TECHNICAL REPORT
Residues of Banned Pesticides in EU food
"A state of play"
By PAN Europe

Pesticide Action Network Europe

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1 BACKGROUND

Regulation (EC) No 396/2005 on maximum residue levels of pesticides in food imposes on EU Member States the obligation to carry out controls to ensure that food placed on the market is compliant with the legal limits of pesticide residues (Maximum Residue Limit, MRL). The Regulation takes into consideration food produced in Europe as well as food imported from non-EU countries. Member States are requested to share the results of the official controls and other relevant information with the European Food Safety Authority (EFSA). Based on these results, EFSA prepares an Annual Report on pesticide residues, analysing the data in view of the MRL compliance and the exposure of European consumers to pesticide residues.

Following the publication of 2020 EFSA report[1], EFSA published online the monitoring data that received from the Member States concerning pesticide residues in their food (fruits, vegetables and animal origin) for the year 2018[2]. Among others, these data contain information about which pesticide residues were detected on which food, in which country the food was produced and in which country it was sampled.

Pesticide substances that are hazardous for humans, animals and/or the environment are banned from use in Europe according to Regulation (EC) 1107/2009. In theory, for pesticides that are banned in EU for human health reasons, the MRL is set below the limit of detection and therefore residues of this pesticide should not be detected in EU food. However, there are a number of exceptions.

2 METHODOLOGY

Exports and imports of hazardous substances is governed by Prior Informed Consent (PIC) Regulation (EU) 649/2012. All pesticides listed in PIC are considered hazardous and they are either banned in EU or their use is severely restricted.

PAN Europe extracted the PIC list of pesticides from European Chemical Agency website (approx. 170 pesticides)[3], to investigate whether hazardous and EU banned pesticides are detected in food sold in the European market. The food residue data were taken from the EU official 2018 monitoring data used to produce EFSA's annual report.

Since the food monitoring took place in 2018, we used the PIC pesticide list from 2018, and therefore the pesticides that were banned after 2018 were excluded from the list, even though they are not no longer in the market today. These are: amitrole, beta-cypermethrin, flupyrsulfuron-methyl, fipronil, iprodione, isoproturon, linuron, maneb, orthosulfamuron, picoxystrobin, triasulfuron. We also excluded those that have been used only as biocides. In total, we analysed the data for 160 pesticides.

NOTE: The sampling and analysis of food samples is not homogenous. This means that neither the number of samples collected is equal among types of food and Member states, nor all samples have been screened for all pesticides under investigation. Therefore, the current assessment is indicative rather than quantitative and comparisons may not be possible. Further, PAN Europe has no responsibility if the samples were mislabelled by Member States (e.g. errors in country of origin or type of food sample).

[1] http://www.efsa.europa.eu/en/efsajournal/pub/6057
[2] Available in EFSA Knowledge junction https://zenodo.org/communities/efsa-kj/?page=1&size=20
[3] https://echa.europa.eu/information-on-chemicals/pic/chemicals

3 OVERVIEW OF RESULTS

3.1 PESTICIDE COCKTAILS IN EU FOOD

- About 93,153 samples were collected during the Member States official controls, this includes plant-based and animal-based, raw and processed food samples, including organic food and baby food from Europe or third countries, or of unknown origin, enforcement or surveillance[4]. Out of these **47.7% samples had residues from at least one pesticide and 30.1 % had residues of 2 or more pesticides**.
- As expected, plant-based products are the ones most often found with pesticide residues, **over half (53.9%) of samples had residues of at least 1 pesticide and over one third (35.1%) had residues of 2 or more pesticides**. This is the average, when we look in detail, we see higher values:
    - Fruits had the most pesticides, **two thirds of the fruit samples (68.7%) had at least one pesticide residue, and over half (51.6%) had residues of 2 or more pesticides**.
    - **Spices, herbs and teas follow up, where 66.9%, 63.5% and 58.9% of samples, respectively, had residues of at least 1 pesticide and 53.4%, 45.6% and 44.6% of two or more pesticides.**
    - Nuts were the samples with least pesticides.

Table 1. Pesticide residues in food according to 2018 official national controls (EFSA, 2020). Percentage of samples (%) with pesticide residues, including pesticide mixtures (residues of 2 or more pesticides).

Product category	Category	Samples (N)	% with residues	% multiple residues
Plant-based	*Fruit*	*29468*	*68.7%*	*51.6%*
	Spices	*697*	*66.9%*	*53.4%*
	Herbs	*1401*	*63.5%*	*45.6%*
	Teas	*897*	*58.9%*	*44.6%*
	Fungi	*1445*	*49.1%*	*16.9%*
	Vegetables	*32127*	*47.7%*	*27.9%*
	Legumes	*2751*	*44.3%*	*24.9%*
	Cereals	*5715*	*36.9%*	*12.5%*
	Seeds	*733*	*32.3%*	*6.7%*
	Oil fruits	*1561*	*19.9%*	*6.9%*
	Cocoa and coffee bean	*340*	*13.2%*	*9.1%*
	Nuts	*274*	*7.7%*	*1.8%*
	Other	*805*	*7.2%*	*2.0%*
Plant-based	Total	78214	**53.9%**	**35.1%**
Animal products	Total	12756	13.8%	3.0%
Other	Total	2183	24.2%	11.7%
ALL	**Grand Total**	93153	**47.7%**	**30.1%**

[4] Surveillance means that the samples were taken without targeting specific growers/producers/ importers or consignments likely to be non-compliant and enforcement samples means where a suspect sampling strategy was applied. In 2018 most samples (80,340 samples, 88.3%) were classified as surveillance samples.

3.2 EU VERSUS NON-EU SAMPLES

- A higher % of food samples from third countries had pesticide residues and pesticide mixtures than food from EU countries (all EEA countries are included). About 61.5% of food from non-EU countries had residues of one or more pesticides and 43.2% had residues of mixtures of pesticides [Figure 1]. Both plant-based food and animal food samples contained more residues than food samples from EU [Figure 2]. Plant-based food from unknown origin had a high percentage of pesticides or pesticide mixtures.

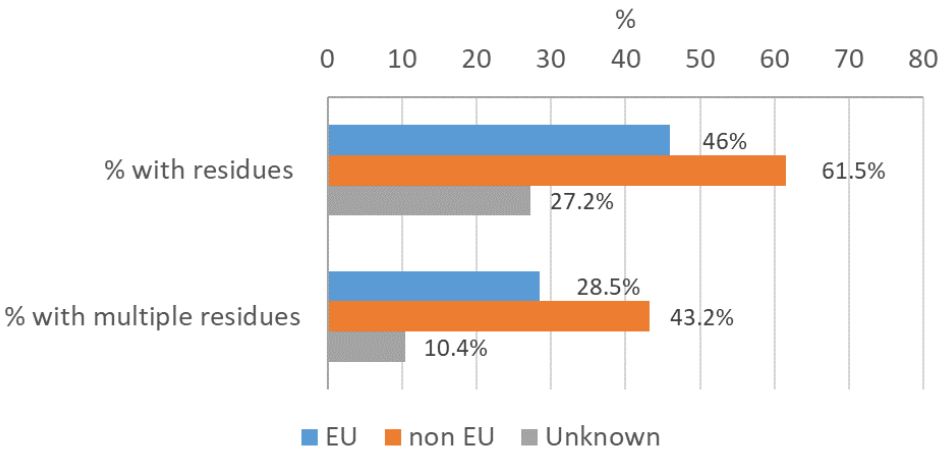


Figure 1. Food samples (%) from EU (including EEA countries), outside EU and of unknown origin with pesticide residues (of one pesticide and of two or more pesticides).

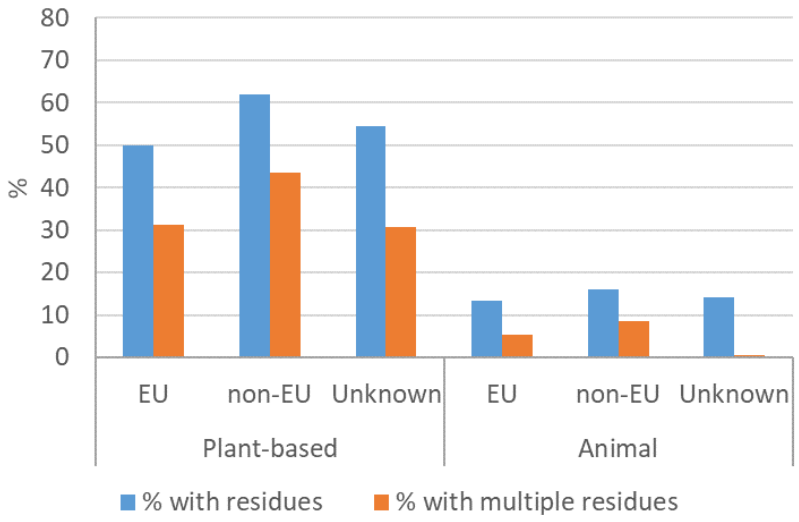


Figure 2. Plant-based or animal-based food samples (%) from EU (including EEA countries), outside EU and of unknown origin, with pesticide residues (of one pesticide and of two or more pesticides).

- For imported food, more than two thirds (71.7%) of spices were found with pesticide residues and over half (59.6%) contained residues of two or more pesticides, making it the number one food with pesticide residues. A high number of imported fruits also had pesticide residues; 71.7% of imported fruit had pesticides and 55% had more than one. Teas, herbs and vegetables are also high on the list [Table 2].
- For European products, pesticides were most often detected in fruits; 67% of fruits produced in Europe had pesticides, and about half of the samples (49.8%) had residues of at least two or more pesticides. Herbs, fungi and spices are also on the top of the list [Table 2].

Table 2.Plant-based products from EU and non-EU countries. Percentage of food with pesticide residues (at least one) and pesticide mixtures (residues of 2 or more pesticides)

	EU		non-EU	
Plant-based foods	% with residues	% mixtures	% with residues	% mixtures
Fruit	**67**	**49.8**	**71.7**	**55**
Herbs	**62.4**	**43.3**	60.4	47.8
Fungi	49.4	15.9	45.3	28.4
Spices	49.3	34.5	**73.3**	**59.6**
Teas	43.8	25.3	63.5	49.8
Vegetables	43.4	25.1	57.2	34.7
Legumes	36.8	16.3	46.9	30.1
Cereals	36.6	11.1	30.1	17.8
Seeds	29.9	5.4	32.3	12.1
Oil fruits	18.7	6.7	21.8	5.6
Nuts	7.4	2.7	10.8	1.1
Other	7.3	1.3	13.3	8.9
Cocoa & coffee beans	0	0	16.5	11.4

4 PIC-LIST PESTICIDES

4.1 OVERVIEW

- In total, **74 pesticides from the PIC list were detected in 5811 food samples** (6.2%) from the European market. Out of those 5811, the majority were detected in plant-based products (75.2%) [figure 3].

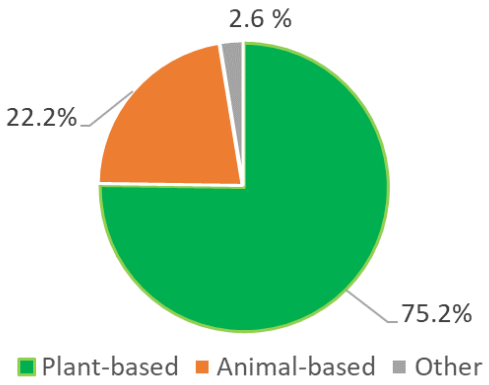


Figure 3. PIC-list pesticides were detected in 5811 samples of food sold in EU market (including EEA countries). Most of these samples were plant-based food.

- The top 35 PIC pesticides detected in all food samples (all types and origin) are given in **Figure 4**. Carbendazim, a mutagenic and toxic to reproduction substance, was the banned pesticide detected the most in both EU (644 samples) and third countries (859 samples), in a total of 1,596 samples.
- Overall PIC-list pesticides were detected mostly in food from third countries or of unknown origin, although there are some concerning exceptions, for example highly toxic DDT and hexachlorobenzene were mainly detected in samples of EU origin.
- Chlorate was detected in 1,115 samples, mainly from the EU. Although it is banned for use as pesticide it is also a by-product of chlorine solutions (chlorine dioxide, chlorite and hypochlorite salts) used as sanitising and disinfection agents in the food industry and as biocides. This means that residues are not always present because of pesticide use.
- Chlorfenapyr which is highly toxic to bees and aquatic life was also on the top of the list, whereas other hazardous pesticides such as carcinogenic anthraquinone, neurotoxic malathion and omethoate, and tricyclazole were found in significant amounts in certain samples tested.

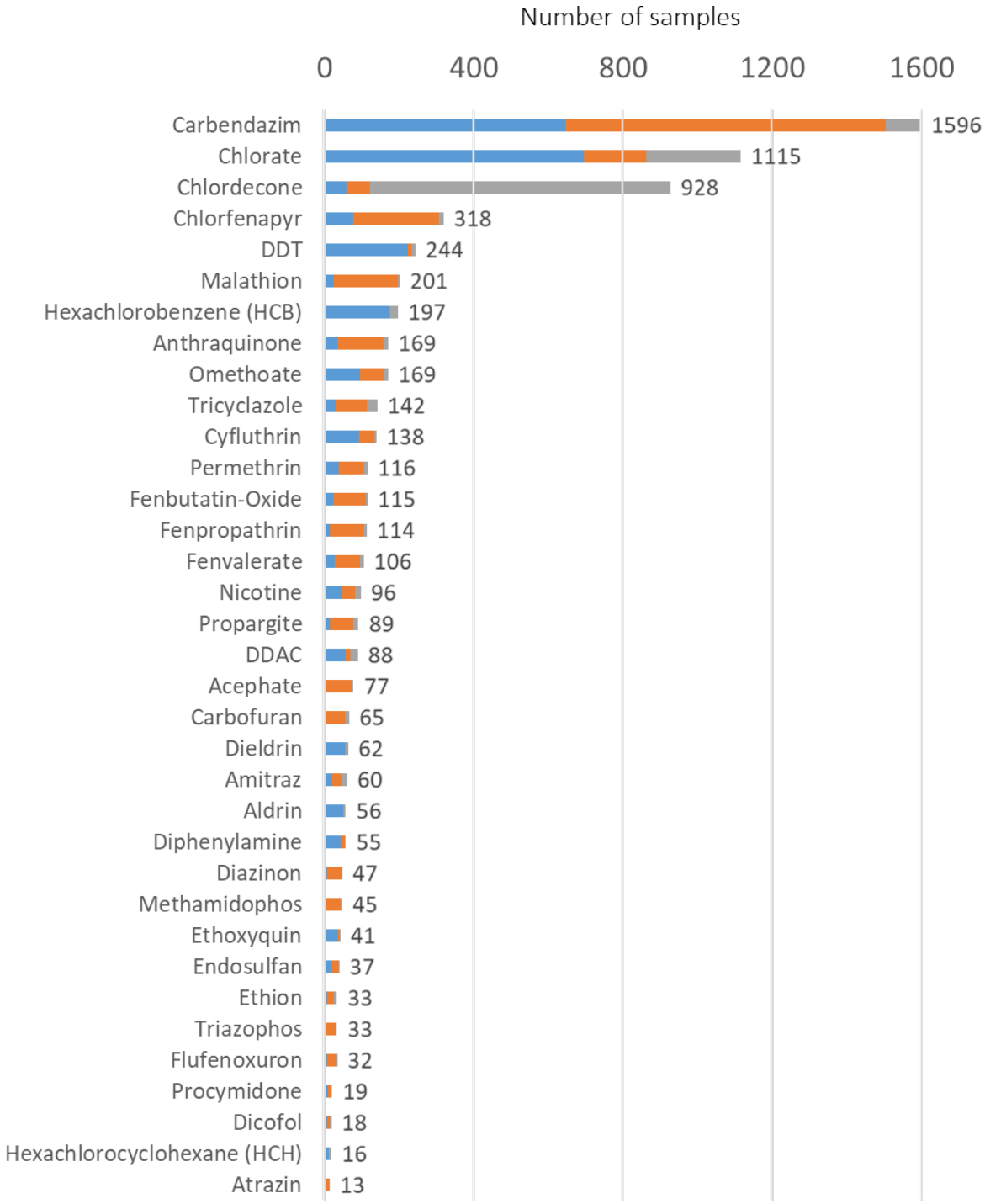
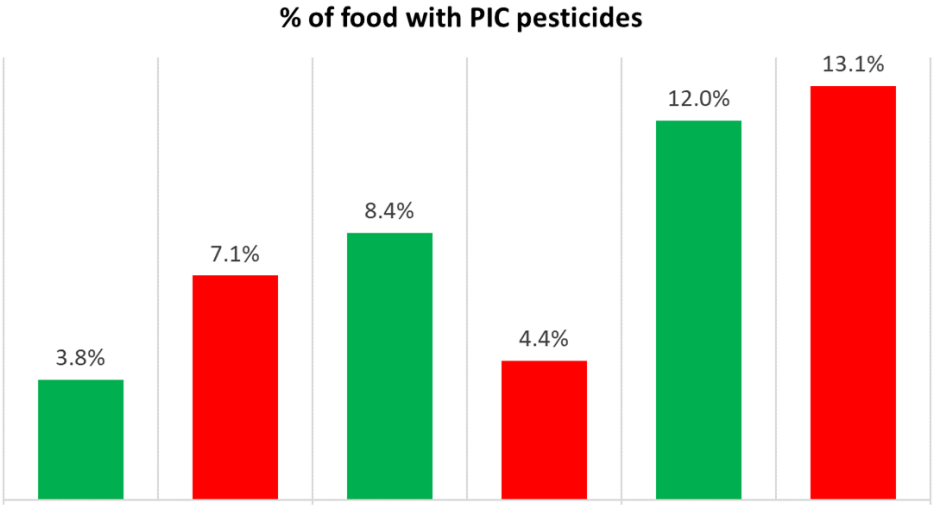


Figure 4. PIC-list pesticides detected in food sold in EU market

4.2 IMPORTED VERSUS EU PRODUCTS

- The highest number of PIC-pesticides were detected in imported plant-based food (61 pesticides in 8.4% of the samples). Twice as much imported food contained at least 1 PIC pesticide or more, compared to food grown in EU (3.8%) although a high number of PICs were also detected (54 in total) [Figure 5].
- The highest percentage of food that contained at least 1 PIC pesticide, was of unknown origin (12% and 13.1% for plant and animal-based food respectively).

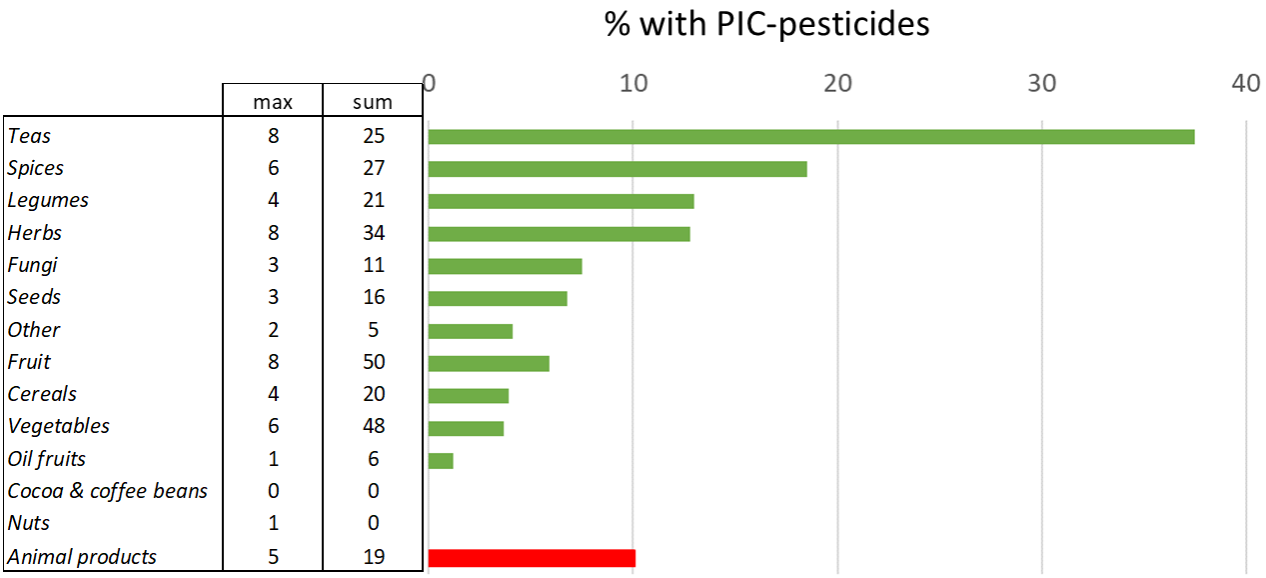


	EU		non EU		Unknown	
	Plant-based	Animal-based	Plant-based	Animal-based	Plant-based	Animal-based
PIC pesticides (N)	54	16	61	5	40	12
% samples	3.8%	7.1%	8.4%	4.4%	12.0%	13.1%

Figure 5. Percentage of samples where PIC pesticides were detected (one or more) and total number of PIC pesticides detected, divided in plant-based and animal-based products, produced in Europe (EU), imported (non-EU) or of unknown origin.

- By examining all the different types of food analysed, we see that most PICs were found in fruit (50) and vegetables (48), and a single sample of fruit or vegetable had up to 8 or 6 PIC pesticides respectively. Nevertheless, the types of food samples with the highest number of samples with PIC pesticide residues were teas (38%), followed by spices (19%), legumes (13%) and herbs (13%) [Figure 6].

- Animals are exposed to pesticides through their food and the environment. In total, 19 different PIC pesticide residues were found in 10% of animal products analysed, and up to 5 PIC pesticide residues were detected in a single sample.



	max	sum
Teas	8	25
Spices	6	27
Legumes	4	21
Herbs	8	34
Fungi	3	11
Seeds	3	16
Other	2	5
Fruit	8	50
Cereals	4	20
Vegetables	6	48
Oil fruits	1	6
Cocoa & coffee beans	0	0
Nuts	1	0
Animal products	5	19

Figure 6. Percentage of all food tested with PIC pesticide residues (max refers to maximum number of PIC pesticides detected in a single sample; sum refers to the total number of PIC-pesticides detected in all samples of each food category).

- We decided to screen all the data and find the top products that were found most often with pesticide residues.
- Exotic fruit, like guavas (85%), goji berries (55%), breadfruit (42%) and cherimoyas (40%) are on the top of the list, together with teas (37%), peppercorns (29%), coriander leaves (25%), as well as animal products such as liver (48%) and milk (24%) [Figure 7].
- Teas, herbs and spices had a high number of different PICs in all sample category tested and in individual samples. For example, all tea and chilli samples had 25 and 23 PIC-pesticides, and an individual sample had 8 and 6 PIC residues, respectively. High number of PIC pesticide residues were also found in individual samples of coriander (8), and curry leaves (7), as well as goji berries.

No.	Product	Max ..	Sum	n	
1	Guavas	3	5	13	85%
2	Goji berries	8	14	136	55%
3	Liver (swine)	1	1	67	48%
4	Vegetables	1	2	61	43%
5	Breadfruits	2	2	12	42%
6	Cherimoyas	2	4	15	40%
7	Teas	8	25	897	37%
8	Passionfruits	3	9	119	29%
9	Peas (with pods)	3	7	581	29%
10	Peppercorn (black, gr..	3	4	42	29%
11	Pitahaya	3	3	219	27%
12	Laurel/bay leave	4	6	31	26%
13	Coriander leaves	8	12	52	25%
14	Fruits and tree nuts	1	2	92	25%
15	Tissues (other farmed..	4	4	74	24%
16	Products of animal ori..	1	4	1,145	24%
17	Yardlong beans	3	12	168	24%
18	Milk (sheep)	1	2	17	24%
19	Basil and edible flowe..	3	12	115	23%
20	Chili peppers	6	23	415	22%
21	Swine Tissues	1	1	213	22%
22	Herbs and edible flow..	2	2	14	21%
23	Infant formulae	1	3	172	20%
24	Maté	1	1	31	19%
25	Curry leaves	7	10	26	19%
26	Pumpkin seeds	3	6	172	19%
27	Follow-on formulae	1	2	147	19%
28	Cassava roots/manioc	1	3	245	18%
29	Sesame seeds	2	6	39	18%
30	Animal tissues	5	8	201	17%

Figure 7. Top 30 products, where PIC-list pesticide residues were most often detected (n: sample size, max: total number of PIC-pesticides detected in all samples, max: maximum number of PIC pesticides detected in a single sample

- Residues of PIC pesticides were most often detected in food coming from outside Europe. Approximately 40% of the few food samples imported from Laos, Malaysia and Iran had PIC pesticides, with 10, 7 and 11 different PIC pesticide detected in their products [Figure 8].
- About 30% of all food imported from China and Vietnam had PIC pesticide residues. The 1179 food samples imported from China had about 31 PIC pesticides, and the 400 food samples from Vietnam had 14.
- Europe only appears at the 20th place with Czech Republic, and then Cyprus at 23th and Moldova at 30th place.

No.	Country of orig..	Max..	Sum	n	
1	Laos	4	10	16	44%
2	Malaysia	3	7	38	39%
3	Iran	5	11	39	38%
4	China	8	31	1,179	30%
5	Vietnam	6	14	400	28%
6	Suriname	3	6	58	24%
7	Kenya	3	10	373	24%
8	Bangladesh	4	5	36	22%
9	Japan	2	4	20	20%
10	Sri Lanka	2	5	92	20%
11	India	7	25	777	19%
12	Jordan	2	4	42	17%
13	Rwanda	1	2	12	17%
14	Dominican Rep..	4	12	492	16%
15	Uganda	2	4	226	16%
16	Thailand	6	23	456	16%
17	Guatemala	1	3	94	15%
18	Zimbabwe	1	4	60	13%
19	Unknown	8	44	10,043	13%
20	Czech Republic	2	3	423	12%
21	Brazil	3	14	798	12%
22	Guadeloupe	1	2	317	11%
23	Cyprus	3	8	373	11%
24	Mexico	3	6	197	11%
25	Peru	2	13	511	10%
26	Martinique	1	1	285	10%
27	Senegal	2	2	73	10%
28	South Korea	1	2	21	10%
29	Morocco	2	15	820	9%
30	Moldova	2	4	156	9%

Figure 8. Top 30 countries of origin where food with PIC-list pesticide residues was most often detected (n: sample size, max: total number of PIC-pesticides detected in all samples, max: maximum number of PIC pesticides detected in a single sample)

- European countries carried different analysis in their food products and selected different sample sizes. Hence, we decided to find the top products per country of origin.
- With this analysis it becomes evident that different types of samples, either from Europe or third countries, have a high percentage of the samples analysed with PICs.
- For example, PIC pesticides were detected in over 80% of certain animal products (fat, liver swine and milk) from Czech Republic, and in over 70% of apples, passionfruit and wine grapes from Brazil, Vietnam and Cyprus, respectively [Table 3].
- In chilli peppers from Vietnam and goji berries and teas from China, up to 11, 14 and 18 different PIC pesticides were detected. These are very high number of PICs that not only reveal bad agricultural practices at the country of origin but could be putting the health of European consumers at risk.

Table 3. Top 30 food samples analysed by Member States with most PIC-pesticide residues, together with the country of origin of the samples (n: sample size, max: total number of PIC-pesticides detected in all samples, max: maximum number of PIC

		max	sum	n	%
1	Liver (swine), unknown	1	1	32	100
2	Vegetables, UK	1	1	20	95
3	Fat (bovine) Czech Republic	2	2	16	88
4	Fat (sheep), Czech Republic	2	2	11	82
5	Milk Czech Republic	2	2	10	80
6	Chilli peppers, Vietnam	6	11	14	79
7	Apples, Brazil	2	2	31	77
8	Passionfruits, Vietnam	3	7	23	70
9	Pumpkin seeds, unknown	2	2	23	70
10	Wine grapes, Cyprus	1	1	10	70
11	Teas, Vietnam	4	6	12	67
12	Gojiberries, unknown	6	9	31	65
13	Table grapes, Iran	5	7	16	63
14	Teas, France	8	9	13	62
15	Fat (bovine), Slovakia	2	2	15	60
16	Rice, Brazil	2	2	10	60
17	Apples, China	1	1	10	60
18	Peas (wth pods) Uknown	2	2	135	57
19	Aubergines, Suriname	3	3	11	55
20	Beans (dry), Brazil	2	4	15	53
21	Infant formulae, unknown	1	1	59	51
22	Peppercorns, Vietnam	1	2	12	50
23	Fat (bovine), Cyprus	1	1	12	50
24	Rice, India	4	8	136	50
25	Gojiberries, China	8	14	97	49
26	Fat (swine), unknown	1	2	55	49
27	Milk, UK	1	2	35	49
28	Teas, China	6	18	473	48
29	Mangoes, Thailand	2	2	15	47
30	Fruits and tree nuts, UK	1	1	38	45

5 PIC-LIST PESTICIDES IN FOOD - *IN FOCUS*

Since the analysis by Member States is not homogenous i.e. neither the number of samples and type nor the pesticides analysed are the same, it is important to examine in focus where these pesticides have been detected.

5.1 PIC RESIDUES IN PLANT-BASED IMPORTED FOOD

- By examining imported food in detail, we see that a much higher % of certain foods contain PIC pesticides. For example, 41.5% of imported tea samples contain at least one or more PIC-pesticide residues. 24 PIC pesticides were detected in imported tea samples in total, and the maximum number of PIC pesticides in one tea sample was 6 [Figure 9].
- Spices, Fungi and herbs are also high on the list, and samples of spices and herbs were found to contain up to 6 and 7 PIC pesticides in a single sample.
- For fruits, although a smaller % of all samples tested contained PIC pesticide residues, it was where the most PIC pesticides were detected (42 in total) and where the sample with highest number of PIC was found (8 different PICs in one sample).

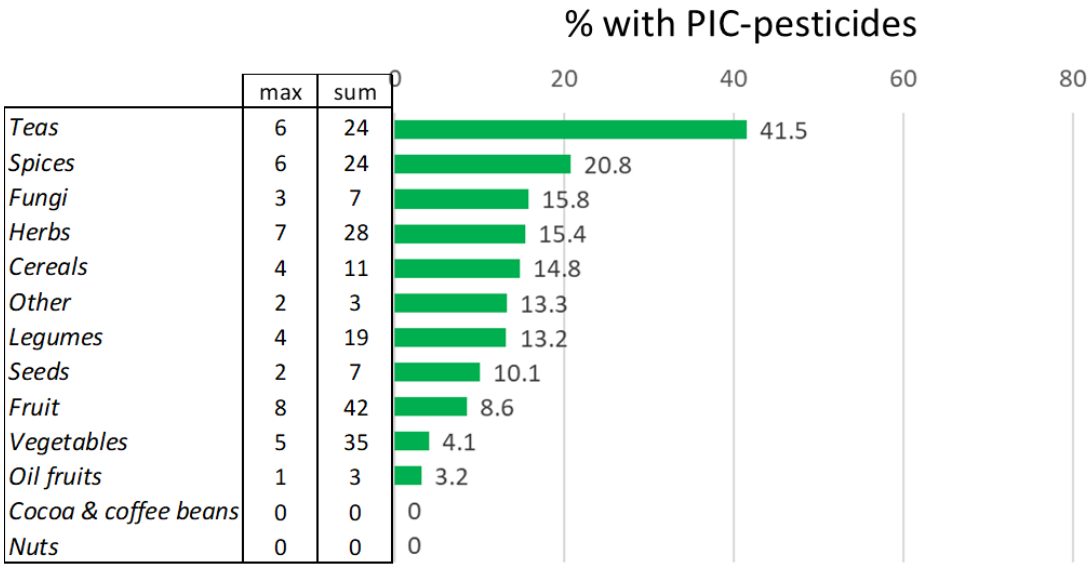
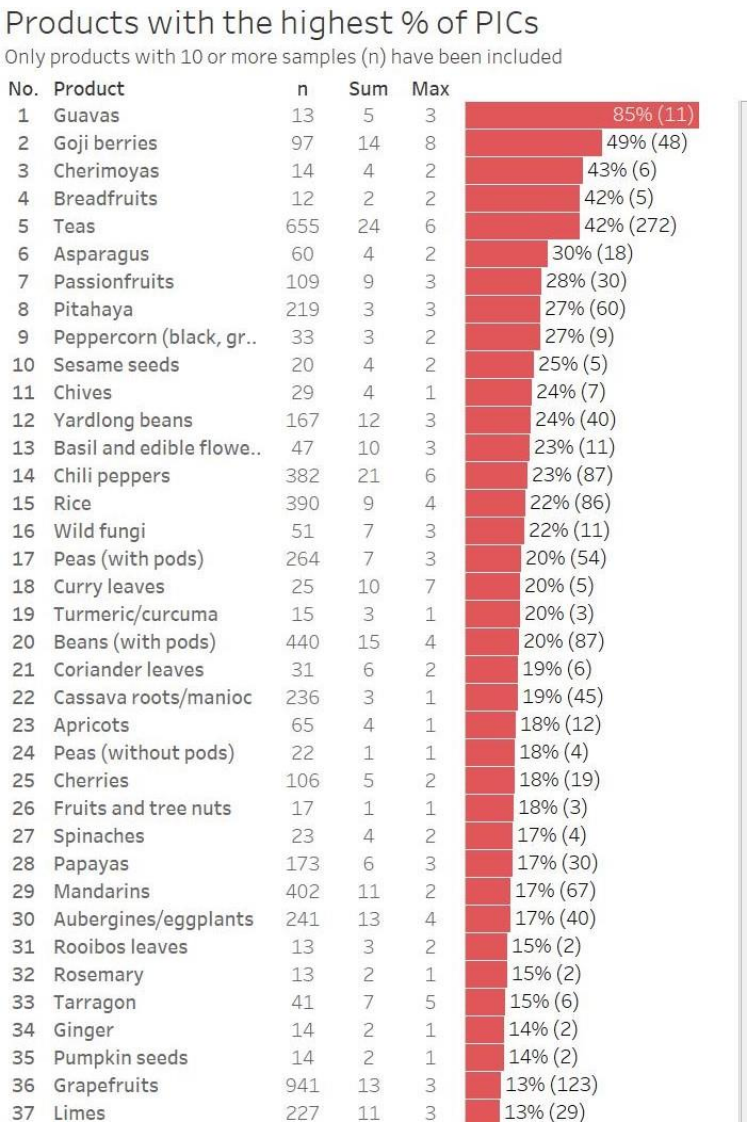


Figure 9. PIC pesticide residues in imported food (max refers to maximum number of PIC pesticides detected in a single sample; sum refers to the total number of PIC-pesticides detected in all samples of each food category).

- By examining the different samples separately, we see that certain imported food items have high % of PIC pesticide residues. For example, 85% of the guava samples had at least one or more PIC pesticide residues. Over 40% of goji berries, cherimoyas and breadfruits had PIC pesticide residues, whereas for asparagus, passion fruits and pitayas this was 30%. The top 37 foods that were most often found with PICs is shown in Figure 10.



No.	Product	n	Sum	Max	
1	Guavas	13	5	3	85% (11)
2	Goji berries	97	14	8	49% (48)
3	Cherimoyas	14	4	2	43% (6)
4	Breadfruits	12	2	2	42% (5)
5	Teas	655	24	6	42% (272)
6	Asparagus	60	4	2	30% (18)
7	Passionfruits	109	9	3	28% (30)
8	Pitahaya	219	3	3	27% (60)
9	Peppercorn (black, gr..	33	3	2	27% (9)
10	Sesame seeds	20	4	2	25% (5)
11	Chives	29	4	1	24% (7)
12	Yardlong beans	167	12	3	24% (40)
13	Basil and edible flowe..	47	10	3	23% (11)
14	Chili peppers	382	21	6	23% (87)
15	Rice	390	9	4	22% (86)
16	Wild fungi	51	7	3	22% (11)
17	Peas (with pods)	264	7	3	20% (54)
18	Curry leaves	25	10	7	20% (5)
19	Turmeric/curcuma	15	3	1	20% (3)
20	Beans (with pods)	440	15	4	20% (87)
21	Coriander leaves	31	6	2	19% (6)
22	Cassava roots/manioc	236	3	1	19% (45)
23	Apricots	65	4	1	18% (12)
24	Peas (without pods)	22	1	1	18% (4)
25	Cherries	106	5	2	18% (19)
26	Fruits and tree nuts	17	1	1	18% (3)
27	Spinaches	23	4	2	17% (4)
28	Papayas	173	6	3	17% (30)
29	Mandarins	402	11	2	17% (67)
30	Aubergines/eggplants	241	13	4	17% (40)
31	Rooibos leaves	13	3	2	15% (2)
32	Rosemary	13	2	1	15% (2)
33	Tarragon	41	7	5	15% (6)
34	Ginger	14	2	1	14% (2)
35	Pumpkin seeds	14	2	1	14% (2)
36	Grapefruits	941	13	3	13% (123)
37	Limes	227	11	3	13% (29)

Figure 10. Imported food products with highest percentage of PIC pesticide residues. (n: total number of samples in the analysis, sum: total number of PICs pesticides detected in all samples of this food category, max: total number of PIC pesticide residues in a single sample).

- Malaysia, Laos and Iran, were on the top of the list of countries producing plan-based food with most PIC pesticide residues (47, 44 and 38%, respectively), but only few samples were tested [Figure 11].
- China, is next on the list with 31% of samples containing PIC-list pesticides and where the highest number of PIC pesticide residues (30 PICs in total).
- Other countries were a high number of PIC pesticide residues were found in their products were India (25 PICs), Thailand (23 PICs), Vietnam (14 PICs), Brazil (13), Morocco (12), Dominican Republic (12) and Peru (12).
- The countries from where a single sample contained the most different PIC pesticide residues were China (8 different PICs), India (7), Vietnam (6), Thailand (6)

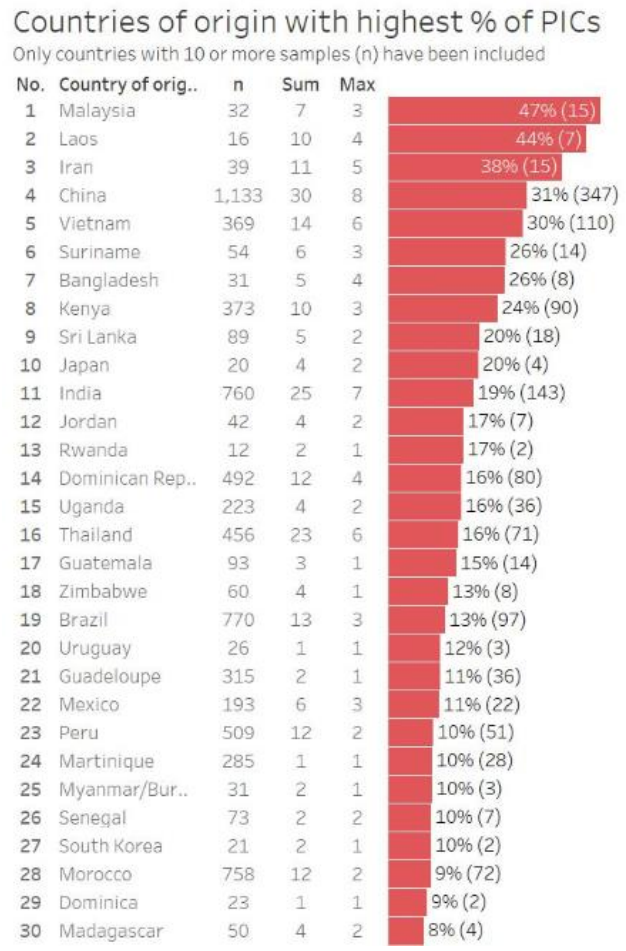


Figure 11. Top 30 countries of origin where plant-based food with PIC-list pesticide residues were most often detected (n: sample size, max: total number of PIC-pesticides detected in all samples, max: maximum number of PIC pesticides detected in a single sample)

- These products enter Europe and are sold in the EU market. Following an analysis of imported food with pesticide residues from the PIC list, we found the top 30 product-country combinations [Figure 12].
- Over 60% of the imported teas that were tested in Poland and Belgium had PIC-pesticide residues, and 5 and 6 different PIC residues were texted in a single sample, respectively. About 50% of imported teas tested in Spain and France also had PIC pesticide residues, with all teas from France containing 19 different PIC pesticides in total.
- Over half of the goji berries sold in the Netherlands and Germany had PIC pesticide residues, and between 38-53% of imported rice in Austria, Portugal and Greece.
- Evidently, these pesticides enter the European market via imported food.

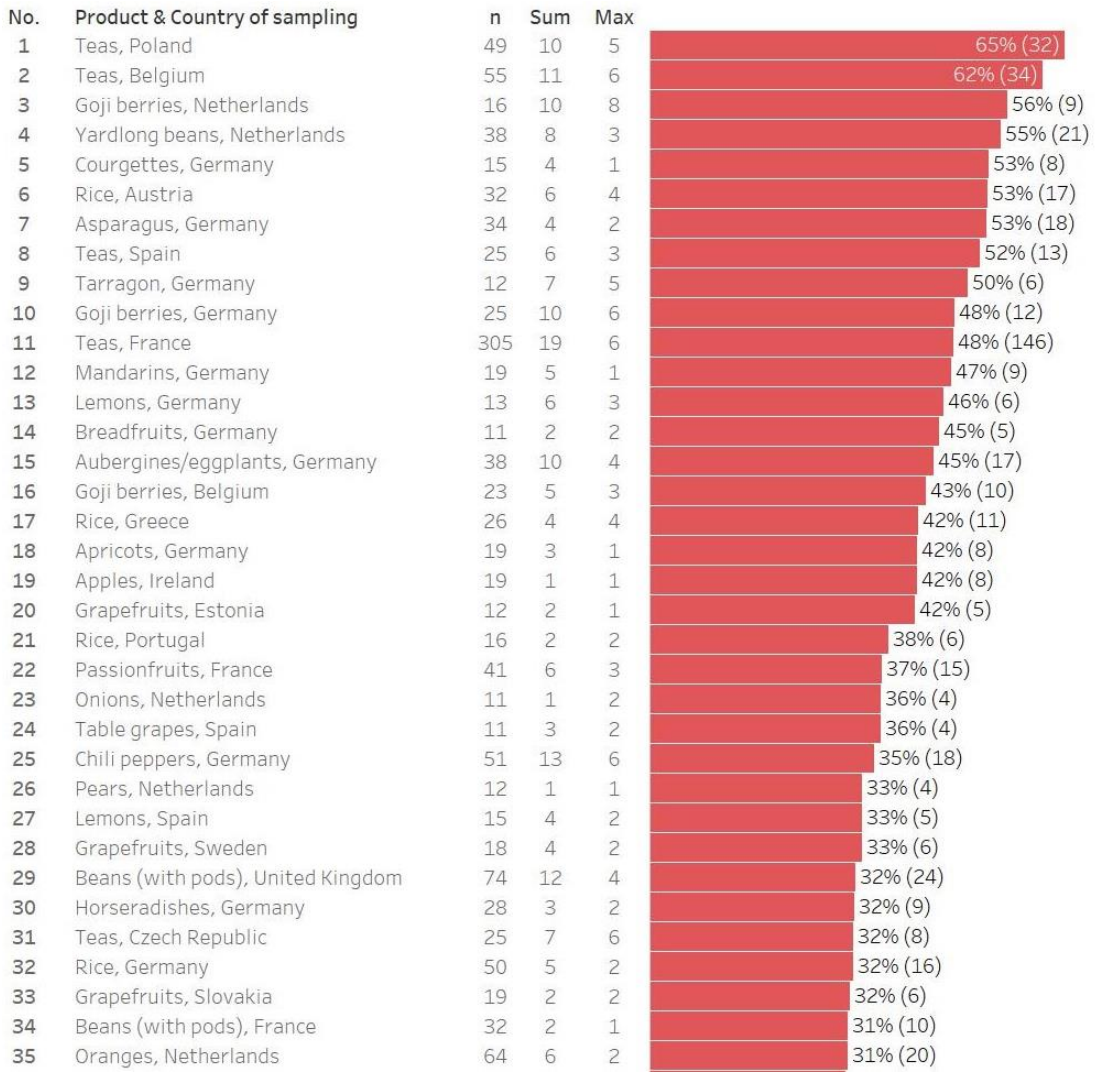


Figure 12. Country of destination of food imports with highest % of PIC pesticide residues (n: total number of samples in the analysis, sum: total number of PICs pesticides detected in all samples of this food category, max: total number of PIC pesticide residues in a single sample)

5.2 FOOD PRODUCED IN EUROPE- ANIMAL PRODUCTS

- In Europe, 7.1% of the animal products produced had PIC-list pesticides. When we look in focus in specific foods, we can see that highly hazardous organochlorine pesticides such as DDT, HCB and chlordecone were detected in significant numbers of samples tested [Figure 13].
- By examining the top 10 animal-based products from Europe that most often contained PIC-list pesticides, we see that 44% of milk tested had chlorates, 39% of animal tissues (non-poultry) had DDT, 36% of products of animal origin (non-specified) contained chlordecone (POP and suspected carcinogen) and 18% of animal tissues had hexachlorobenzene (HCB), a very toxic (carcinogenic, toxic to organs and very toxic to aquatic life) persistent compound (POP).

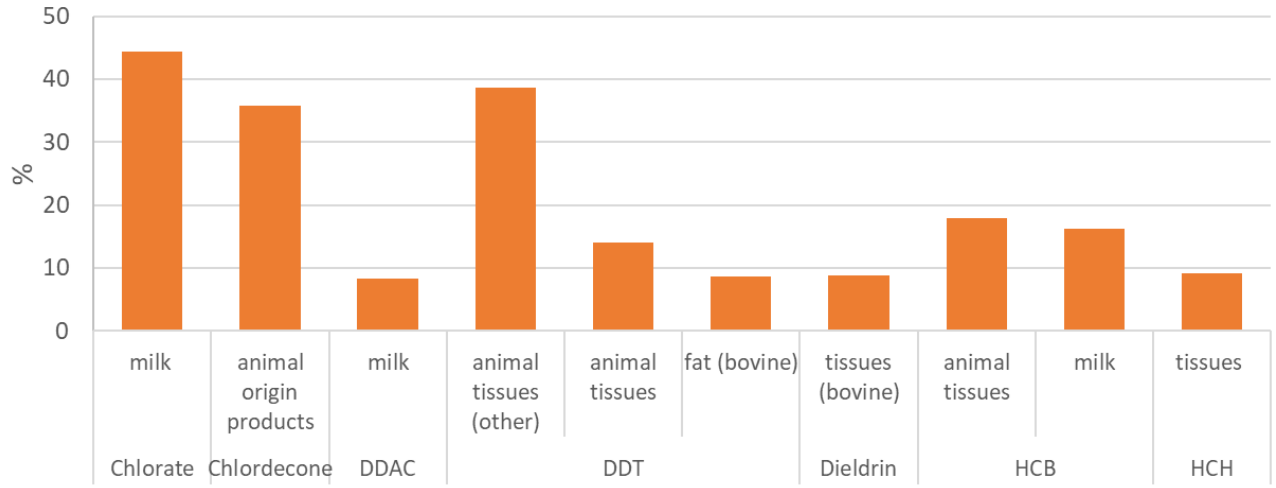


Figure 13. Percentage of animal products produced in Europe with PIC-list hazardous pesticides

- The ranking of European countries that had animal-based products with the highest % of PIC list pesticides is given in Figure 14. Czech Republic, Slovakia, Cyprus, Croatia and France are on the top of the list.
- The animal-based products where most PIC-pesticide residues were detected were from Germany (11 PICs in total).
- Simlarly, the countries that consume animal-based products with highest % of PIC-residues are Czech Republic, Slovakia, France, Cyprus, Croatia, Germany and UK. [Figure 15].

No.	Country of orig..	n	Sum	Max	
1	Czech Republic	118	2	2	35% (41)
2	Slovakia	31	2	2	32% (10)
3	Cyprus	26	1	1	23% (6)
4	Croatia	59	3	2	19% (11)
5	France	338	3	1	19% (63)
6	Germany	1,578	11	5	13% (203)
7	Latvia	21	2	1	10% (2)
8	Greece	46	2	1	9% (4)
9	Netherlands	42	3	2	7% (3)
10	Romania	35	1	1	6% (2)
11	Belgium	37	2	1	5% (2)
12	United Kingdom	648	4	1	5% (32)
13	Hungary	64	2	1	5% (3)
14	Lithuania	225	1	1	4% (10)
15	Norway	39	1	1	3% (1)
16	Ireland	449	5	1	2% (9)
17	Spain	390	2	1	1% (5)
18	Italy	1,007	3	2	1% (11)
19	Denmark	222	1	1	1% (2)
20	Poland	232	1	1	1% (2)
21	Austria	106	0	0	0% (0)
22	Bulgaria	14	0	0	0% (0)
23	Estonia	24	0	0	0% (0)
24	Iceland	67	0	0	0% (0)
25	Luxembourg	18	0	0	0% (0)
26	Malta	24	0	0	0% (0)
27	Portugal	38	0	0	0% (0)
28	Slovenia	37	0	0	0% (0)
29	Sweden	30	0	0	0% (0)

Figure 14. Countries of origin of animal-based products with highest % on PIC-list pesticides (sum: total number of PIC-list pesticide residues detected in all samples, max: maximum number of PIC-list pesticides detected in one sample)

No.	Country of sampling	n	Sum	Max	
1	Czech Republic	118	2	2	35% (41)
2	Slovakia	32	3	2	34% (11)
3	France	180	1	1	32% (57)
4	Cyprus	25	1	1	24% (6)
5	Croatia	59	3	2	19% (11)
6	Germany	1,767	12	5	12% (213)
7	United Kingdom	761	4	2	7% (53)
8	Latvia	30	2	1	7% (2)
9	Romania	39	1	1	5% (2)
10	Lithuania	219	1	1	5% (10)
11	Belgium	24	1	1	4% (1)
12	Norway	35	1	1	3% (1)
13	Ireland	410	3	1	2% (7)
14	Hungary	59	1	1	2% (1)
15	Spain	379	2	1	1% (5)
16	Italy	1,042	1	1	0% (1)

Figure 15. Countries of consumption (food in the market) of animal-based products with highest % on PIC-list pesticides (sum: total number of PIC-list pesticide residues detected in all samples, max: maximum number of PIC-list pesticides detected in one sample)

6 INDIVIDUAL PIC-LIST PESTICIDES IN FOCUS (PLANT-BASED FOOD)

6.1 CARBENDAZIM

Name	carbendazim
Status	Not approved – approval expired in November 2014
Toxicity	Mutagenic (1B), Toxic to reproduction (1B), Acutely toxic to aquatic life
Details	Carbendazim is a systemic and broad-spectrum fungicide used in Europe until 2015 against fungi developed in cereals and fruit. It was also used in green areas such as golf courses and tennis yards.
Are residues allowed in EU food (MRLs>LOD)?	**YES:** citrus, pome and stone fruit, grapes, mangoes, papayas, tomatoes, Brussel sprouts, beans, peas, oats, barley and honey
Why?	Due to the accumulated evidence on the high toxicity of carbendazim, its approval was not renewed in November 2014. Since it is highly toxic to humans (mutagenic and toxic to reproduction), according to the EU pesticides law (1107/2009), detectable residues in food are not allowed. However, the European Commission decided not to set the legal limits MRL below the limit of detection. This is because, although the use of carbendazim was banned in 2014 in Europe, its parent compound thiopheneate-methyl, which is metabolised to toxic carbendazim was not banned. Therefore, since residues could be present in food due to use of thiopheneate-methyl, the MRLs were not set below the limit of detection. In this way, not only consumers are exposed to this toxic chemical via their food but third countries may freely use it putting workers, the local community and environment at great risk and Europe indirectly approves these practices by importing their food products.

- Out of the 1596 samples with detectable carbendazim residues, 54% were from third countries and 40% were from EU (including EEA countries) [Figure 16, A].
- To take this into perspective, fenhexamid, another fungicide substance that is authorised across the EU was detected in 1333 samples (1.8%) and fenpyrazamine, another authorised fungicide substance in just 132 samples (0.4%). Carbendazim, although it has been banned for being highly toxic appears to be in the upper rank of fungicide residues in food (2.3% of all samples) [EFSA,2020].
- 133 were apples, 100 lemons, 92 tomatoes, 64 pears, 60 peas and 56 teas. Residues were found in a variety of products [Annex I.1]
- Some of the food samples from EU that carbendazim residues were most often detected were wine grapes from Cyprus (70%), grape leaves from Bulgaria (45%), pears from Greece (41%), peas (29%) and beans (25%) from Belgium among others [Figure 15, B1].
- In general, a higher percentage of samples of imported food that were tested contained carbendazim. Some of the imported food samples that carbendazim was most often detected were: apples from Brazil (80%), chili peppers (69%), peppercorns (50%) and passion fruits (45%) from Vietnam, pears from Turkey (45%) and mangoes from Thailand (40%) among others [Figure 15, B2].

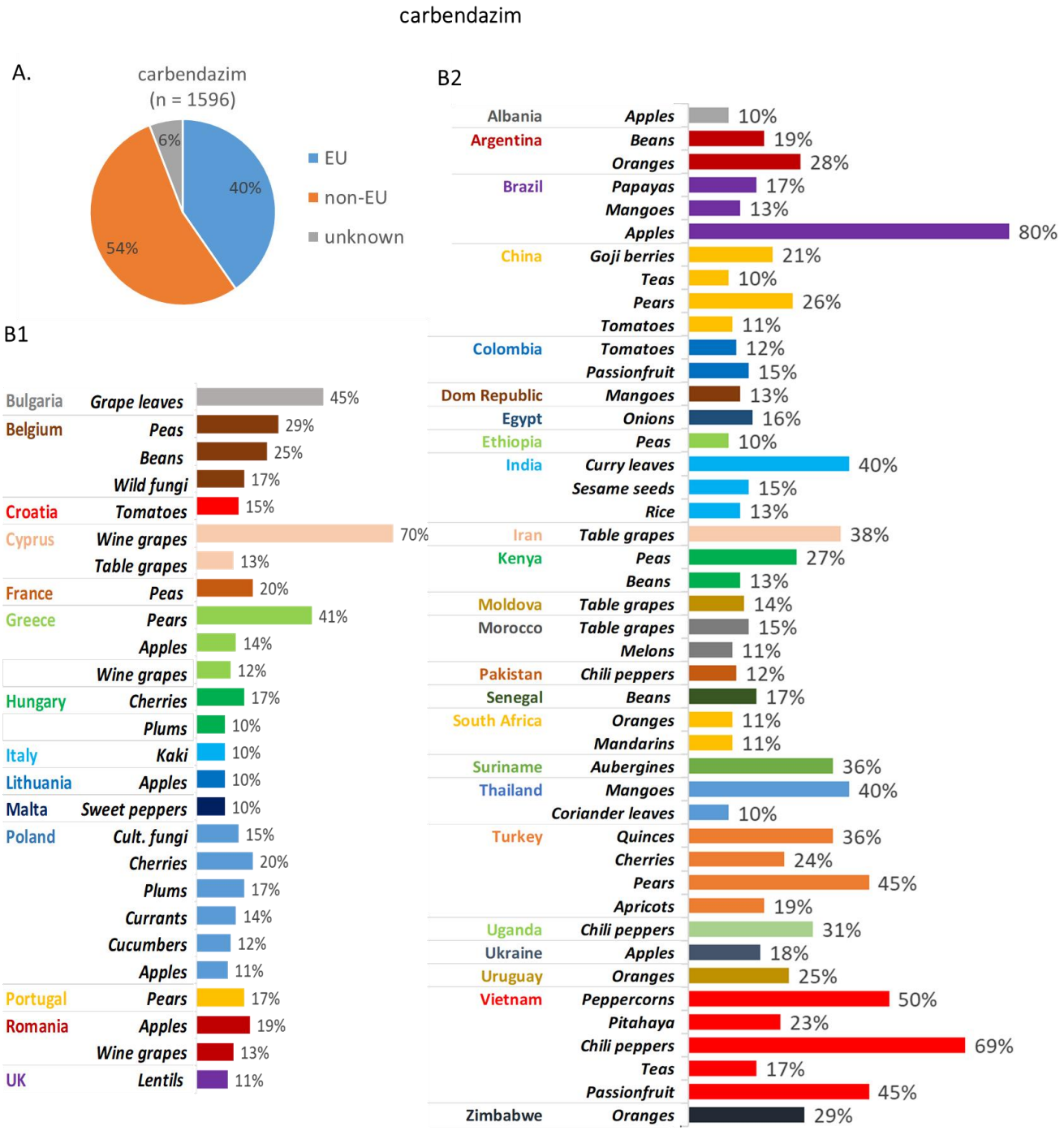


Figure 16. Carbendazim detected in food sold in EU market A. Percentage of samples in relation to their origin. B1. Percentage of plant-based EU food samples taken with carbendazim residues B2. Percentage of plant-based imported food samples taken with carbendazim residues (only samples that contain over 10% of residues of are shown)

6.2 CHLORATE

Name	Chlorate
Status	Banned in 2009
Toxicity	Sodium chlorate: Acute toxicity (class 4), chronic toxicity to aquatic life (2), suspected carcinogen (class 2)
Details	Chlorates are the inorganic salts of chloric acid, used as herbicides in agriculture, on various crops. Chlorate is also a by-product of chlorine solutions (chlorine dioxide, chlorite and hypochlorite salts) used as sanitising and disinfection agents in the food industry and as biocides.
Are residues allowed in EU food (MRLs>LOD)?	**Yes**, in most products.
Further information	At first the MRL was set below the limit of detection (0.01 mg/kg) but due to residues present in drinking water and disinfectants used in food industry, the levels were adjusted based on the occurrence data. It is assumed that chlorates are no longer used in agriculture.

- Chlorate was detected in 1115 food samples, 62% of these were produced in EU and 15% in non-EU countries [Figure 17 A].
- 205 of these were from Germany, 160 from Spain, 97 from UK, 66 from Italy, 55 from Netherlands and smaller numbers from other European countries. From outside the EU, 28 were from Turkey, 22 from Morocco, 21 from Peru, and less samples were found with chlorate residues from other countries [Annex I.2].
- Peas, lettuces, sweet peppers, aubergines, parsley and strawberries were some of the plant-based products that chlorates were detected [Annex I.2].
- By looking into the different food samples where chlorate was detected, we see that high % of food samples with chlorates, were vegetables (unspecified) from UK (100%), asparagus from Peru (90%) and Mexico (64%), lettuces from Spain (67%) and Germany (63%) and escaroles from Germany (57%) among others [Figure 17B].

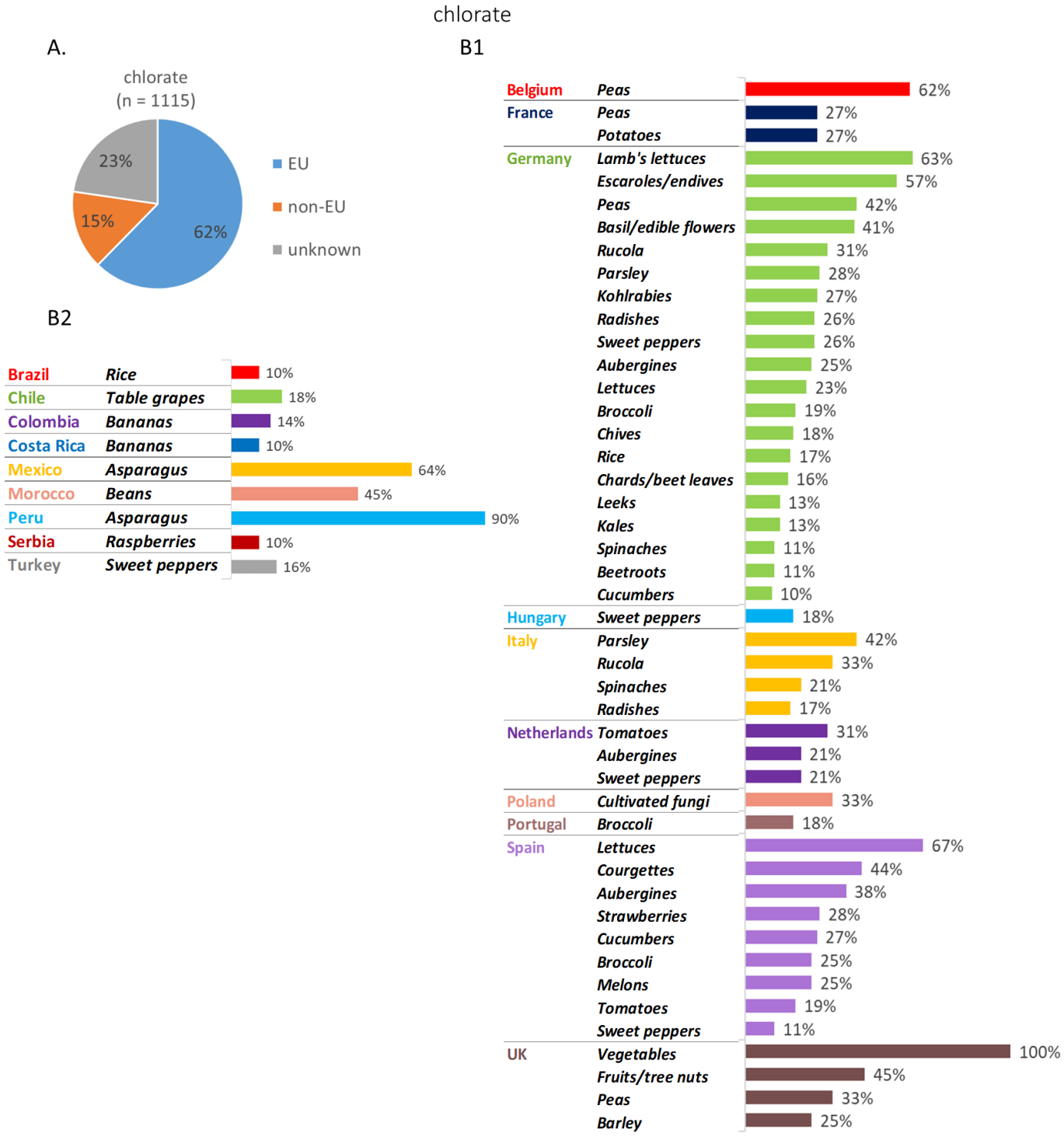


Figure 17. Chlorate detected in food sold in EU market A. Percentage of samples in relation to their origin. B1. Percentage of plant-based EU food samples taken with chlorate residues B2. Percentage of plant-based imported food samples taken with chlorate residues (only samples that contain over 10% of residues of are shown)

6.3 CHLORDECONE

Name	Chlordecone
Status	Banned
Toxicity	POP, acute toxicity, suspected carcinogen (classification Cat. 2), suspected toxic for reproduction, acute toxicity and chronic toxicity to aquatic life.
Details	Chlordecone is an organochlorine insecticide substance, highly toxic which is prohibited in the western world. It is a Persistent Organic Pollutant (POP), which is why is mainly detected in animal products.
Are residues allowed in EU food (MRLs>LOD)?	**Yes**, for most food products.
Further information	Being a POP, it remains in the environment, and it is common that animal products are contaminated with this chemical. Low residues are also allowed in a variety of plant-based products, although detectable residues are only found in non-western countries were this chemical is still being used (or has been used heavily in the past).

- Chlordecone was detected in 928 samples but 87% was of unknown origin. It was mainly found in animal products (864 samples), which are analysed in previous chapter [Figure 18A].
- Nevertheless, it was also detected in 59 plant-based products from Martinique and Guadalupe, which are French overseas territories, above the legal limits (according to EFSA). The samples that were most often contaminated with chlordecone were manioc from Guadeloupe (52%), and manioc (25%), pumpkins (20%) and cucumbers (19%) from Martinique [Figure 18B].

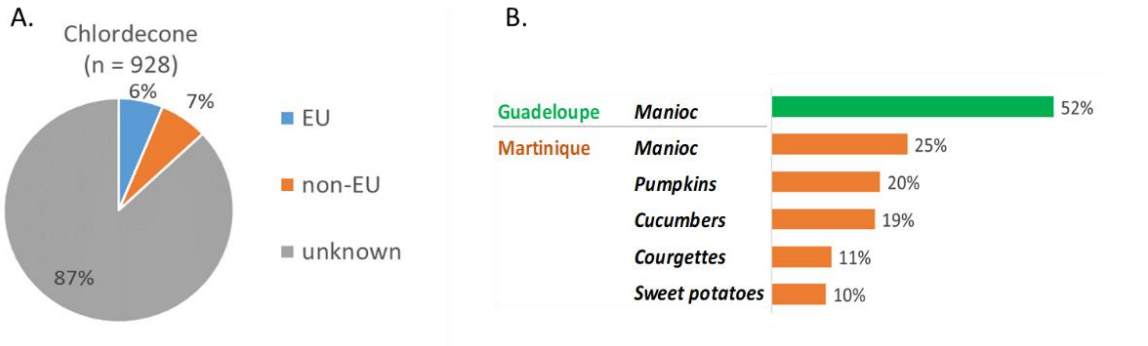


Figure 18. Chlordecone detected in food sold in EU market A. Percentage of samples in relation to their origin. B. Percentage of plant-based food samples taken with chlordecone residues from the different countries (only those with more than 10% residues are shown)

6.4 CHLORFENAPYR

Name	Chlorfenapyr
Status	Banned in 2001.
Toxicity	Acute Toxicity (classification 3 and 4), acute and chronic toxicity to aquatic life, highly toxic to bees, suspected carcinogen.
Details	Chlorfenapyr is a broad spectrum pyrrole insecticide and acaricide. It has a long-lasting action (20-35 days).
Are residues allowed in EU food (MRLs>LOD)?	**No**. Exception: tea (MRL=50 mg/kg) possibly following an import tolerance request.
Further information	Chlorfenapyr is highly toxic not only to all insect, including bees but also to birds and aquatic life.

- Chlorfenapyr was detected in 318 samples, in total. 24% of these were produced in Europe (including EEA countries) and 73% were imported [Figure 19A].
- 150 were teas, 68 tomatoes, 22 chilli peppers, 5 aubergines, and a smaller number of a variety of food products [Annex I.3].
- 146 came from China, 31 from Greece, 18 from Italy, 15 from Dominican Republic, 1 from Vietnam, 10 from Albania and a smaller number of samples with chlorfenapyr were from a variety of other countries across the globe [Annex I.3].
- By looking into the different food samples tested in which chlorfenapyr was detected, we see that the highest % of food samples with chlorfenapyr were: teas (58%) and chili peppers (55%) from Vietnam, teas from China (32%), aubergines from Suriname (27%), strawberries from Cyprus (23%) and chilli peppers from Pakistan (23%) [Figue 19B].
- According to EFSA, with the exception of tea products, the residue levels of chlorfenapyr in food exceed the legal limits indicating illegal use of this pesticide product.

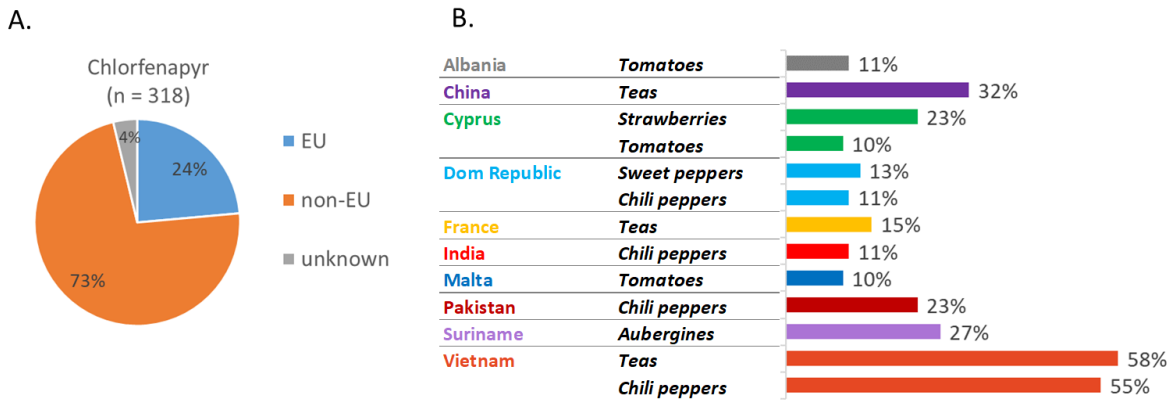


Figure 19. Chlorfenapyr detected in food sold in EU market A. Percentage of samples in relation to their origin. B. Percentage of plant-based food samples taken with chlorfenapyr residues from the different countries (only those with more than 10% residues are shown)

6.5 MALATHION

Name	Malathion
Status	Severely restricted, only use as an insecticide in greenhouses with a permanent structure may be authorised. It is now authorised only in 5 EU countries (EL, ES, PL, RO, SK).
Toxicity	Acute toxicity (class 4), probable carcinogen (IARC, WHO), acute and chronic toxicity to aquatic life, highly toxic to bees, suspected toxic for reproduction, developmental neurotoxicity (reported in academic literature).
Details	Malathion is an organophosphate insecticide, widely used in agriculture and public areas. Due to its toxicity it's now used only in greenhouses in Europe.
Are residues allowed in EU food (MRLs>LOD)?	**Yes** : citrus fruit, lettuce, cereals, teas and chamomile.
Further information	The high toxicity of malathion to the environment has been clearly demonstrated and scientific evidence indicate that this substance is also toxic to humans (it is a probable carcinogen and can cause developmental toxicity and neurotoxicity). In EU 2007 malathion was excluded from use as pesticide and was re-authorised in 2010 for use under specific conditions (mitigation measures for operators and the environment). In 2018 applications of malathion were restricted to permanent greenhouses. Since residues are permitted in food, Europe can import food from third countries where it is used without restrictions.

- In total, 201 samples had detectable residues of malathion. 12% were from EU (including EEA countries) and 86% were from third countries [Figure 20A].
- 50 were lemons, 35 mandarins, 25 oranges, 24 sweet peppers, 13 rice, 10 grapefruits and a smaller number of other plant-based food products [Annex I.4].
- Out of these 94 were from Turkey, 15 from India, 15 from South Africa, 14 from Morocco, 11 from Italy and a smaller number from a variety of other countries [Annex I.4].
- By looking into the different food samples tested in which malathion was detected, we see that the highest % of food with dimethoate was: sesame seeds from India (23%), wheat from Canada (18%), mandarins from Morocco (12%), wheat from USA (12%) and in smaller percentage of other samples (less than 9%) [Figure 20B].

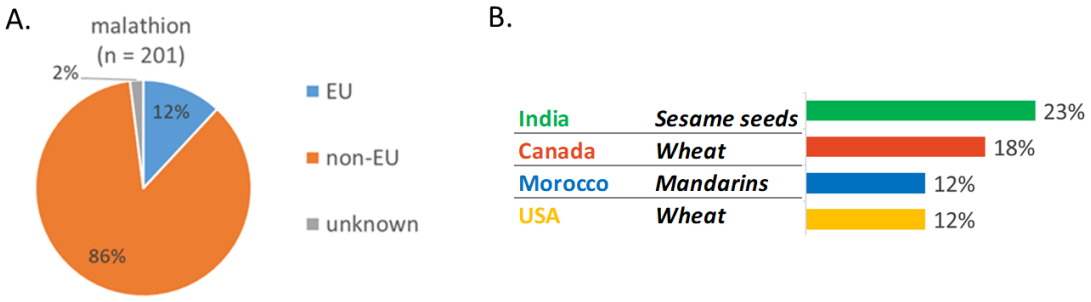


Figure 20. Malathion detected in food sold in EU market A. Percentage of samples in relation to their origin. B. Percentage of plant-based food samples taken with malathion residues from the different countries (only those with more than 10% residues are shown)

6.6 OMETHOATE

Name	Omethoate
Status	Banned, withdrawal of authorisations in 2002, does not meet the approval criteria.
Toxicity	Acute Toxicity (classification 3 and 4), acute toxicity to aquatic life, highly toxic to bees, suspected carcinogen, suspected mutagen.
Details	Omethoate is a systemic organophosphorous insecticide and acaricide. It was used on several field grown agricultural crops (e.g. leaf greens, citrus, and melons), tree crops, and ornamentals.
Are residues allowed in EU food (MRLs>LOD)?	**Yes:** cherries, olives and green onions. Other MRLs have been set to 0.02 mg/kg instead of 0.01 mg/kg (detection limit) due to data gaps.
Further information	Omethoate is the metabolite of the organophosphorus pesticide dimethoate, which was not banned in 2002 as omethoate but only much later in 2019. Therefore, even though omethoate was banned due to its high toxicity, residues were still permitted in food. MRLs were lowered in 2018 close to the limit of detection (0.01 mg/kg) but as mentioned above there are some exceptions.

- In total, omethoate was detected in 169 plant-based products. 56% of these were produced in the EU and 40% were imported [Figure 21A].
- 24 of these were cherries, 9 aubergines and 9 tomatoes, and smaller numbers of a variety of fruit and vegetables [Annex I.5].
- The EU products that contained omethoate came from across Europe, with Germany, Italy, Greece, Poland and Belgium on the top of the list. A smaller number of imported food contained omethoate, and this was produced in different countries across the globe. Most food came from the Dominican Republic, Thailand, Uganda, India and Morocco. From the other countries just 2 or one samples had omethoate residues [Annex I.5].
- By looking into the different food samples tested in which omethoate was detected, we see that the highest % of food with dimethoate was: beans from India (19%), mangoes from Thailand (13.3%), cherries from Belgium (12.9%), courgettes from Morocco (12.5%) [Figure 21B].
- According to EFSA report, many of these residue levels exceeded the legal MRLs.

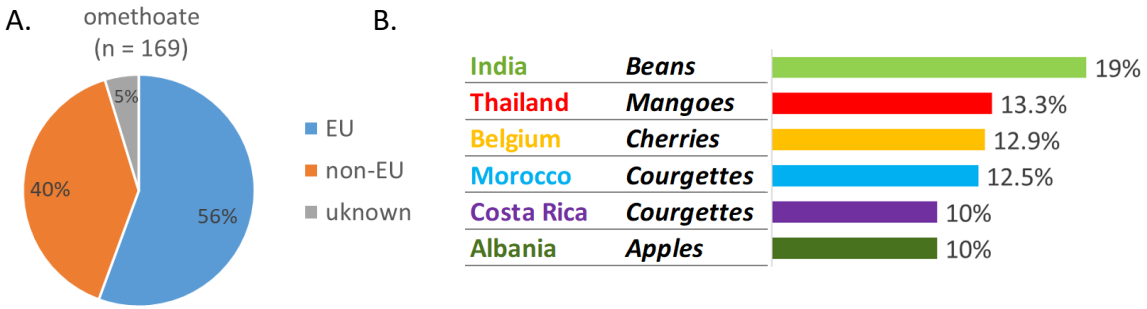


Figure 21. Omethoate detected in food sold in EU market A. Percentage of samples in relation to their origin. B. Percentage of plant-based food samples taken with omethoate residues from the different countries (only those with more than 10% residues are shown)

6.7 ANTHRAQUINONE

Name	Anthraquinone
Status	Banned in 2008
Toxicity	Carcinogenic (Cat 1b), acute toxicity (cat 4), acute toxicity to aquatic life, toxic to birds.
Details	Anthraquinone is an insecticide substance.
Are residues allowed in EU food (MRLs>LOD)?	**No**, MRLs are set at the detection limit.
Further information	Anthraquinone was not approved in 2008, the application dossier had several data gaps to assess its safety and concerns were identified for operators, consumers, environmental contamination and toxicity to birds, aquatic and non-target organisms.

- Anthraquinone was detected in 169 samples in total. 20% were from EU (including EEA countries) and 73% were from third countries [Figure 22A].
- The majority (123) were teas, 5 were Goji berries from China, and the rest were wheat, oats and sweet peppers [Annex I.6].
- Out of these, 94 came from China, 10 from Germany, 9 from Sri Lanka, 7 from India and 6 from France [Annex I.6].
- By looking into the different food samples tested in which anthraquinone was detected, we see that the highest % of food with anthraquinone is teas: from France (50%), from Sri Lanka (26%) and from China (23%) [Figure 22B].

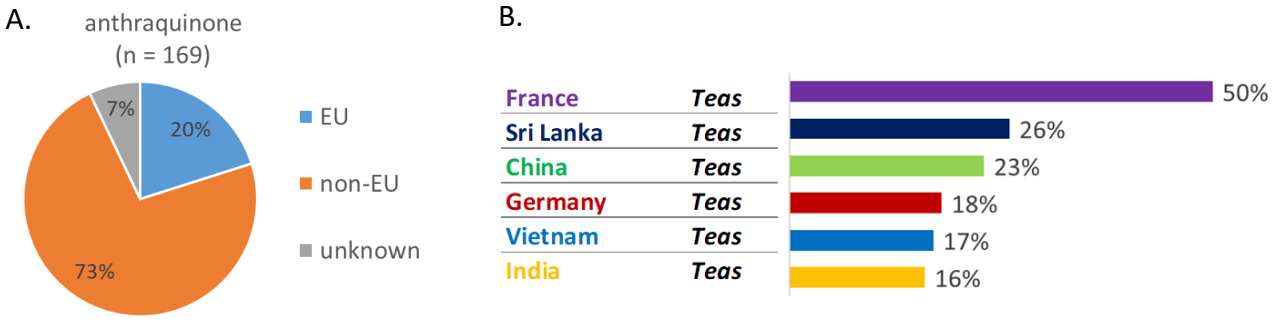


Figure 22. Anthraquinone detected in food sold in EU market A. Percentage of samples in relation to their origin. B. Percentage of plant-based food samples taken with anthraquinone residues from the different countries (only those with more than 10% residues are shown)

6.8 TRICYCLAZOLE

Name	Tricyclazole
Status	Banned in 2016
Toxicity	Acute toxicity (4), suspected carcinogen, suspected mutagen, suspected toxic to reproduction.
Details	Tricyclazole is a systemic fungicide, it is used mainly in rice crops.
Are residues allowed in EU food (MRLs>LOD)?	**No,** MRLs are set at the detection limit.
Further information	Several concerns were identified during the assessment of tricyclazole, among them it was not possible to set safe reference values based on the incomplete carcinogenicity and genotoxicity assessment by the applicant, therefore consumer risk assessment was not possible. This is of particular concern especially since ECHA has identified tricyclazole as a suspected mutagen, carcinogen and toxic to reproduction.

- Tricyclazole was detected in 142 samples. 20% were from produced in the EU, 60% in third countries and 20% were of unknown origin [Figure 23A].
- 93 were rice, 6 were chilli peppers and 3 were tea samples [Annex I.7].
- Out of these 60 were from India, 11 from Germany, 6 from Vietnam, 6 from Brazil, 5 from Thailand and smaller amounts were from other countries [Annex I.7].
- By looking into the different food samples tested in which tricyclazole was detected, we see that the highest % of food with tricyclazole is mainly rice and chili peppers: rice from Brazil (60%), chili peppers from Vietnam (50%), rice from India (48%), rice from Germany (18%), rice from Netherlands (14%), rice from Portugal (14%) [Figure 23B].

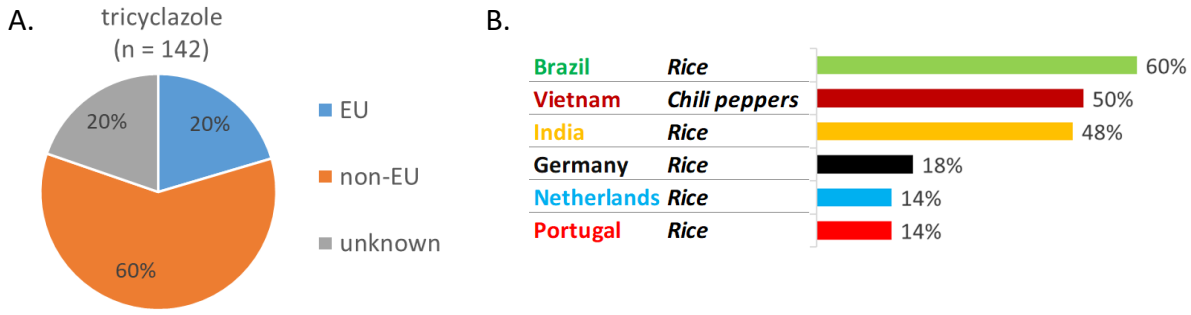


Figure 23. Tricyclazole detected in food sold in EU market A. Percentage of samples in relation to their origin. B. Percentage of plant-based food samples taken with tricyclazole residues from the different countries (only those with more than 10% residues are shown)

6.9 PROPARGITE

Name	Propargite
Status	Banned in 2011
Toxicity	Acute toxicity (3), probable carcinogen (Cat 2), acute and chronic toxicity to aquatic life.
Details	Propargite is an insecticide used to kill mites (acaricide). It is used in various fruits and vegetables.
Are residues allowed in EU food (MRLs>LOD)?	**Yes:** oranges (4mg/kg) and teas (10mg/kg) (import tolerances).
Further information	Several concerns were found during the assessment of propargite in 2001. These are the risk for consumers, operators, workers and bystanders, high long term risk for mammals, risk for secondary poisoning to birds, and high risk for aquatic life. In 2015 the legal limits for propargite residues in food were set at the limit of detection (LOD). Nevertheless, in 2018 EFSA partly approved Italy's application based on the request of Arysta LifeScience Great Britain Ltd to place an import tolerance for tea from India and oranges from Brazil. As a result, the MRL for these items increased to 10 and 4 mg/kg respectively. The application was for all citrus fruit but EFSA concluded that data was missing for such an extrapolation.

- In total, propargite was detected in 89 samples. About 15% were from Europe and 71% from third countries. 15% were of unknown origin [Figure 24A].
- 26 were goji berries, 18 teas, 8 tomatoes, 5 chili peppers and the rest were a smaller number of a variety of plant-based products [Annex I8].
- Out of these, 31 were from China, 12 of unknown origin, 8 from India, 6 from Egypt, 3 from Vietnam and a smaller number of samples from other EU and non-EU countries [Annex I8].
- By looking into the different food samples tested in which propargite was detected, we see that the highest % of food with residues was: Goji berries (20%) and tomatoes (14%) from China, chili peppers from Egypt (13%), teas (12%) and curry leaves (10%) from India [Figure 24B].

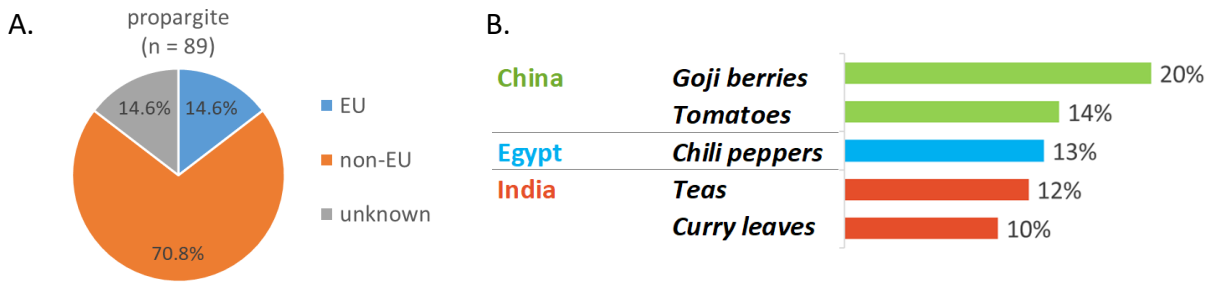


Figure 24. Propargite detected in food sold in EU market A. Percentage of samples in relation to their origin. B. Percentage of plant-based food samples taken with propargite residues from the different countries (only those with more than 10% residues are shown)

ANNEX I

1. Carbendazim

	EU	samples with carbendazim	non-EU	samples with carbendazim
top 5 - country of origin EU/non-EU	*Romania*	117	*Turkey*	173
	Greece	112	*China*	107
	Poland	106	*Vietnam*	79
	Italy	52	*Brazil*	64
	France	41	*Kenya*	64
top 10 food products	*Apples*	133	*Teas*	56
	Lemons	100	*mushrooms*	53
	Tomatoes	92	*Beans*	50
	Pears	64	*Cherries*	46
	Peas	60	*Chili peppers*	45

2. Chlorate

	EU	samples with chlorate	non-EU	samples with chlorate
top 5 - country of origin EU/non-EU	*Germany*	205	*Turkey*	28
	Spain	160	*Morocco*	22
	UK	97	*Peru*	21
	Italy	66	*Guatemala*	12
	Netherlands	55	*Mexico*	11
top 10 food products	*Peas*	42	*Parsley*	19
	Lettuces	37	*Broccoli*	19
	Sweet peppers	32	*Strawberries*	19
	Aubergines	28	*Fruits & tree nuts*	17
	Vegetables	19	*Rucola*	17

3. Chlorfenapyr

		samples with chlorpenapyr		samples with chlorpenapyr
top 10 - country of origin EU/non-EU	*China*	146	*Albania*	10
	Greece	31	*Pakistan*	5
	Italy	18	*South Africa*	5
	Dom Republic	15	*Spain*	5
	Vietnam	13	*Colombia*	4
top 10 food products	*Teas*	150	*Passionfruits*	3
	Tomatoes	68	*Horseradishes*	3
	Chili peppers	22	*Goji berries*	3
	Aubergines	5	*Yardlong beans*	3
	Strawberries	3	*Sweet peppers*	3

4. Malathion

		samples with malathion		samples with malathion
top 10 - country of origin EU/non-EU	*Turkey*	94	*Egypt*	7
	India	15	*Spain*	5
	South Africa	15	*Argentina*	2
	Morocco	14	*Brazil*	2
	Italy	11	*Canada*	2
top 10 food products	*Lemons*	50	*Grapefruits*	10
	Mandarins	35	*Wheat*	6
	Oranges	25	*Sesame seeds*	3
	Sweet peppers	24	*Granate apples*	3
	Rice	13	*Limes*	2

5. Omethoate

	EU	samples with omethoate	non-EU	samples with omethoate
top 5 - country of origin EU/non-EU	*Germany*	21	*Dom Republic*	5
	Italy	20	*Thailand*	5
	Greece	15	*Uganda*	5
	Poland	8	*India*	4
	Belgium	4	*Morocco*	4
top 10 food products	*Cherries*	24	*Chili peppers*	5
	Aubergines	9	*Mandarins*	5
	Tomatoes	9	*Beans*	4
	Plums	6	*Cucumbers*	4
	Table grapes	6	*Head cabbages*	4

6. Anthraquinone

		samples with anthraquinone		samples with anthraquinone
top 10 - country of origin EU/non-EU	*China*	94	*Vietnam*	2
	Germany	10	*Estonia*	1
	Sri Lanka	9	*Netherlands*	1
	India	7	*Poland*	1
	France	6	*Spain*	1
food products	*Teas*	123	*Apples*	1
	Wheat	1	*Oats*	1
	Goji berries	5	*Sweet peppers*	1

7. Tricyclazole

		samples with tricyclazole		samples with tricyclazole
country of origin EU/non-EU	*India*	60	*Italy*	3
	Germany	11	*Netherlands*	3
	Vietnam	6	*Portugal*	3
	Brazil	6	*China*	3
	Thailand	5	*Greece*	1
food products	*Rice*	93	*Teas*	3
	Chili peppers	6		

8. Propargite

		samples with propargite		samples with propargite
top 10 - country of origin EU/non-EU	*China*	31	*France*	2
	Unknown	12	*Germany*	2
	India	8	*Greece*	2
	Egypt	6	*Italy*	2
	Vietnam	3	*Poland*	2
top 10 food products	*Goji berries*	26	*Limes*	2
	Teas	18	*Peaches*	2
	Tomatoes	8	*Strawberries*	2
	Chili peppers	5	*Table grapes*	2
	Apples	3	*Beans*	1