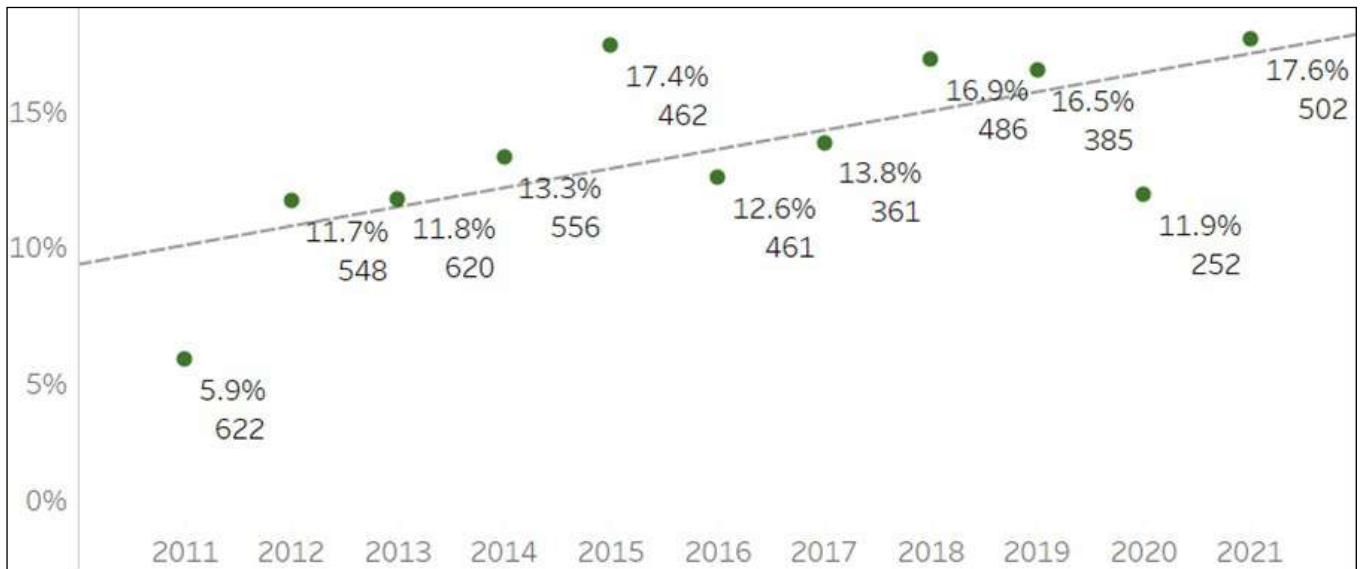




## PFAS contamination of fruit between 2011 and 2021

The proportion of fruit samples contaminated with residues of PFAS pesticides has risen from 5.9% in 2011 to 17.6% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of fruit samples containing PFAS pesticide residues has increased by 70% over a 10-year period.

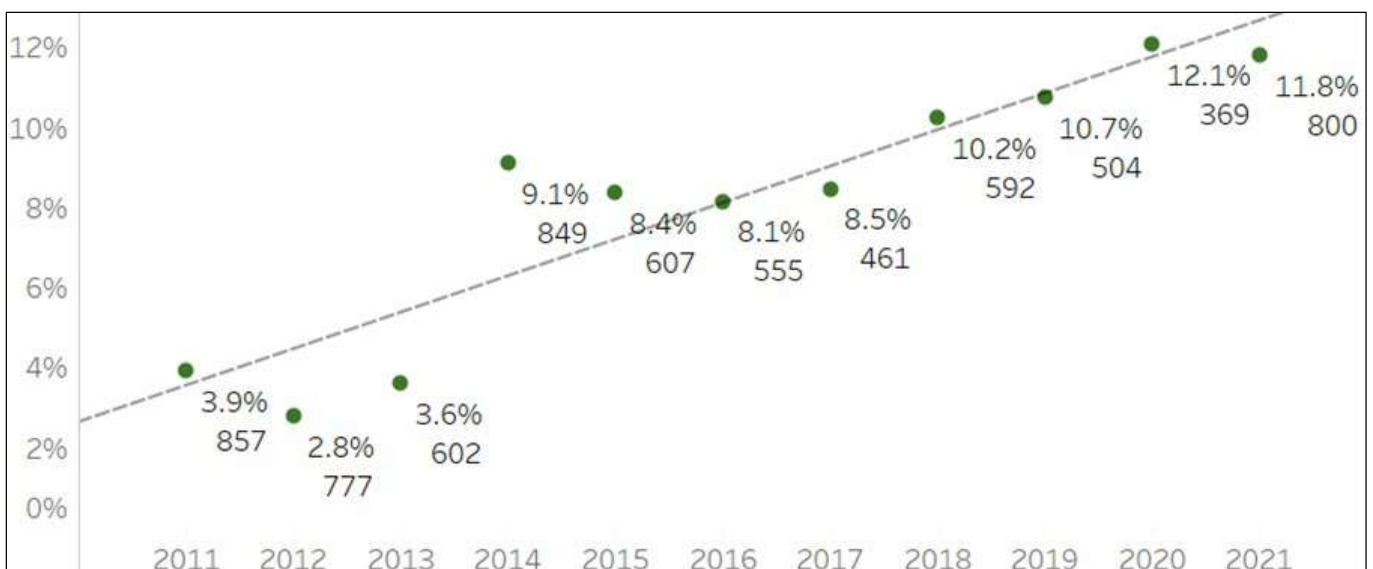
**Figure 50.** Average contamination of PFAS in popular fruit sampled in The Netherlands in the period 2011-2021.



## PFAS contamination of vegetables between 2011 and 2021

The proportion of vegetable samples contaminated with residues of PFAS pesticides has risen from 3.9% in 2011 to 11.8% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of vegetable samples containing PFAS pesticide residues has increased by 257% over a 10-year period.

**Figure 51.** Average contamination of PFAS in popular vegetables sampled in the Netherlands in the period 2011-2021.





## 2021: Overview of PFAS contamination in fruit and vegetables in the Netherlands

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 10 times are presented in the graphs.

### PFAS contamination of fruit in 2021

#### Dutch fruit

In 2021, residues of PFAS pesticides were detected in 26% of all fruit samples.

Strawberries, apples and pears stood as the most frequently contaminated Dutch fruit:

- 70% of the strawberry samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 11% of the apple samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples.
- 9% of the pear samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples.

Overall, strawberry samples contained the maximum number of different PFAS pesticides detected in a single sample (3) and displayed the greatest diversity in terms of different PFAS pesticides detected across samples (5).

**Figure 52.** Most contaminated fruit grown in the Netherlands in 2021.

No.	Product	n	Avg	Sum	Max	
1	Strawberries	43	1.12	4	3	70% (30)
2	Apples	28	0.11	3	1	11% (3)
3	Pears	82	0.09	3	1	9% (7)
<b>Grand Total</b>						<b>26% (40)</b>

<b>n:</b> number of samples	<b>Avg:</b> average number of PFAS per sample	<b>Sum:</b> sum of different PFAS detected across all sampled
<b>Max:</b> maximum number of PFAS detected in one sample		



## Imported fruit

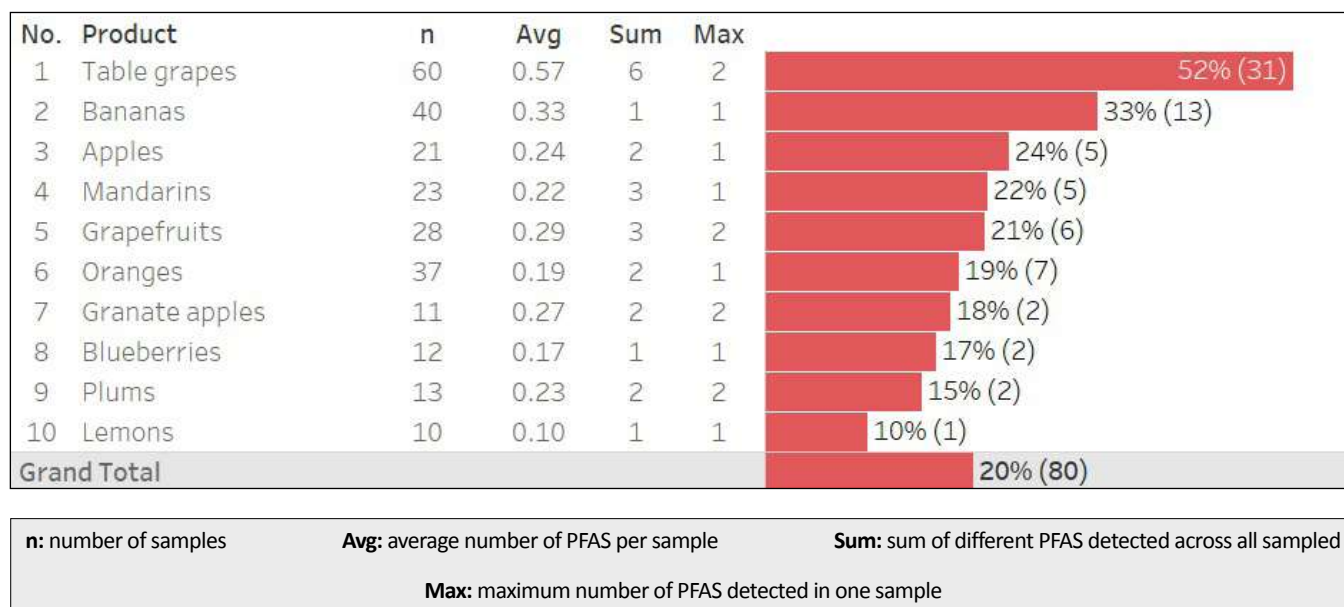
In 2021, residues of PFAS pesticides were detected in 20% of all fruit samples.

Table grapes, bananas and apples stood as the most frequently contaminated fruit imported into the Netherlands:

- 52% of the table samples contained residues of at least one PFAS pesticide. In total, six different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 33% of the banana samples contained residues of a single PFAS pesticide, which was detected across all contaminated samples.
- 24% of the apple samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples.

Overall, table grape samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (6).

**Figure 53.** Most contaminated fruit imported in the Netherlands in 2021.





## PFAS contamination of vegetables in 2021

### Dutch vegetables

In 2021, residues of PFAS pesticides were detected in 30% of all vegetable samples.

Escaroles, cucumbers and peppers stood as the most frequently contaminated Dutch vegetables:

- 70% of the escarole samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 60% of the cucumber samples contained residues of at least one PFAS pesticide. In total, five different PFAS pesticides were detected across all samples, with certain individual samples containing two different PFAS pesticides.
- 52% of the pepper samples contained residues of at least one PFAS pesticide. In total, six different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

Overall, aubergine samples contained the greatest diversity in terms of different PFAS pesticides detected across samples (7).

**Figure 54.** Most contaminated vegetables grown in the Netherlands in 2021.

No.	Product	n	Avg	Sum	Max	
1	Escaroles	10	0.80	2	2	70% (7)
2	Cucumbers	45	0.73	5	2	60% (27)
3	Peppers	203	0.63	6	2	52% (105)
4	Aubergines	139	0.50	7	2	42% (59)
5	Lettuces	43	0.30	3	2	28% (12)
6	Leeks	22	0.32	3	2	23% (5)
7	Celeriacs	31	0.23	1	1	23% (7)
8	Carrots	33	0.15	1	1	15% (5)
9	Brussels sprouts	33	0.12	1	1	12% (4)
10	Chinese cabbages	18	0.11	2	1	11% (2)
<b>Grand Total</b>						<b>30% (246)</b>

**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample



## Imported vegetables

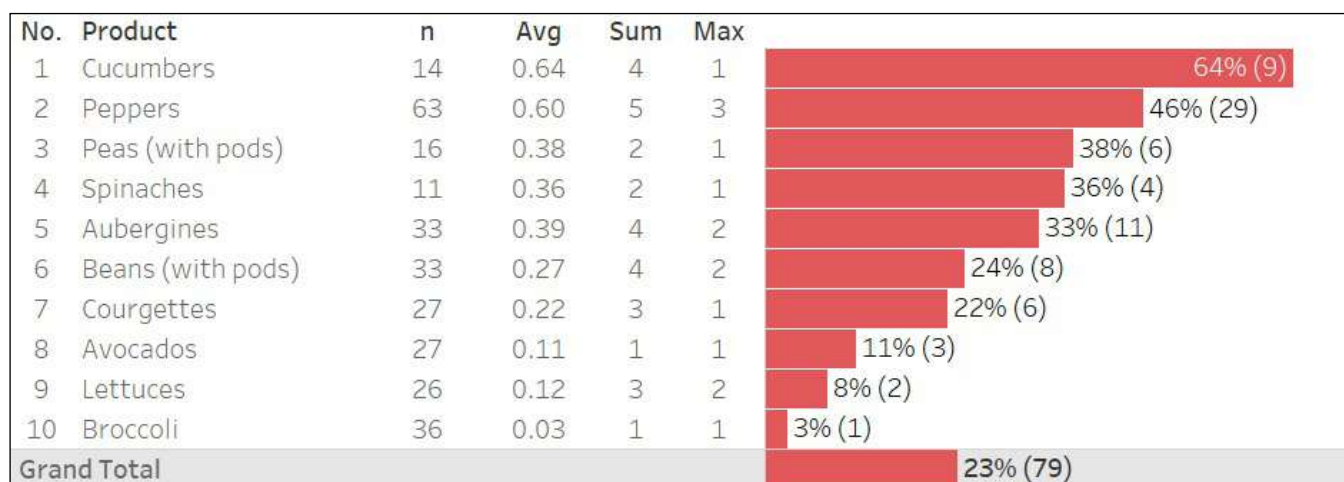
In 2021, residues of PFAS pesticides were detected in 23% of all vegetable samples.

Cucumbers, peppers and peas with pods stood as the most frequently contaminated vegetables imported into the Netherlands:

- 64% of the cucumber samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across samples.
- 46% of the pepper samples contained residues of at least one PFAS pesticide. In total, five different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 38% of the pea samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples.

Overall, pepper samples contained the maximum number of different PFAS pesticides detected in a single sample (3) and the greatest diversity in terms of PFAS pesticides detected across samples (5).

**Figure 55.** Most contaminated vegetables imported in the Netherlands in 2021.



**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample





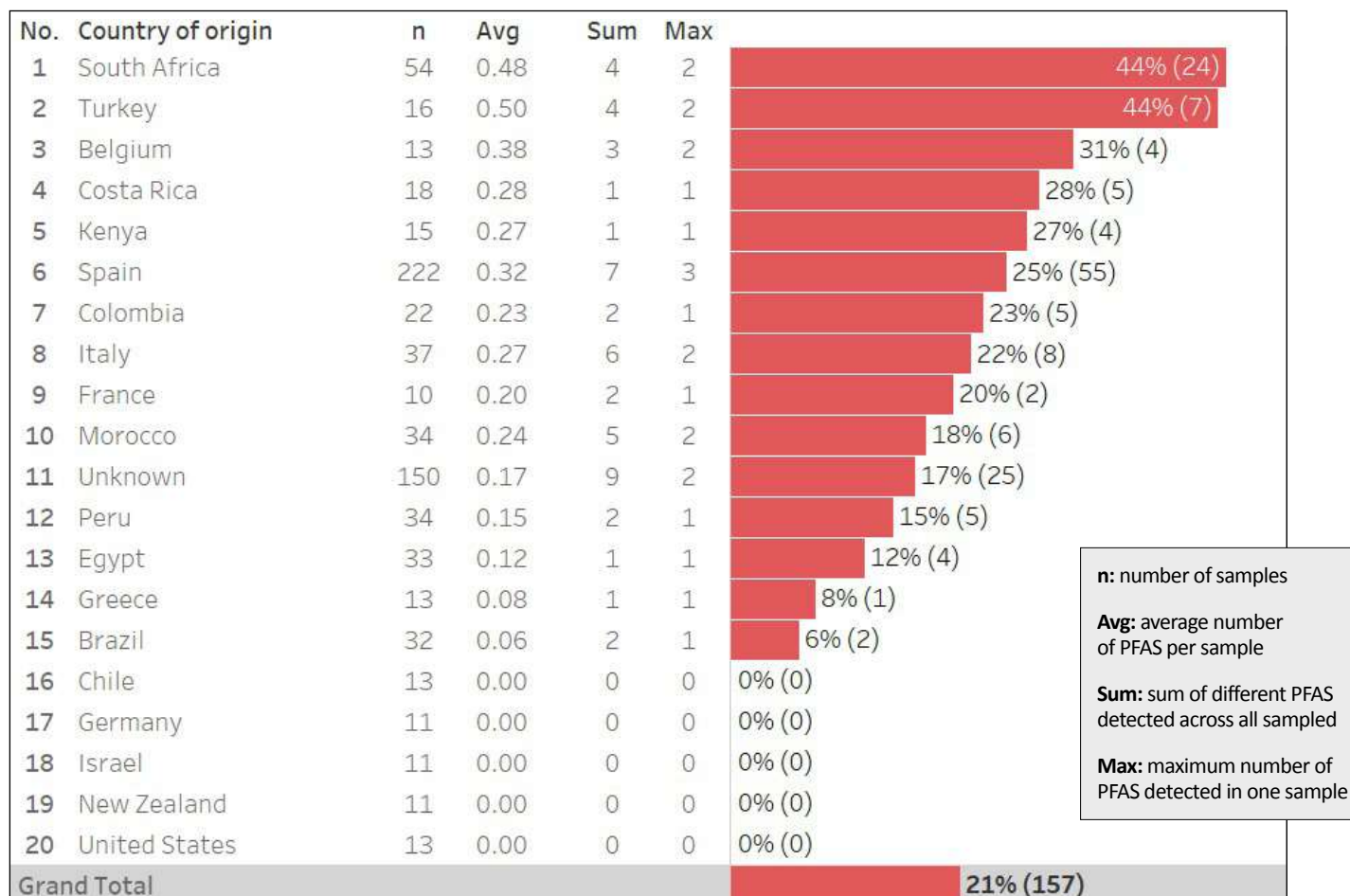
## Countries of origin of contaminated fruit and vegetables

In 2021, the countries of origin of imported fruit and vegetables with the highest presence of PFAS were South Africa, Turkey, and Belgium:

- 44% of the South African samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 44% of the Turkish samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.
- 31% of the Belgium samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

Overall, residues of PFAS pesticides were detected in 21% of all samples. Spanish samples contained the maximum number of different PFAS pesticides detected in a single sample (3). They also contained the greatest diversity in terms of different PFAS pesticides detected across all samples (7).

**Figure 56.** Countries of origin of imported products in The Netherlands with the highest PFAS contamination in 2021.





## Top 10 most detected PFAS in fruit and vegetables in 2021

### Dutch products

In 2021, in the 296 samples of contaminated Dutch fruit and vegetables collected across Member States, the three most frequently detected PFAS active substances were flonicamid, fluopyram and pyridalil.

No.	PFAS Pesticide	
1	Flonicamid	158
2	Fluopyram	97
3	Pyridalil	33
4	Trifloxystrobin	31
5	Fluopicolide	13
6	Sulfoxaflor	9
7	Metaflumizone	6
8	Lambda Cyhalothrin	3
9	Triflumizole	3
10	Cyflumetofen	2

**Table 25.** Top 10 PFAS detected in Dutch fruit and vegetables in 2021.

### Imported products

In 2021, in the 175 samples of contaminated fruit and vegetables imported in the Netherlands, the three most frequently detected PFAS active substances were fluopyram, lambda cyhalothrin and trifloxystrobin.

No.	PFAS Pesticide	
1	Fluopyram	92
2	Lambda Cyhalothrin	30
3	Trifloxystrobin	29
4	Bifenthrin	13
5	Flonicamid	12
6	Sulfoxaflor	9
7	tau-Fluvalinate	7
8	Fluopicolide	4
9	Cyflufenamid	3
10	Penthiopyrad	1

**Table 26.** Top PFAS detected in fruit and vegetables imported to the Netherlands in 2021.

# Spain: PFAS residues in fruit and vegetables



## 2011-2021: Evolution of PFAS contamination in fruit and vegetables in Spain

In Spain, between 2011 and 2021, a total of 12,989 fruit and vegetable samples met the study selection criteria. During this period, 7.6% of the 8,132 fruit samples contained residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single fruit sample was three, while 18 different PFAS pesticides were detected across all samples. The rate of PFAS contamination in vegetable samples was comparatively lower, with 4.4% of the 4,857 vegetable samples containing residues of at least one PFAS pesticide. The maximum number of PFAS detected in a single sample was three, while 17 different PFAS pesticides were detected across all samples. When considering both fruit and vegetables, 22 different PFAS pesticides were detected across all samples.

**Table 27.** Samples per product category included in the trend analysis for Spain in the period 2011-2021.

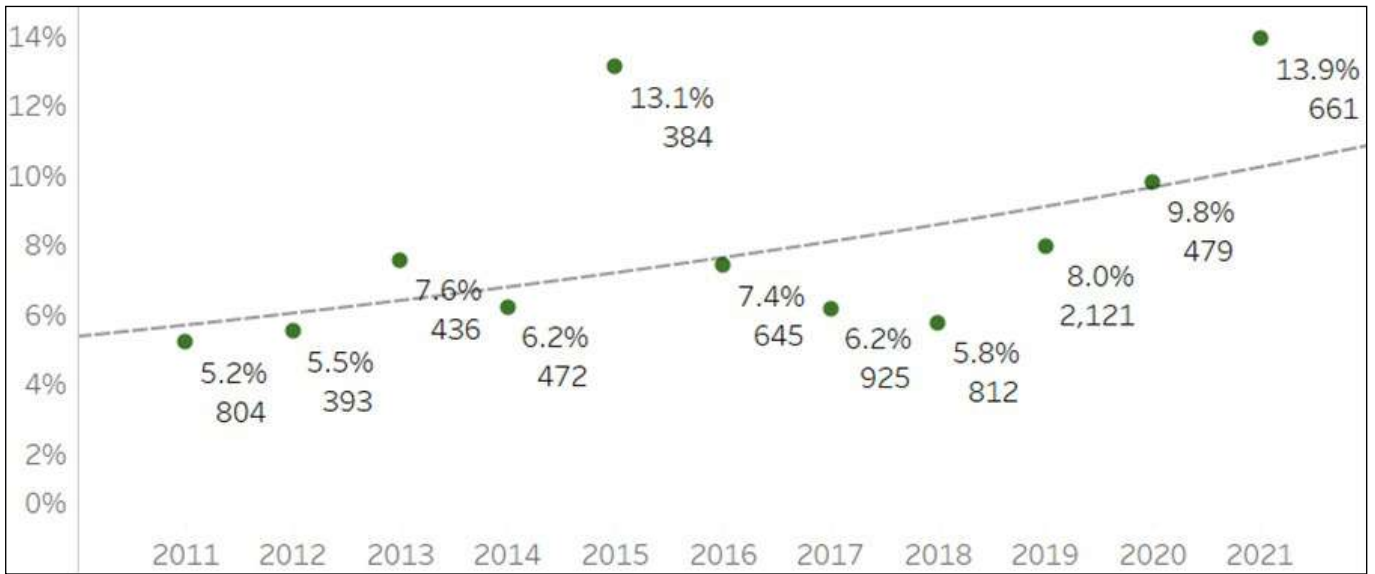
Product category	Samples	Samples with PFAS	%Samples with PFAS	Max. PFAS per sample	PFAS detected
<b>Fruit</b>	8,132	616	7.6%	3	18
<b>Vegetables</b>	4,857	215	4.4%	3	17
<b>Total</b>	12,989	831	6.4%	3	22



## PFAS contamination of fruit between 2011 and 2021

The proportion of fruit samples contaminated with residues of PFAS pesticides has risen from 5.2% in 2011 to 13.9% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of fruit samples containing PFAS pesticide residues has increased by 80% over a 10-year period.

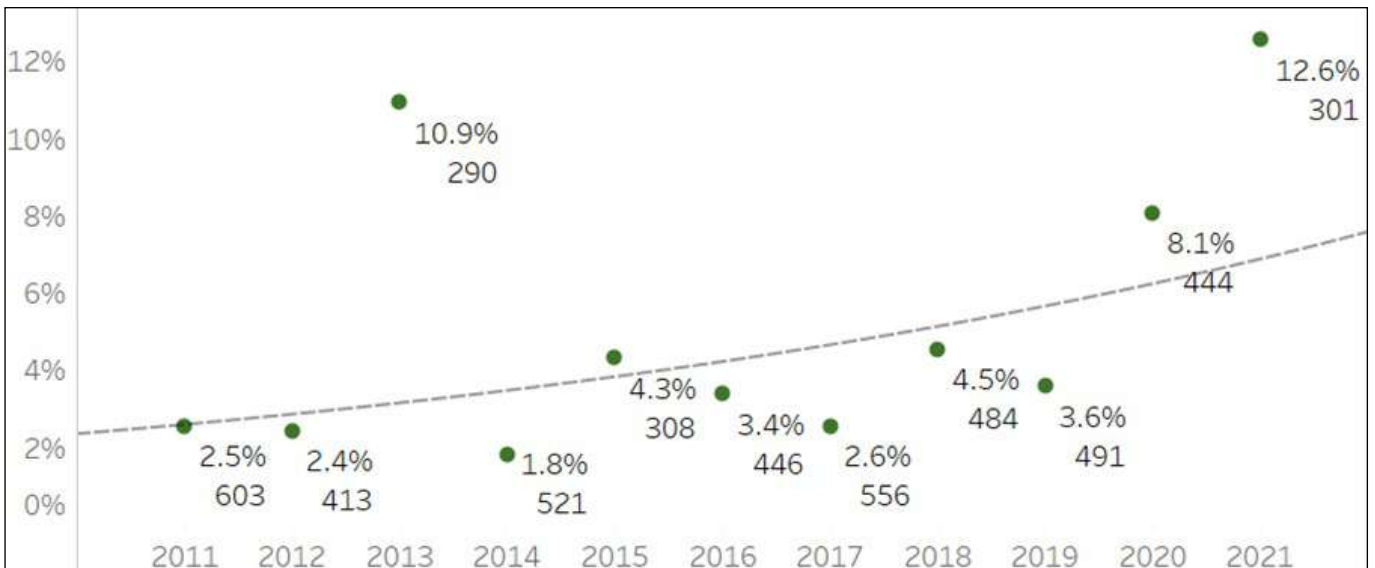
**Figure 57.** Average contamination of PFAS in popular fruit sampled in Spain in the period 2011-2021.



## PFAS contamination of vegetables between 2011 and 2021

The proportion of vegetable samples contaminated with residues of PFAS pesticides has risen from 2.5% in 2011 to 12.6% in 2021. According to the trendline, which averages out the fluctuations in different years, the average proportion of vegetable samples containing PFAS pesticide residues has increased by 148% over a 10-year period.

**Figure 58.** Average contamination of PFAS in popular vegetables sampled in Spain in the period 2011-2021.





## 2021: Overview of PFAS contamination in fruit and vegetables in Spain

The following sections highlight the fruit and vegetables in which residues of PFAS pesticides were most frequently detected in 2021. Only products and countries that have been sampled at least 10 times are presented in the graphs.

### PFAS contamination of fruit in 2021

#### Spanish fruit

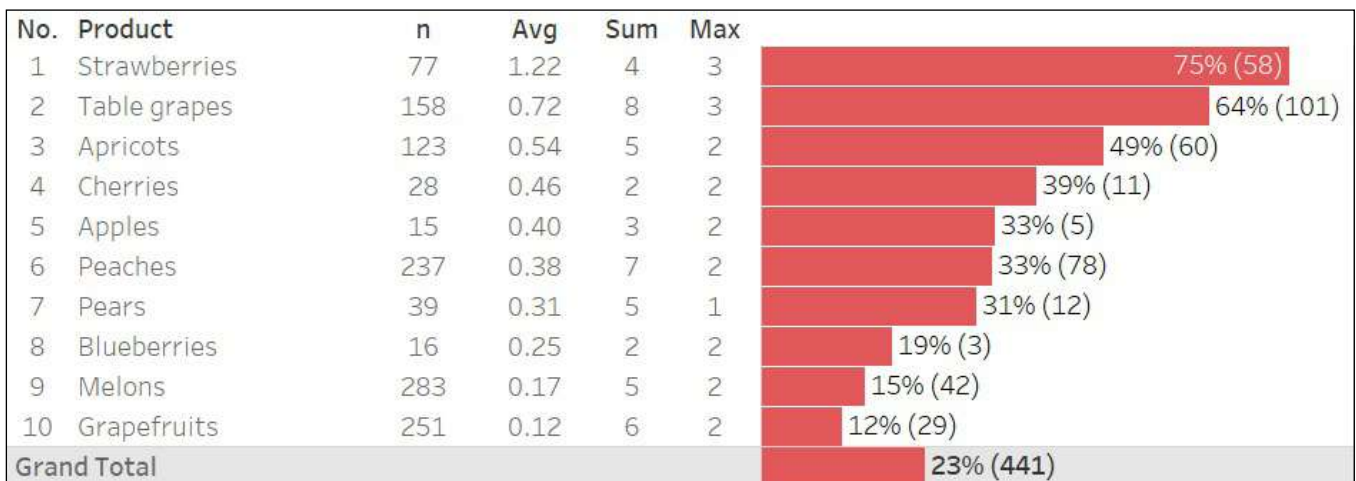
In 2021, residues of PFAS pesticides were detected in 23% of all fruit samples.

Strawberries, table grapes and apricots stood as the most frequently contaminated Spanish fruit:

- 75% of the strawberry samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 64% of the table grape samples contained residues of at least one PFAS pesticide. In total, eight different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to three different PFAS pesticides.
- 49% of the apricot samples contained residues of at least one PFAS pesticide. In total, five different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

Overall, table grape samples contained the maximum number of different PFAS pesticides detected in a single sample (3). They also contained the greatest diversity in terms of different PFAS pesticides detected across samples (8).

**Figure 59.** Most contaminated fruit grown in Spain in 2021.



**n:** number of samples

**Avg:** average number of PFAS per sample

**Sum:** sum of different PFAS detected across all sampled

**Max:** maximum number of PFAS detected in one sample





## Imported fruit

In 2021, residues of PFAS pesticides were detected in 12% of the fruit imported to Spain.

Bananas and table grapes stood as the most frequently contaminated fruit imported into Spain:

- 18% of the banana samples contained residues of a single PFAS, which was detected in all contaminated samples.
- 16% of the table grape samples contained residue of a single PFAS, which was detected across all contaminated samples.
- No residues of PFAS were detected in lemon samples.

**Figure 60.** Most contaminated fruit imported in Spain in 2021.

No.	Product	n	Avg	Sum	Max	
1	Bananas	11	0.18	1	1	18% (2)
2	Table grapes	19	0.16	1	1	16% (3)
3	Lemons	13	0.00	0	1	0% (0)
<b>Grand Total</b>						<b>12% (5)</b>

**n:** number of samples      **Avg:** average number of PFAS per sample      **Sum:** sum of different PFAS detected across all sampled  
**Max:** maximum number of PFAS detected in one sample





## PFAS contamination of vegetables in 2021

### Spanish vegetables

In 2021, residues of PFAS pesticides were detected in 23% of all vegetable samples.

Spinach, peppers and cucumbers stood as the most frequently contaminated Spanish vegetables:

- 42% of the spinach samples contained residues of at least one PFAS pesticide. In total, four different PFAS pesticides were detected across all samples, with certain individual samples containing two different PFAS pesticides.
- 41% of the pepper samples contained residues of at least one PFAS pesticide. In total, seven different PFAS pesticides were detected across all samples, with certain individual samples containing residues of up to four different PFAS pesticides.
- 38% of the cucumber samples contained residues of at least one PFAS pesticide. In total, six different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

Overall, pepper samples contained the maximum number of different PFAS pesticides detected in a single sample (4). They also contained the greatest diversity in terms of different PFAS pesticides detected across samples (7).

**Figure 61.** Most contaminated vegetables grown in Spain in 2021.

No.	Product	n	Avg	Sum	Max	
1	Spinaches	19	0.47	4	2	42% (8)
2	Peppers	333	0.51	7	4	41% (136)
3	Cucumbers	120	0.42	6	2	38% (45)
4	Courgettes	50	0.38	3	2	36% (18)
5	Aubergines	363	0.29	6	2	27% (98)
6	Globe artichokes	16	0.25	2	1	25% (4)
7	Potatoes	19	0.11	1	1	11% (2)
8	Lettuces	122	0.10	5	2	8% (10)
9	Head cabbages	13	0.08	1	1	8% (1)
10	Garlic	17	0.06	1	1	6% (1)
<b>Grand Total</b>						<b>23% (334)</b>

**n:** number of samples      **Avg:** average number of PFAS per sample      **Sum:** sum of different PFAS detected across all sampled  
**Max:** maximum number of PFAS detected in one sample





## Imported vegetables

In 2021, the only vegetable imported in Spain sampled in sufficient amounts by Spanish authorities to generate meaningful statistics was pepper.

27% of the pepper samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples, with certain individual samples containing residues of two different PFAS pesticides.

**Figure 62.** Most contaminated vegetables imported in Spain in 2021.

No.	Product	n	Avg	Sum	Max	
1	Peppers	11	0.36	3	2	27% (3)
<b>Grand Total</b>						<b>27% (3)</b>

<b>n:</b> number of samples	<b>Avg:</b> average number of PFAS per sample	<b>Sum:</b> sum of different PFAS detected across all sampled
<b>Max:</b> maximum number of PFAS detected in one sample		





## Countries of origin of contaminated fruit and vegetables

In 2021, the countries of origin of imported fruit and vegetables with the highest presence of PFAS were South Africa and Morocco.

- 23% of the South African samples contained residues of at least one PFAS pesticide. In total, two different PFAS pesticides were detected across all samples.
- 17% of the Moroccan samples contained residues of at least one PFAS pesticide. In total, three different PFAS pesticides were detected across all samples.

Overall, residues of PFAS were detected in 19% of all samples.

**Figure 63.** Countries of origin of imported products in Spain with the highest PFAS contamination in 2021.

No.	Country of origin	n	Avg	Sum	Max	
1	South Africa	13	0.23	2	1	23% (3)
2	Morocco	24	0.21	3	2	17% (4)
<b>Grand Total</b>						<b>19% (7)</b>

<b>n:</b> number of samples	<b>Avg:</b> average number of PFAS per sample	<b>Sum:</b> sum of different PFAS detected across all sampled
<b>Max:</b> maximum number of PFAS detected in one sample		





## Top 10 most detected PFAS in fruit and vegetables in 2021

### Spanish products

In 2021, in the 778 samples of contaminated Spanish fruit and vegetables collected across Member States, the three most frequently detected PFAS active substances were fluopyram, trifloxystrobin, and lambda cyhalothrin.

No.	PFAS Pesticide	
1	Fluopyram	546
2	Trifloxystrobin	104
3	Lambda Cyhalothrin	73
4	Fonicamid	59
5	Sulfoxaflor	31
6	Fluopicolide	23
7	tau-Fluvalinate	19
8	Cyflufenamid	9
9	Tetraconazole	9
10	Penthiopyrad	7

**Table 28.** Top 10 PFAS detected in Spanish fruit and vegetables in 2021.

### Imported products

In 2021, in the 11 samples of contaminated fruit and vegetables imported in Spain, the three most frequently detected PFAS active substances were fluopyram, bifenthrin and trifloxystrobin.

No.	PFAS Pesticide	
1	Fluopyram	6
2	Bifenthrin	2
3	Trifloxystrobin	2
4	Sulfoxaflor	1
5	Triflumuron	1

**Table 29.** Five PFAS detected in fruit and vegetables imported to Spain in 2021.



# Conclusion

The analysis of official EU monitoring data reveals the growing presence of residues of PFAS pesticides in European fruit and vegetables over the years. EU-wide, the results highlight that PFAS contamination has nearly tripled between 2011 and 2021. In 2021, almost 14% of fruit samples and 7% of vegetables samples contained residues of at least one PFAS pesticide, compared to 4% and 2%, respectively, in 2011.

Samples of summer fruit grown in the EU presented particularly high levels of PFAS contamination. Namely, 37% of the strawberries, 35% of the peaches, and 31% of the apricots contained residues of at least one PFAS pesticides in 2021. Among imported fruit, table grapes (37%), bananas (31%) and apricots (21%) were the most contaminated samples. While European-grown vegetables are on average less heavily contaminated with residues of PFAS pesticides than fruit (12% vs 20%), samples of some products were particularly polluted in 2021: chicories (42%), cucumbers (30%), peppers (27%). For imported vegetables, samples cucumbers (30%), aubergines (24%), and peppers (23%) topped the list of most polluted products.

The Member States with the greatest rate of contaminated fruit and vegetables are Belgium (27%), the Netherlands (27%), Austria (25%), Spain (22%) and Portugal (21%). Among imported fruit and vegetables, the most likely to contain residues of PFAS pesticides come from Costa Rica (41%), India (38%), South Africa (28%), Colombia (26%) and Morocco (24%). In the most extreme cases, residues of PFAS pesticides were detected in more than 75% of the banana samples from Panama, table grapes from South Africa and strawberries from Spain.

The PFAS active substances, including fluopyram, trifloxystrobin, flonicamid and lambda cyhalothrin were identified as the most commonly found residues on EU fruit and vegetables in 2021.

The analysis of PFAS residues in fruit and vegetables sampled in individual EU Member States reflects a similar story. Almost all countries show substantial increases in PFAS contamination of nationally grown fruit and vegetables from 2011 to 2021. The most worrying growths are observed in Austria (+698% for fruit, +3277% for vegetables) and Greece (+696% in fruit, +1974% in vegetables). In 2021, PFAS contamination affected on average a quarter of nationally grown fruit in all Member States. Imported fruit and vegetables also displayed high and rising PFAS levels across most Member States, though contamination rates varied. Products from Costa Rica, India, South Africa, and Turkey consistently ranked among the most contaminated samples.

**The results show that using PFAS in pesticides leads to an increasingly common indigestion of PFAS pesticide residues by European consumers. This source of PFAS contamination should not be downplayed compared with that due to other better-known PFAS. Continued accumulation of PFAS in soils, waters, the food chain and arising cocktails pose chronic risks to both the environment and human health. A ban on PFAS pesticides and residues in food is urgent to curb PFAS exposure in food and protect citizen health, including that of the most vulnerable groups.**

## Annex 1. List of 47 PFAS pesticides (active substances) analysed

Active substance name	Active substance name
Acrinathrin (not approved since 31/12/2021)	Metaflumizone
Beflubutamid	Oxathiapiprolin
Benfluralin (not approved since 12/02/2023)	Oxyfluorfen
Bifenthrin (not approved since 31/07/2019)	Penoxsulam
Cyflufenamid	Penthiopyrad
Cyflumetofen	Picolinafen
Diflufenican	Picoxystrobin (not approved since 31/08/2017)
Fipronil (not approved since 30/09/2017)	Prosulfuron
Flazasulfuron	Pyridalyl
Flonicamid	Pyroxsulam
Fluazifop-P	Sulfoxaflor
Fluazinam	Tau-Fluvalinate
Flubendiamide	Tefluthrin
Flufenacet	Tembotrione
Flufenoxuron (not approved since 31/12/2011)	Tetraconazole
Flumetralin	Trifloxystrobin
Fluometuron	Triflumizole (not approved since 30/06/2020)
Fluopicolide	Triflumuron (not approved since 30/06/2020)
Fluopyram	Triflusulfuron-methyl (not approved since 19/11/2023)
Flurochloridone	Tritosulfuron
Flutianil	
Flutolanil	
Gamma-Cyhalothrin	
Haloxifop-P (not approved since 31/12/2020)	
Isoxaflutole	
lambda-Cyhalothrin	
Mefentrifluconazole	

## Annex 2. List of selected popular fruit and vegetables

Fruit	Vegetables	Vegetables (continued)
Apples	Asparagus	Parsley roots
Apricots	Aubergines	Parsnips
Bananas	Avocados	Peas (with pods)
Blackberries	Beans (with pods)	Peppers
Blueberries	Beetroots	Potatoes
Cherries	Broccoli	Pumpkins
Figs	Brussels sprouts	Radishes
Granate apples	Carrots	Rhubarbs
Grapefruit	Cauliflowers	Shallots
Kiwi fruit	Celeriacs	Spinaches
Lemons	Celeries	Spring onions
Mandarins	Chards	Sweet corn
Mangoes	Chinese cabbages	Sweet potatoes
Melons	Courgettes	Table olives
Mulberries (black and white)	Cucumbers	Turnips
Oranges	Escaroles	Winter squashes
Peaches	Garlic	Chicories
Pears	Globe artichokes	Yams
Pineapples	Head cabbages	
Plums	Kales	
Raspberries	Kohlrabies	
Strawberries	Leeks	
Table grapes	Lettuces	
Watermelons	Onions	

## Annex 3. List of detected PFAS pesticides between 2011 and 2021

Active substance name	Number of contaminated samples
Fluopyram	8,181
Lambda Cyhalothrin	4,712
Trifloxystrobin	4,036
Flonicamid	2,141
Bifenthrin	1,604
Fluopicolide	1,400
Triflumuron	892
Tetraconazole	811
Acrinathrin	511
tau-Fluvalinate	468
Sulfoxaflor	299
Cyflufenamid	226
Fluazifop-P	149
Tefluthrin	128
Triflumizole	98
Flubendiamide	85
Metaflumizone	85
Pyridalyl	77
Flufenoxuron	75
Flutolanil	59
Penthiopyrad	53
Cyflumetofen	43
Fluazinam	39
Flurochloridone	33
Fipronil	25
Haloxifop-P (Haloxifop-R)	16
Picoxystrobin	9
Benfluralin	6
Oxyfluorfen	6
Diflufenican	5
Oxathiapiprolin	3

# TOXIC HARVEST



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