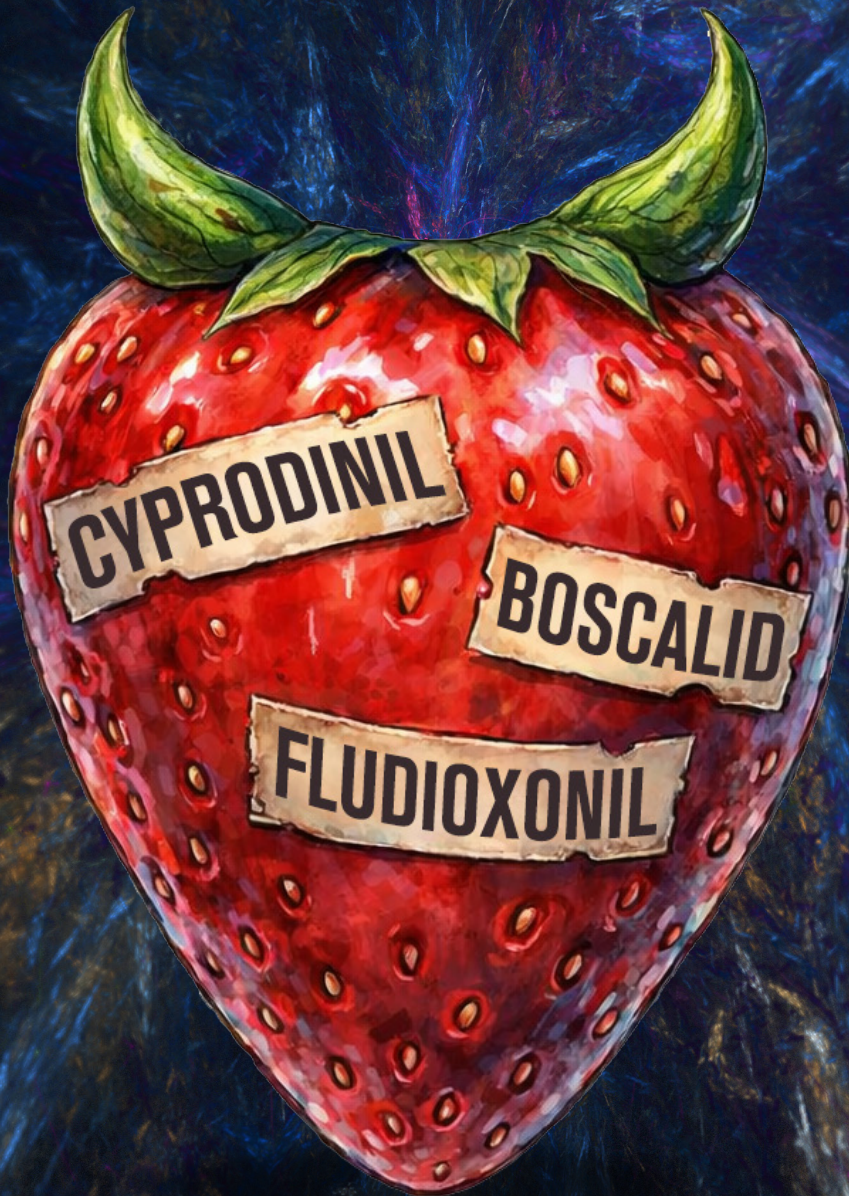


## European strawberries

extensively contaminated with PFAS or endocrine  
disrupting pesticide residues



July 2026

# Executive Summary

Strawberries are among the most popular fruits in Europe. Europeans' strawberry consumption is high, and production has increased over the last decade in several countries<sup>1</sup>. Strawberries are considered as healthy fruits for their vitamin C and antioxidant contents. Being particularly consumed by children in sometimes high quantities, it is of major importance to ensure they are free from pesticides, despite intensive production methods.

Considering the lack of transparency of public authorities regarding the level of contamination of specific products, PAN Europe and its national partner NGOs analysed 41 locally-produced strawberry samples in 11 EU countries<sup>2</sup>. The extent of contamination found in conventional strawberries is highly concerning: on average, European strawberries are contaminated with 3.5 different pesticides substances and the most frequently found pesticides are among the most toxic ones approved in the EU: endocrine disruptors, PFAS, and neurotoxic.

Overall, 78% of the strawberry samples from conventional agriculture had residues of at least one pesticide, and 61% had two or more. The maximum number of residues found in a single sample was found in Belgium (9), Hungary and Slovenia (8) and Ireland (7). Only 22% of conventional strawberries and all 5 organic and pesti-

cide-free labelled samples contained no quantifiable residues of pesticides.

A significant proportion of strawberries contained residues of two endocrine-disrupting pesticides, namely fludioxonil (39%) and cyprodinil (33%) that should, according to EU law, have been taken off the market more than one or two years ago, but EU- and Member State authorities refuse to properly implement the law. PFAS pesticides were found in 58% of the samples, while 56% of the tested strawberries contained pesticides from the more harmful category called 'Candidates for Substitution', that Member States are supposed to phase out since 2011. Finally, nearly one sample out of 5 (17%) contained neurotoxic pesticides, which is concerning, considering the significant quantities young children can ingest.

The results are highly problematic for several reasons. Firstly, because there is no risk assessment of the toxicity of multiple residues of pesticides in the EU. The European Food Safety Authority (EFSA) has been tasked, by law, to produce a method in 2005 but none has been presented up to now. Regulatory authorities therefore have little knowledge of the health impacts of cumulative and synergistic cocktail effects, and no additional safety factor has been set to compensate. In addition, the substances found are among the most toxic approved in the EU. Finally, permit-

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<sup>1</sup> <https://dashboard.groentenfruihuis.nl/files/14691/Factsheet-aardbei-GroentenFruit-Huis.pdf>

<sup>2</sup> Austria, Belgium, Croatia, France, Germany, Hungary, Ireland, Italy, the Netherlands, Slovenia, Spain

ted residue limits are sometimes double or triple those set for apples<sup>3</sup>, even though children are able to consume significant quantities of strawberries, considering their appeal.

A mounting body of scientific evidence shows that chronic exposure to multiple residues of pesticides can lead to chronic diseases such as infertility, so it is unacceptable that EFSA did not provide since 2005 a methodology taking into account multiple exposure.

On a more positive note, cleaner results from France and the Netherlands - with respectively 50% and 66% of samples containing no residue - show that conventional strawberry production methods exist to greatly reduce pesticide use.

The results of this report show a lack of implementation of EU law which leads to citizens' exposure to very toxic pesticides, usually in the form of cocktails. Contrary to a current proposal from the European Commission for a Food and

Feed Safety Omnibus regulation<sup>4</sup>, these results show that a more literal and quicker implementation of the current standards is needed, rather than a weakening of the rules.

This report does not aim to provide a representative overview of the level of contamination of strawberries with pesticides in 11 EU Member States, but rather to raise awareness of the important level of contamination, in particular with cocktails of pesticides, in most Member States. PAN Europe and its partners refer to EU- and Member States' public authorities to increase transparency into available data on the level of contamination of consumed strawberries, and to support farmers in implementing existing non-chemical pest control, as used in organic farming. We recommend that consumers reduce as far as possible their exposure to pesticides via food, in particular for children and during pregnancy. Our results show that consuming organic strawberries prevents such exposure.



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<sup>3</sup> Boscalid: apples 2 vs strawberries 6 mg/kg  
Flonicamid: 0.3 vs 0.7 mg/kg  
Fluopyram: 0.8 vs 2 mg/kg  
Cyprodinil: 2 vs 5 mg/kg

<sup>4</sup> <https://www.pan-europe.info/press-releases/2025/12/eu-commission-retreats-worst-plan-still-opens-door-unlimited-pesticide>

# Country specific results

## Austria



- 2 Austrian conventional and 1 Italian organic strawberry sample
- Average contamination per conventional sample: 3.5 substances
- Highest exceedance of the baby food regulatory limit in a sample was 57 times
- Fludioxonil a PFAS pesticide, endocrine disruptor was found in conventional samples
- Cyprodinil, an endocrine disrupting pesticide, was found in one sample.

## Belgium



- 3 conventional and 1 organic strawberry sample
- Average contamination per conventional sample: 6.3 substances
- Highest exceedance of the baby food regulatory limit in a sample was 136 times
- Up to 9 substances in a single sample, the record of this report: 2 suspected carcinogens, 3 PFAS and 2 pesticides from the 'more toxic pesticides' EU list\*.
- All conventional samples contained 2 fungicides linked to cancer (Category 2): either bupirimate, Captan

## Croatia



- 3 conventional samples
- Average contamination per conventional sample: 3.7 substances
- Highest exceedance of the baby food regulatory limit in a sample was 55 times.
- 100% of samples contained Fludioxonil, a PFAS pesticide, endocrine disruptor and member of the EU's 'more toxic pesticides' list\*.
- 100% of samples contained Cyprodinil a fungicide from the 'more toxic pesticides' EU list\* and an endocrine disruptor
- 100% samples had both PFAS and pesticides from the 'more toxic pesticides' EU list

## France



- 8 conventional samples
- Average contamination per conventional sample: 0.88 substances
- Highest exceedance of the baby food regulatory limit in a sample was 19 times
- 2 samples contained a fungicide linked to cancer (Category 2): Bupirimate
- 2 samples contained flonicamid, a PFAS pesticide on the 'more toxic pesticide' EU list\*

## Germany



- 3 conventional and 1 organic strawberry sample
- Average contamination per conventional sample: 3.7 substances
- Highest exceedance of the baby food regulatory limit in a sample was 80 times.
- 100% of conventional samples had both PFAS pesticides and pesticides from the 'more toxic pesticides' EU list\*
- One sample contained 5 different residues, including 1 PFAS pesticide and 2 pesticides from the 'more toxic pesticides' EU list\*

## Hungary



- 3 conventional strawberry samples
- Average contamination per conventional sample: 4.7 substances
- Highest exceedance of the baby food regulatory limit in a sample was 44 times.
- 2 out of the 3 conventional samples contained a fungicide linked to cancer (Category 2): Captan.
- 2 out of 3 samples contained Cyprodinil, a fungicide from the 'more toxic pesticides' EU list\* and an endocrine disruptor
- One sample contained 8 residues, including 3 pesticides from the 'more toxic pesticides' EU list\* and one carcinogen category 2 (captan).

# Country specific results

## Ireland



- 2 conventional strawberry samples
- Average contamination per conventional sample: 5 substances
- Highest exceedance of the baby food regulatory limit in a sample was 37 times
- An Irish sample contained 7 residues: 2 pesticides from the 'more toxic pesticides' EU list\*, a carcinogen category 2 and a non-approved substance just by the limit of quantification (Ethirimol).
- Both samples contained a fungicide linked to cancer (Category 2): Bupirimate

## Italy



- 5 conventional strawberry samples
- Average contamination per conventional sample: 2.4 substances
- Highest exceedance of the baby food regulatory limit in a sample was 60 times
- A sample contained 6 different substances: 3 PFAS, 1 pesticide from the 'more toxic pesticides' EU list and 1 neurotoxic substance(s).
- 3 out of 5 Italian samples contained Fludioxonil, a PFAS pesticide, endocrine disruptor and member of the EU's 'more toxic pesticides list'\*

## Slovenia



- 2 conventional strawberry samples
- Average contamination per conventional sample: 7 substances
- Highest exceedance of the baby food regulatory limit in a sample was 188 times
- Both samples contained two endocrine disrupting pesticides that are members of the 'more toxic pesticides' EU list\*: cyprodinil and fludioxonil which is, in addition, a PFAS pesticide

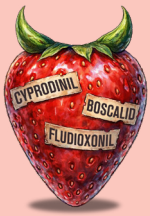
- Both Slovenian samples contained Difenocozanole, a carcinogen (category 2) and member of the 'more toxic pesticides' EU list\*, which also poses serious risks to human health and the environment due to its endocrine-disrupting properties.
- They contained respectively 8 and 6 residues. The sample with 8 different residues contained a carcinogen category 2, 3 pesticides from the 'more toxic pesticides' list\*, one PFAS and one neurotoxic pesticide.

## Spain



- 2 conventional samples and one 'pesticide residue-free' conventional strawberry sample
- Average contamination per conventional sample: 1 substance
- Highest exceedance of the baby food regulatory limit in a sample was 16 times.
- 1 of 3 Spanish samples contained 2 different residues with a Neurotoxic pesticide (spinosad).

\* The EU list of 'more toxic pesticides': This group is composed of 44 pesticide substances that are among the most problematic ones approved in the EU. They present concerning toxicological profiles or are highly persistent in the environment. They are also referred to as 'Candidates for Substitution' under EU law, as EU Member States are meant, since 2011, to substitute them with non-chemical or less toxic chemical alternatives. Despite the presence of numerous safer alternatives, not a single pesticide from the list has been substituted over the last 15 years, as Member States refuse to implement this provision of the regulation. For this reason, 56% of the tested samples contain residues of these particularly toxic substances.



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extensively  
contaminated  
with PFAS or  
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# Introduction

According to estimations<sup>5</sup>, citizens' strawberry consumption is either stable, or increasing in some EU countries. Imported from America in the 18th century, they are highly appreciated by consumers for their sweetness, colour, and spring-seasonality. The EU is a net importer of strawberries, but local production is increasing.

Strawberries are considered as healthy fruits due to their high concentration in vitamin C and antioxidants. They are highly appreciated by children who tend to eat them as candies and can consume significant amounts.

As with many crops, growing demand and production means increased intensity in production methods, leading to rising pest pressure and use of pesticides. Small fruits are known to be more contaminated with pesticides but a general lack of transparency from regulatory authorities prevents us from knowing which pesticides are most

frequently found. In addition, while an EU law from 2005 foresees a regulation of mixtures of pesticides, in order to contain the risks posed by exposure to multiple pesticides, there is currently no rule on exposure to cocktails of pesticides.

This report aims at better grasping the toxicity profile found in strawberries, and highlighting that a majority of strawberries contain cocktails of pesticides that are currently not assessed nor regulated.

PAN Europe and its national partner NGOs<sup>6</sup> have collected 41 locally produced strawberry samples in 11 EU countries. While this report does not aim to provide a representative overview of the level of contamination in 11 EU Member States, it aims to raise awareness on the extent of pesticide contamination of strawberries in most Member States.



<sup>5</sup> <https://dashboard.groentenfruihuis.nl/files/14691/Factsheet-aardbei-GroentenFruit-Huis.pdf>

<sup>6</sup> Global 2000 (Austria), Nature et Progrès (Belgium), Earth Trek (Croatia), Générations Futures (France), PAN Germany, Friends of the Earth Hungary, Irish Environmental Forum, Greenpeace Italy, PAN Netherlands, Zveza Biodinamikov (Slovenia), Ecologistas en Acción (Spain)

# 1. Methodology

Between 29th April and 2nd June 2026, 36 conventionally-farmed, 4 organic and one pesticide-free labelled samples of strawberries were collected in Austria, Belgium, Croatia, France, Germany, Hungary, Ireland, Italy, the Netherlands, Slovenia, and Spain. They were maintained at 4°C and delivered within 48h<sup>7</sup> to accredited Eurofins laboratories in Belgium, Ireland and Hungary<sup>8</sup>.

Strawberries were collected mostly in supermarkets. Only results above the Limit of Quantification (LOQ), i.e. 10 µg/kg, were considered in this report. Samples containing residues between the Limit of Detection (LOD) and the LOQ were not taken into account. In other words, the concentration of pesticides present in “positive strawberry

samples” cannot be considered as simple traces.

Specific statistics were derived from the analyses results for a series of pesticide substances:

1. PFAS pesticides, based on their chemical formula;
2. More toxic pesticides’ list, i.e. Candidates for Substitution based on their properties as defined by EU pesticides Law (Regulation 1107/2009);
3. Neurotoxic pesticides, based on work carried out by the European Food Safety Authority (EFSA)<sup>9</sup>;
4. Endocrine disruptors, based on their regulatory identification by EFSA.



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<sup>7</sup> With the exception of the Spanish samples whose delivery took one week, due to carrier delays.

<sup>8</sup> For Austria, Croatia, Hungary, Italy, Slovenia, Spain; Eurofins Analytical Services Hungary Kft, Anonymus u. 6 1045 Ungarn Budapest Hungary,  
For Belgium, France, Germany, Netherlands, Spain; Eurofins Belgium NV, Nazareth Venecoweg 5 9810 Nazareth, Belgium  
For Ireland: Eurofins Food Testing Ireland Limited, Hoffman Park, Inchera, Cork, T45 PC80, Ireland

<sup>9</sup> <https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2021.6392>  
<https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2019.5800>

# 2. Results

## Overview

Overall, 78% of the strawberry samples from conventional agriculture contained at least one pesticide, usually below the regulatory limit. Pesticides were detected in strawberries in all tested countries, although the extent of contamination varied significantly, as well as within the same country.

In total, 22 different pesticide active substanc-

es were detected in samples collected across all countries.

All five tested organic and pesticide-free labelled samples, and 22% of the tested conventional samples, were pesticide-free.

A table with the results is available on PAN Europe's website<sup>10</sup>.

## 2.1 Cocktails of pesticides in 61% of the samples

One of the most concerning results is the number of identified pesticides per sample. On average, 61% of conventional strawberry samples contained residues of more than one pesticide, with an average of 3.5 pesticides per sample.

There are important variations among the re-

sults. Slovenia, Belgium and Ireland contain the most diverse cocktails with, on average, residues of 7, 6.3 and 5 pesticides per sample, respectively, while Dutch and French samples contained an average of 0.3 and 0.9 pesticides. Some samples contained up to 9 (Belgium), 8 (Slovenia and Hungary) and 7 different pesticide residues (Ireland).

## 2.2 PFAS pesticides in 58% of the samples

In the EU, ca. 30 approved pesticide active substances are PFAS pesticides. Those are among the most problematic substances found on the market, as they are very persistent and toxic themselves, and almost all degrade into trifluoroacetic acid (TFA). TFA was recently classified as Toxic to Reproduction category 1B (meaning it may damage the development of the foetus) by the European Chemicals Agency (ECHA)<sup>11</sup>.

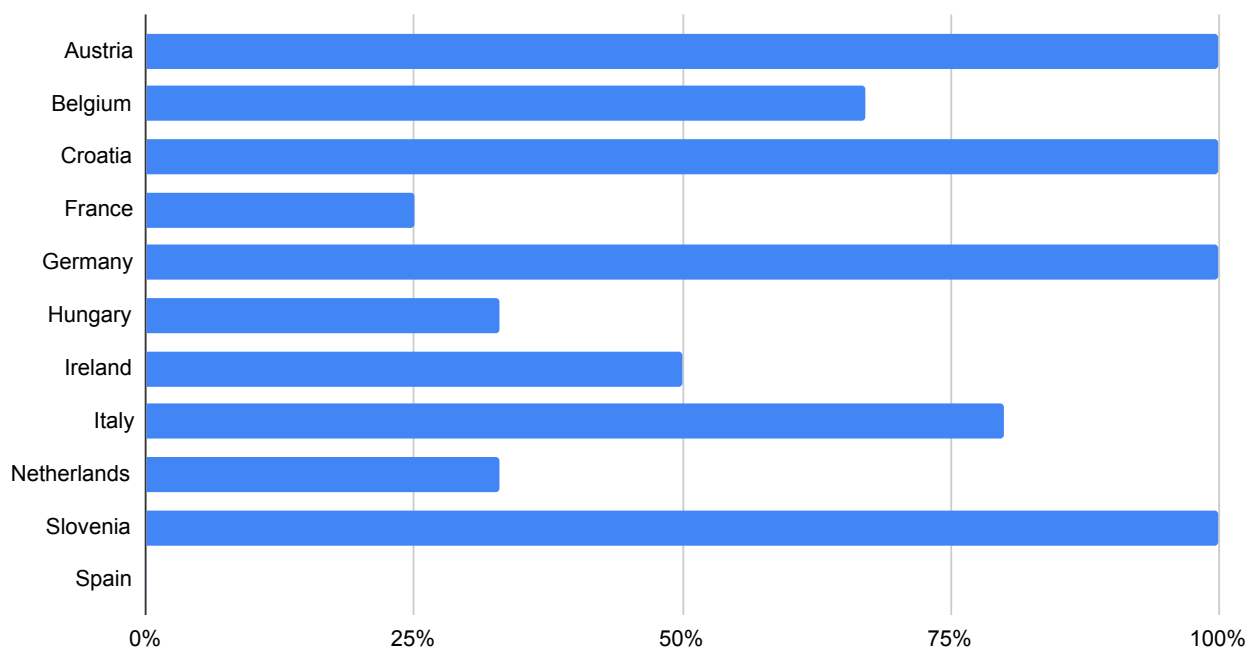
Our findings show that 58.3% of the conventional samples contained PFAS pesticides and 11% contained at least 2 PFAS pesticides. In three cases, even 3 PFAS pesticides were detected in a single sample (among the Italian, French and Belgian samples).

The metabolite TFA was not quantified as it is detected with a different method.

<sup>10</sup> <https://www.pan-europe.info/sites/pan-europe.info/files/public/resources/reports/Strawberry%202026%20report%20public%20spreadsheet.pdf>

<sup>11</sup> <https://www.pan-europe.info/press-releases/2026/06/confirmed-echa-classifies-tfa-highly-hazardous-early-life-development-all>

## 2. Results



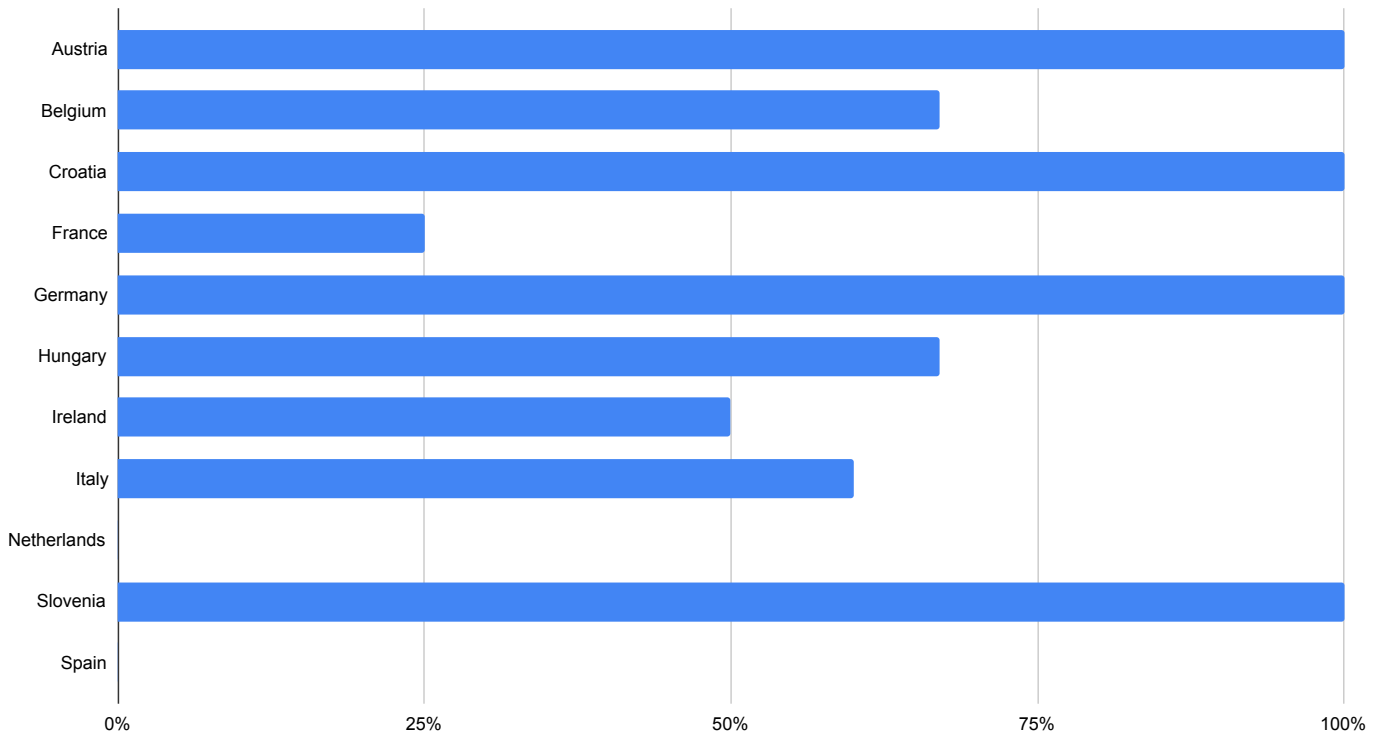
*Proportion of strawberry samples contaminated with PFAS pesticides*

### 2.3 Pesticides from the “more toxic pesticides” category found in 56% of the samples

Because of their higher toxicity, the EU has created the category of the “Candidates for substitution” (CfS), a list of 44 pesticides Member States are meant to substitute with non-chemical or less toxic chemical alternatives since 2011. More than half of strawberry samples are contaminated with at least one candidate for substitution. In some cases, samples contained cocktails of up to 3 CfS (two Slovenian samples, one Croatian and one Hungarian).

The most frequently detected pesticides were in fact two CfS: fludioxonil (39%) and cyprodinil (33%), substances which were identified by EFSA as endocrine disruptors in 2024 and 2025, respectively. More specifically, it was indicated that both pesticides substances impact reproductive health in animal studies following prenatal exposure, altering the function of sex steroid hormones. Cyprodinil was also found to affect the thyroid, which is linked to many vital functions, including brain development.

## 2. Results



*Proportion of strawberry samples contaminated with pesticides from the 'More toxic pesticides' EU list*

### 2.4 Neurotoxic substances in one fifth of conventional strawberries

Based on an EFSA evaluation, 17% of the samples contained one residue of neurotoxic pesticides. Exposure to neurotoxic pesticides during early life stages, including during pregnancy, may interfere with the development of the foetus' or child's brain. More specifically, some strawberry

samples contained deltamethrin, a pyrethroid that interferes with brain development, as well as Flupyradifurone, an insecticide from the group of neonicotinoids, that are known to interact with developing brains.



## 2. Results

### 2.5 Top 5 identified pesticide substances

As mentioned previously, the two most frequently identified pesticides are two endocrine disruptors that should have been banned by law over a year ago. To complete the top 5 list of pesticides most frequently detected:

Rank	Pesticide	Number of detection out of 36 conventional samples	Effects
1	Fludioxonil	14	A PFAS fungicide, identified as endocrine disruptor by EFSA (it interferes with the function of sex steroid hormones in animal studies; prenatal exposure impairs reproductive health in male and female offspring, delayed sexual maturation, altered oestrus cycle and lower birth outcomes) and member of the EU's more toxic pesticides list, CfS.
2	Cyprodinil	12	A <a href="#">CfS fungicide</a> , also identified by EFSA as an endocrine disruptor for human health (it interferes with the function of thyroid and steroid hormones in animal studies; prenatal exposure leads to impaired reproductive health in male and female offspring, including delayed sexual maturation and lower ovarian/egg maturation)
3	Boscalid	10	A fungicide and succinate dehydrogenase inhibitor (SDHI), with evidence of endocrine disruption (undergoing assessment), causes mitochondrial damage and proliferation in cancer cells and is highly toxic to bees and aquatic species
4	Azoxystrobin	9	A fungicide <a href="#">known to impair bee development and potentially neurotoxic to humans</a>
5	Bupirimate	6	A fungicide linked to cancer: Carcinogen Category 2



# 3. Discussion

The findings in this report highlight that strawberries are highly contaminated with pesticides, and that citizens who want to make healthy choices should favour organic strawberries, particularly during pregnancy and early life stages. The results are in line with previous official<sup>12</sup>, and NGO reports<sup>13</sup>. Contrary to official annual monitoring of food residue reports, the ones published each year by EFSA<sup>14</sup>, our report highlights the identity of the most frequently found residues, by substance. Official reports only focus on the number of identified substances, and do not communicate their identity nor their toxicity. The raw data of the official tests but in a format that only a few experts are able to extract and analyse. This lack of trans-

parency is problematic, as it does not give a clear picture of the risks of pesticides found in specific food items.

Many of the identified pesticides should have been banned, as will be detailed further. This demonstrates that a significant portion of human exposure to pesticides via food could be avoided with a more effective implementation of the law, particularly regarding the identified endocrine disruptors, PFAS or neurotoxic pesticides, as well as the issue of exposure to pesticide mixtures. Furthermore, these results show that producing pesticide-free strawberries is possible. Alternatives exist, and these should be promoted by regulators.

## 3.1 Regulators do not apply the law

### 3.1.1 Endocrine disruption: Top 2 pesticides, illegal pesticides

The EU pesticide legislation<sup>15</sup> forbids the use of Endocrine Disrupting (ED) pesticides. The EU has adopted criteria to define endocrine disruptors in 2018. Since then, the pesticide industry is requested to provide scientific information on potential endocrine-disrupting properties of their substances. A series of ED pesticides have been banned, but several have been identified by EFSA while their ban is still pending, meaning farmers, citizens and consumers continue to be exposed to these harmful chemicals.

Endocrine disruption is a biological mechanism where exogenous chemical substances, such as

pesticides, mimic natural hormones (e.g. thyroid, steroid, reproductive hormones), prevent or interfere with their functioning. This may lead to reproductive disorders and diseases, impairment in foetal and childhood brain development or even endocrine-related cancers.

Considering the high appetite from children for strawberries, it is highly concerning that, due to the non-respect of EU law by the European Commission and Member States, children, developing fetuses and the general population are highly exposed to ED pesticides.

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<sup>12</sup> [EFSA residue monitoring publication 2019](#)

[EFSA residue monitoring publication 2022](#)

<sup>13</sup> [PAN Netherlands strawberry report 2024](#)

<sup>14</sup> <https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2026.10054>

<sup>15</sup> Regulation (EC) 1107/2009, Annex II, point 3.6.5

## 3. Discussion

### 3.1.2 PFAS pesticides: the indispensable grouped phase-out

Our findings show that 58% of conventional strawberries contain at least one PFAS pesticide. In some cases, up to 3 PFAS pesticides were found in one sample (a Belgian, a French and an Italian sample). PFAS pesticides are a group of ca. 30 pesticide active substances that are among the most toxic approved pesticides in the EU, but favoured by farmers due to their efficacy that is partly due to their long life-span as “forever pesticides”.

Most PFAS pesticides break down into a very small but highly persistent and mobile PFAS substance, named trifluoroacetic acid (TFA). As reported in a series of reports by PAN Europe and its members, TFA heavily contaminates groundwater<sup>16</sup>, surface water<sup>17</sup>, mineral water<sup>18</sup>, cereal-based products<sup>19</sup> and wine<sup>20</sup>.

For approximately 9 out of 28 PFAS pesticides with the potential to break down into TFA, evidence of TFA formation exists in industry’s regulatory dossiers, but for 19 PFAS pesticides, there is incomplete or equivocal evidence. This is because the regulatory test protocols to measure degradation into TFA are not suited for PFAS pesticides, partly because the duration of the tests is too short for TFA to form .

Considering the classification of TFA as R1B, PAN Europe advocates for an immediate ban on all TFA-producing PFAS pesticides, and the suspension of approval of all other PFAS pesticides that could break down to TFA, based on their chemical structure, until the approval owners provide sufficient regulatory scientific evidence. This is necessary to protect public health and the environment, in line with the precautionary principle.

### 3.1.3 Cocktails, EFSA to take its responsibility

The European Food Safety Authority was tasked in 2005<sup>21</sup> to develop a methodology to assess the risk of exposure to multiple simultaneous residues of pesticides via food.

After 20 years, no methodology exists. While synergistic and additive effects - the so-called

“cocktail effects” - are well described in the scientific literature, EFSA has failed to provide a methodology to assess their impact, which has never been questioned by the European Commission. Over two decades, the EFSA has funded a few research projects and decided to focus on cumulative (additive) effects, through the con-

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<sup>16</sup> <https://www.pan-europe.info/resources/reports/2024/07/tfa-forever-chemical-water-we-drink>

<sup>17</sup> <https://www.pan-europe.info/resources/reports/2024/05/tfa-water-dirty-pfas-legacy-under-radar>

<sup>18</sup> <https://www.pan-europe.info/resources/briefings/2024/12/tfa-%E2%80%98forever-chemical%E2%80%99-european-mineral-waters>

<sup>19</sup> <https://www.pan-europe.info/press-releases/2025/12/high-levels-forever-chemical-tfa-everyday-cereal-products-all-across-europe>

<sup>20</sup> <https://www.pan-europe.info/press-releases/2025/04/study-reveals-alarming-surge-forever-chemical-tfa-european-wine>

<sup>21</sup> Regulation (EC) 396/2005 on the establishment of Maximum Residue Levels of pesticides in food and feed.

### 3. Discussion

cept of Cumulative Assessment Groups (CAGs)<sup>22</sup>. These CAGs include substances with a similar mode of action, and EFSA carries out a risk assessment based on additivity, for some aspects of their toxicity. While PAN Europe acknowledges the importance of this work, this approach does not cover potential synergistic effects (cocktail effects), meaning that EFSA has failed to develop a methodology to implement the EU legislation. Mounting scientific evidence shows that chronic exposure to higher levels of pesticide residues via food is associated with health concerns. Long-term exposure to multiple residues of pesticides is linked to reduced fertilisation rate<sup>23</sup>, lower ovary reserve<sup>24</sup>, lower sperm quality<sup>25</sup>, as well as a lower chance of success of reproduction under assisted reproductive technology<sup>26</sup>. In addition, a French epidemiological study concluded that the regular consumption of organic food reduces by 25% the likelihood of developing different types of cancers, particularly lymphomas (blood cancers)<sup>27</sup>. More recently, exposure to mixtures of pesticides was linked to inflammatory bowel disease<sup>28</sup>.

Testing every pesticide cocktail combination is not possible, but growing knowledge on the link between pesticide exposure via food and chronic diseases must lead to more protective measures. While the EFSA continues to assess the risk of pesticides, substance by substance, this does

not correspond to the reality. Until a methodology is developed, an additional safety factor of 10 should be set, in order to account for the absence of a methodology.



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<sup>22</sup> [https://food.ec.europa.eu/plants/pesticides/maximum-residue-levels/cumulative-risk-assessment\\_en](https://food.ec.europa.eu/plants/pesticides/maximum-residue-levels/cumulative-risk-assessment_en)

<sup>23</sup> [Kazemi et al. 2025](#)

<sup>24</sup> [Kazemi et al. 2025](#)

<sup>25</sup> [Chiu et al. 2015](#)

<sup>26</sup> [Chieu et al. 2017](#)

<sup>27</sup> [Baudry et al. 2018](#)

<sup>28</sup> [Ma et al. 2026](#)

## 3. Discussion

### 3.2 Concerns regarding babies and children exposure via food

While the setting of maximum residue levels (MRLs) is based on a statistical methodology that assumes that citizens consume average quantities of food per day, our research highlights worrying results for babies and children.

Firstly, 78% of the tested conventional strawberries do not comply with legal requirements for baby food. Indeed, the EU legislation<sup>29</sup> forbids the presence of residues of pesticides above the so-called “analytical 0”, i.e. 0.01 mg/kg. When parents intend to prepare themselves fresh food from conventionally-farmed strawberries, they

will expose their babies to pesticide residues up to 188 times higher than the legal limit.

In addition, PAN Europe has identified that for certain pesticides, the MRL authorised in strawberries is sometimes two to three times higher than for apples, including for PFAS pesticides<sup>30</sup>. This is highly concerning, considering the significant quantities of strawberries a child can ingest compared to apples. Furthermore, strawberries cannot be peeled, or thoroughly washed, contrary to apples, to reduce their pesticide load.

### 3.3 Sustainable Use of Pesticides Directive: 17 years of inaction

In 2009, the EU adopted a Directive on the Sustainable Use of Pesticides (SUD)<sup>31</sup>. The objective of this legislation is to gradually reduce pesticide dependence in the EU, while protecting citizens and the environment against exposure to pesticides. While the SUD does not deal with pesticide residues in food, it should have led to a gradual reduction of the presence of such residues through the implementation of alternative crop protection methods, and a reduction in synthetic pesticide use. Indeed, the SUD foresees that Integrated Pest Management (IPM) must be manda-

tory in all farms as from 2014. IPM is a systemic approach of crop protection, investing in prevention, while giving priority to non-chemical pest control approaches when needed.

According to our results, up to 9 residues of pesticides can be found in a single strawberry sample, showing the huge reliance on chemical pest control. In samples from France and the Netherlands, few pesticides were found, showing that low-chemical input methods are already implemented by some growers.

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<sup>29</sup> Regulation (EU) 2016/127

<sup>30</sup> Boscalid: apples 2 vs strawberries 6 mg/kg

Flonicamid: 0.3 vs 0.7 mg/kg

Fluopyram: 0.8 vs 2 mg/kg

Cyprodinil: 2 vs 5 mg/kg

<sup>31</sup> Directive 2009/128/EC

## 3. Discussion

Intensive strawberry production is challenging but non-chemical approaches to synthetic pesticides are available. The use of more resistant varieties is a pre-requisite to reducing pesticide use, while cultivation methods reduce the need for fungicides. Non-chemical and low-risk insect control methods are also available. A recent research from the university of Wageningen highlights that IPM can lead to a 90% reduction in pesticide use in greenhouses<sup>32</sup>. Implementing such practices leads to nearly pesticide-free strawberries (see “The Netherlands case” p.18).

Implementing alternative pest-control methods is knowledge-intensive. According to farmers’ testimonies, the major source of crop-protection advice comes from sellers of pesticides, as Member States do not comply with their obligation

to provide independent advice on alternative crop-protection methods. Indeed, the SUD foresees (article 4 §2) that Member States develop advisory services on IPM to support their farmers in their transition towards low-input agriculture. Unfortunately, this provision of the directive is implemented on a very low scale and, where implemented, concerns only major crops.

The non-implementation of the SUD has been highlighted in a report from 2020 from the European Court of Auditors<sup>33</sup>, which underlines that the transposition of the SUD into national legislation was never assessed by the European Commission. The report also highlights that the SUD did not meet its objectives, mostly through a non-implementation at Member States level.

### 3.4 Candidates for substitution: 17 years of inaction

Member States have been requested to phase out Candidates for Substitution (the “More toxic pesticides”) since 2011, under the pesticide regulation. This category represents particularly toxic pesticides that should be phased out in priority at Member States’ level, when alternatives are available (see Recommendations section p.19).

While a proper implementation of this obligation should lead to a reduction of CFS residues in food, a previous report from PAN Europe has shown that the presence of CFSs in European

food is on the rise over the last decade<sup>34</sup>. The fact that no less than four samples contained 3 CFS pesticides each is not acceptable, since those should have been gradually phased out since more than 15 years. The non-implementation of the substitution principle has been raised to the European Commission by PAN Europe many times, without a reaction.

At national level, although countries do have the obligation to carry out an assessment of the existence of alternatives, they refuse to comply

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<sup>32</sup> <https://www.wur.nl/nl/onderzoek/plant/de-chemievrije-aardbei-komt-steeds-dichterbij>

<sup>33</sup> <https://www.eca.europa.eu/en/publications?did=53001>

<sup>34</sup> <https://www.pan-europe.info/resources/reports/2024/02/toxic-harvest-rise-forever-pfas-pesticides-fruit-and-vegetables-europe>

### 3. Discussion

with this legal requirement and do authorise or renew systematically the authorisation of these

highly toxic pesticides, despite the existence of alternatives.

#### The case of Netherlands:

PAN Europe tested strawberry samples purchased from four supermarkets in Maastricht, the Netherlands: Albert Heijn, Jumbo, Aldi and Coöperatie Gedeelde Weelde. One sample was marketed as organic and three were conventionally produced. Overall, residue levels were remarkably low. Indeed, while the average contamination in the 11 tested countries was 3.5 different pesticides per sample, the Dutch samples contained only 0.3 residue per sample on average. Only sample out of the four tested contained one pesticide residue (fluopyram, a fungicide classified as a PFAS pesticide). The detected concentration was below the applicable EU Maximum Residue Level (MRL), and no other pesticide residues were found.

These findings are particularly noteworthy in the context of previous PAN Netherlands monitoring. PAN Netherlands' supermarket strawberry tests conducted in [2021](#), [2022](#) and [2024](#) found an average of 3.5, 3.7 and 3.0 different pesticide residues per conventional strawberry sample, respectively. According to [PAN Netherlands' analysis](#) of three years of the Dutch Food Authority (NVWA) official monitoring data, strawberries contained an average of 4.4 pesticide residues per sample, making them jointly the most pesticide-contaminated fruit in the Dutch market (together with citrus fruits). To complement PAN Europe's 2026 sampling in Maastricht, PAN Netherlands also analysed 12 additional conventionally-grown strawberry samples from other regions of the Netherlands in 2026. These 12, together with the 3 convention-

al samples taken by PAN Europe, contained together a total an average of 2.1 pesticide residues per sample, with four samples (27%) containing no detectable residues. Although five PFAS pesticides, two endocrine-disrupting pesticides (EDCs), three Candidates for Substitution (Cfs), three suspected carcinogens (C2) and one suspected reprotoxic (R2) pesticide were identified, the results indicate a marked reduction in the number of pesticide residues compared with previous years.

The results are consistent with broader developments in Dutch strawberry production, including [recent initiatives in Limburg by Lidl, supported by Natuur & Milieu](#), where retailers and growers substitute synthetic pesticides through biological pest control against insects, UV-C treatment against fungal diseases and other integrated crop protection techniques.

As previously outlined, [Wageningen University & Research has shown](#) that Integrated Pest Management can reduce pesticide use in greenhouse strawberries by more than 90%. Although the producer(s) of the strawberries purchased in the frame of this report could not be verified, the near-absence of residues, together with the lower residue levels found by PAN Netherlands elsewhere in the country, suggests that reduced-pesticide cultivation practices may be beginning to reach a wider share of the Dutch market.

Nevertheless, continued monitoring will be necessary to determine whether this represents a lasting structural shift rather than year-to-year variation.

# 4. Recommendations to citizens

## 4.1 Favour local organic strawberries

Organic strawberries are grown without synthetic pesticides, and our results show that organic samples were indeed pesticide-free. Buying local, organic food ensures a significant reduction in the risk of being exposed to pesticides via food, while supporting local organic farmers. As organic strawberries are significantly more expensive than conventional ones, the recommendation is to buy them in farmers' markets rather than supermarkets, often at a cheaper price. Fruits and vegetables must represent a significant share of citizens' diet, for the health benefits they represent. In the case that no organic food is available, PAN Europe recommends prioritising the consumption of fruits and vegetables that can be peeled, (not the case with strawberries) in order to remove part of their pesticide load (part of the pesticide loads, nevertheless, still remains).

## 4.2 Write to your politicians

Citizens often underestimate the impact of writing to their local, national and European decision-makers. But writing to your ministers of health, agriculture or environment, your members of the European Parliament, or your political parties to inform them of your demands, as a citizen, may have more impact than you think, especially if you collect signatures. It is unacceptable that the toxicity of exposure to multiple residues is still not assessed in the EU, and that some strawberry samples contain nine pesticides, while alternatives exist, at an affordable price.

## 4.3 Grow your own strawberries

Strawberry cultivation does not require much space and can even be done in pots on a balcony. Remember, however, that they need pollination, so ensure that bees and other pollinators have direct access to the strawberries' flowers. Favour ancient varieties that are more resistant to pests, and ensure that the soil is well fertilized and remains humid at all times. Since strawberries are sensitive to fungi, ensure that soil is covered with litter, such as grass mulch, wood chips, or straw. They will further help maintain soil humidity and carbon content.

# 5. Recommendations to policymakers

## 5.1 Food and Feed Safety Omnibus regulation: Set more protective rules, rather than weakening the pesticide legislation

In 2017, in the frame of a regulatory fitness and performance programme (REFIT), the European Commission concluded that the current legislation on pesticides' authorisations is 'fit for purpose', and that most issues with regards to its implementation were linked to Member States' prerogatives<sup>35</sup>. The report highlighted that the EU system of periodic, 10-15 year re-assessment of pesticides was an important tool for updating the risk assessment of pesticides, in the light of new scientific knowledge. Prior to this, in 2019, a European Parliament Special Committee on the EU's authorisation procedure for pesticides concluded that long-term toxicity of pesticides should be better assessed, with a better uptake of non-industry scientific findings.

In addition, scientific publications highlight, on a daily basis, the toxicity of pesticides, both for human health and the environment. As outlined above, the European Chemicals Agency recently concluded that TFA, a common metabolite to PFAS pesticides, should be classified as Toxic to reproduction category 1B, which should lead to a global ban on all PFAS pesticides. PFAS pesticides have been used for decades, and early scientific evidence on their persistence and potential harm

was systematically overlooked by regulators. As a result, our groundwater supplies, as well as the environment in general, are greatly contaminated with this harmful metabolite, the concentrations of which continue to increase.

Scientific and regulatory evidence show that more protection is needed, not less. This runs against the current European Commission proposal to relax the rules on pesticide approvals in the EU. One of the most controversial elements within the Commission's proposal is the provision of time-unlimited approvals to pesticides. Periodic 10-15 year reassessment of pesticides is a cornerstone of the EU regulatory system which allows the update of the risk assessment of pesticide substances based on new scientific evidence and developments. Over the last years, a series of pesticides have been banned thanks to this system the European Commission now wants to weaken.

Considering the fact that the identified pesticides in strawberries are, almost systematically, highly toxic pesticides, it is of major importance to maintain a strict regulatory system that allows regular reassessment, and eventually the phase-out of, pesticides.

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<sup>35</sup> [https://food.ec.europa.eu/plants/pesticides/refit\\_en](https://food.ec.europa.eu/plants/pesticides/refit_en)

## 5. Recommendations to policymakers

### 5.2 Inform (future) parents

A mounting body of scientific evidence points towards exposure to multiple pesticide residues as a cause of infertility. Furthermore, in order to protect babies and toddlers, industrial baby food must not contain pesticide residues above the Limit of Quantification (0.01 mg/kg). This is a proper implementation of the precautionary principle, considering the scientific limitations in the setting of Maximum Residue Levels by EFSA. Most parents are unaware that processed food and fresh food are not regulated in a similar way. It follows

that parents should not feed their young children with conventional strawberries - neither fresh nor processed at home - considering that nearly 80% of the tested conventional strawberries technically exceed regulatory limits for young infants.

Public authorities should run continuous information campaigns towards citizens to inform them on the importance of consuming organic fruit and vegetables to protect foetuses, babies and young children, while consumption of organic food could potentially reduce infertility rates.

### 5.3 Implement the SUD immediately to reduce pesticide use

Europeans are well aware, throughout the EU, of the risks posed by pesticides. They regularly raise their voice to demand a rapid and significant reduction of pesticide use in Europe. The Directive on the sustainable use of pesticides sets the legislative framework to reach such a reduction since 2009 but it is not properly transposed or implemented.

The European Commission ought to audit national transpositions of the SUD, which has never been done, and ensure a gradual reduction of pesticide use in the EU.

Member States must implement, without delay, article 14 of the SUD, and employ Integrated Pest Management, while ensuring that farmers receive high quality and independent crop pest management advice. Furthermore, Member States ought to develop or improve IPM guidelines and make them mandatory, to increase knowledge on alternative practices, and accompany farmers in their proper implementation.

## 5. Recommendations to policymakers

### 5.4 Better implement the pesticide legislation

The most toxic pesticides, namely Candidates for Substitutions, must be replaced by available alternatives, and banned by Member States, which currently do not implement the provision of the legislation. PAN Europe and its members have regularly requested that the European Commission review its guidance document on the implementation of the substitution principle in the EU to make it more effective.

In the same vein, Denmark has banned a series of PFAS pesticides to protect the quality of its groundwater. PFAS pesticides are also among the most toxic to humans and degrade into a metabolite (trifluoroacetic acid- TFA), recently classified as 'Toxic to reproduction category 1B'<sup>36</sup>. These re-

strictions should take place across the entire EU: all Europeans deserve protection against PFAS pesticides and their metabolites.

Finally, scientific evidence shows that deltamethrin and neonicotinoids (such as flupyradifurone), two neurotoxic insecticides, are toxic to fetuses. PAN Europe considers that they should be banned, as sufficient scientific knowledge is available for decision-makers to make this decision. As was observed in the case of chlorpyrifos, a neurotoxic pesticide that reduces children's IQ, or with bee-toxic neonicotinoids, it often takes 20 years for the EU to ban pesticides, even when the scientific evidence is present.

### 5.5 Develop a methodology to evaluate the toxicity of multiple exposure in food

EU Maximum Residue Levels (MRLs) regulation (EC) 396/2005 foresees that the European Food Safety Authority (EFSA) will develop a methodology to assess the risk of exposure to multiple residues of pesticides in food. EFSA has financed a series of research projects that include scientists with dubious conflict-of-interest issues. These projects included industry-linked researchers that promoted a probabilistic approach that does not protect all Europeans, but rather serve agro-industry's interests.

Since 2005, EFSA has not delivered an assessment methodology to consider the impact of chronic exposure to multiple pesticides via food. In the meantime a mounting body of scientific evidence points at the impact of pesticides on citizens' health, and in particular on fertility issues (see references in Cocktail section p.15.). As a scientific agency, EFSA must take into account the most recent scientific knowledge and respect EU law. It is high time that it delivers a methodology which protects Europeans from exposure to cocktails of pesticides.

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<sup>36</sup> <https://www.pan-europe.info/press-releases/2026/06/confirmed-echa-classifies-tfa-highly-hazardous-early-life-development-all>

## 5. Policy recommendations

### 5.6 More protective rules on multiple residues

Until a scientifically-robust methodology is developed in order to assess the risk of exposure to multiple pesticides in food, PAN Europe advocates for the setting of a “Mixture Assessment Factor” (MAF) of 10, based on the absence of risk

assessment for exposure to multiple residues, and based on the precautionary principle. A MAF of 10 means that regulatory “safe levels” will be set 10 times lower.

### 5.7 Increase scientific knowledge on exposure to multiple residues

Considering the highly concerning scientific findings mentioned above, the European Union should finance research on the impact of exposure to multiple residues of pesticides on citizens’ health. Citizens are exposed to chemicals present in their environment, such as in the air, in clothing, and in the home. Pesticides are chemicals that are

intentionally sprayed on our food, and for which alternatives exist. It is therefore unacceptable that, with the constant rise in infertility, neurologic disorders or cancers, and in particular those associated with pesticide exposure (breast and prostate cancers, as well as lymphoma), the EU does not fund more research in this area.



# Conclusion

This research carried out in 11 European countries confirmed the omnipresence of pesticide residues in strawberries, with up to nine (9) different pesticide residues in one of the tested samples. The most frequently found pesticides are endocrine disruptors and other toxic PFAS pesticides. Most strawberries contain multiple residues of pesticides, which are linked to health concerns, such as infertility or cancers. Despite its legal obligation for over 20 years, the European Food Safety Authority has not developed yet a methodology

that accounts for multiple residues of pesticides in our food. Public authorities have not acted, despite the availability of non-chemical alternatives in strawberry production. The production of conventional but pesticide-free strawberries is achievable, as demonstrated by the almost pesticide-free samples from France and the Netherlands. PAN Europe recommends that consumers choose organic strawberries in priority, and in particular in case of pregnancy, as well as for children.



# European strawberries

**extensively contaminated with PFAS or endocrine  
disrupting pesticide residues**

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