EURL Residue Findings Report on a Pilot Monitoring Study in Honey

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Consolidated report by the EURL AO and EURL SRM

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Contents

1. Background information

Honey has been a staple food in human diet since the prehistoric times as it combines richness in calories and exceptional storage stability. Nowadays, between 250,000 and 300,000 tons of honey are produced every year in the European Union (EU). The EU countries with the largest honey production are Romania, Spain, Hungary, Germany, Italy, Greece, France and Poland. As the EU is not self-sufficient in honey, around 40 % of the required honey is imported from third countries. The main exporters of honey to the EU are Ukraine (UA), China (CN), Argentina (RA), Mexico (MX), Chile (CL), Cuba (CU) Vietnam (VN), and Turkey (TR). China is by far the global leader in both honey production and exports with India, Argentina, Ukraine, and Brasil following [1],[2].

A few years ago, honey was included in the MANCP[1]-WD by DG-SANTE ("Working document on pesticides to be considered for inclusion in the national control programmes" [3]. Within this framework, the need of selecting a suitable and reasonable scope of pesticides to be recommended to the EU-member states (EU-MS) arose. It was therefore decided to run a pilot monitoring study among the EURL-AO and the EURL-SRM to explore the current pesticide residue situation in honey with the help state-of-the-art sensitive and selective instrumentation, covering a very wide scope of compounds. To cover the most possibly broad scope, the routine labs of the respective hosting laboratories were also to be involved in the analysis.

While searching for nectar and pollen, honey bees often travel long distances and visit a variety of agricultural fields where plant protection products are being sprayed. As a result, a large number of pesticides present in the environment slowly accumulate in the bee-hive. For this reason, the pesticides residue profile in honey differs greatly from that of other commodities of animal origin and resembles more the scope of pesticides found in food of plant origin.

Beyond the pesticides inevitably collected by the bees from the fields, there are also residues resulting from the purposeful application of veterinary drugs in the bee hive [4]. A number of acaricides (miticides) are used against the so called varroa mite (*varroa destructor*), which is one of the most destructive mite-parasites affecting bee colonies [4]. Other compounds are used against the nosema desease (e.g. fumagillin) or against the wax moth (e.g. p-dichlorobenzene). Bacterial diseases (e.g. foulbrood) are treated with antibiotics, although their use is restricted within the EU. Some of the veterinary drugs were also included in the scope of this study.

The most lipophilic of the above compounds enrich in the wax where they persist for a long time and even get recycled as the wax is reused by the apiaries to facilitate the built up of new colonies. In contrast, the more polar ones remain in the honey. Compounds of intermediate polarity will partition between the two phases.

The aim of this pilot-monitoring was to get a broad overview on the pesticide residue situation in honey marketed in Europe. Therefore, commercially available honey samples from the European marked were collected. Additionally, few samples from outside the EU and some samples at the level of business to business (B2B) trade were also included in this study and were kindly provided by a private laboratory.

For honey, maximum residue levels (MRLs) are set in Regulation (EC) No 396/2005. Considering the lack of field studies about residue situation in honey, the MRLs in honey have been traditionally set at the compromise level of 0.05 mg/kg. Nevertheless, the residues typically encountered in honey are far below this level. Collecting information about the typical residue levels in honey may eventually be of help in case it will be eventually decided to consider the real findings in MRL-setting in honey,

Prior to the start, as well as during the analysis of the honey samples of this monitoring project, both EURLs performed extensive validation experiments in different types of honey to check the applicability of the routine methods and to establish the reporting limits for quantitative

[1] MANCP = Multi Annual National Control Program

results and in addition the lowest limit for tracking semi-quantitative results to be used for statistical purposes.
The EURL-AO analysed the samples for compounds amenable to multiresidue methods (MRMs) using GC- and LC-based methods combined with mass spectrometry. The EURL-SRM covered both compounds amenable to MRMs as well as compounds not amenable to MRMs. The later were covered by so-called single residue methods (SRMs).
The pilot monitoring study was conducted from 2021 to 2024. In 2021 and 2022, about 150 samples were collected and thereof 80 samples were analyzed in 2022. Eventually it was decided to continue with the study, so additional samples were collected in 2023 and 2024.
The information collected has been already considered in adjusting the scope of the MANCP-WD and as a contribution for establishing the MRL for glyphosate in honey and copper, and will hopefully also be of use in future revisions of honey MRLs.

2. Samples and sampling

In total, 187 honey samples were collected between 2022 and 2024. Thereof, 83 samples originated from EU countries and 87 samples from non-EU countries. Further 11 samples were blends from EU and non-EU countries and two samples each were from unspecified EU and non-EU countries. Finally, two further samples had no indication about their origin. An overview of the origin of the analysed honey samples is shown in **Figure 1**.
The majority of the samples was purchased at retail level. However, 50 of the samples originated from bulk material. These types of samples were included as in order to consider the large share of honey that is traded at a business to business (B2B) level and ends up as an ingredient in processed products or in honey blends. The samples were kindly provided by a private laboratory. The origin of these samples was known in all cases and shared but unfortunately the type of honey remained unspecified.

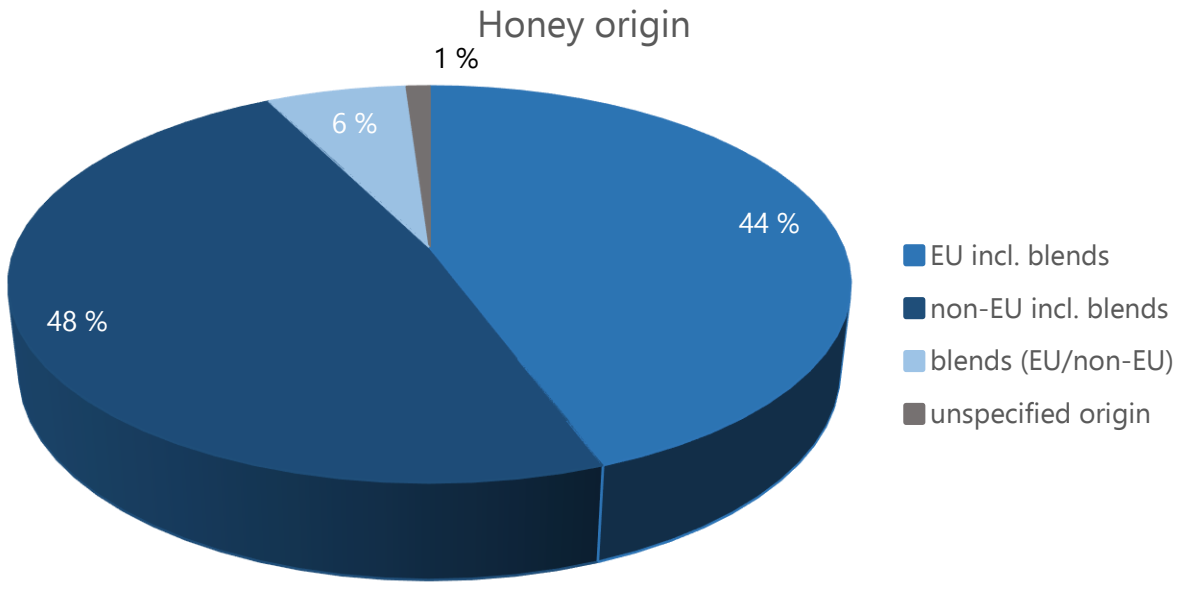

Figure 1: *Origin of honey samples in %.*

A more detailed overview of the countries of origin is given in **Figure 2**. The number of honey samples with a known single origin are shown separately. Honey samples being blends of different countries were grouped and named as follows: "*EU blend*" for blends from EU countries, "*non-EU blend*" for blends from non-EU countries, "*Latin-American blend*" for blends from countries of Latin-American countries and "*EU/non-EU blend*" for blends from EU- and non-EU countries. Overall, the honey samples of single origin originated from 30

different countries. A small number of so called “urban honeys” was also included, as this type of honey production has come into fashion lately.

Different kinds of blossom and honeydew honey as well as blends of different kinds were analysed. The study furthermore included honeys of at least 25 different specified varieties (e.g. linden, pine, rape). **Figure 3** gives an overview about the analysed honey samples. 56 % of the collected samples were labelled as blossom honeys and 5 % were labelled as honeydew honeys. For 39 % of the samples no information was provided regarding the type.
Twelve samples out of 187 were from organic production. An overview of the findings in the organic honey samples is given in **Table 3**.

A list of all samples is given in the **Annex**.

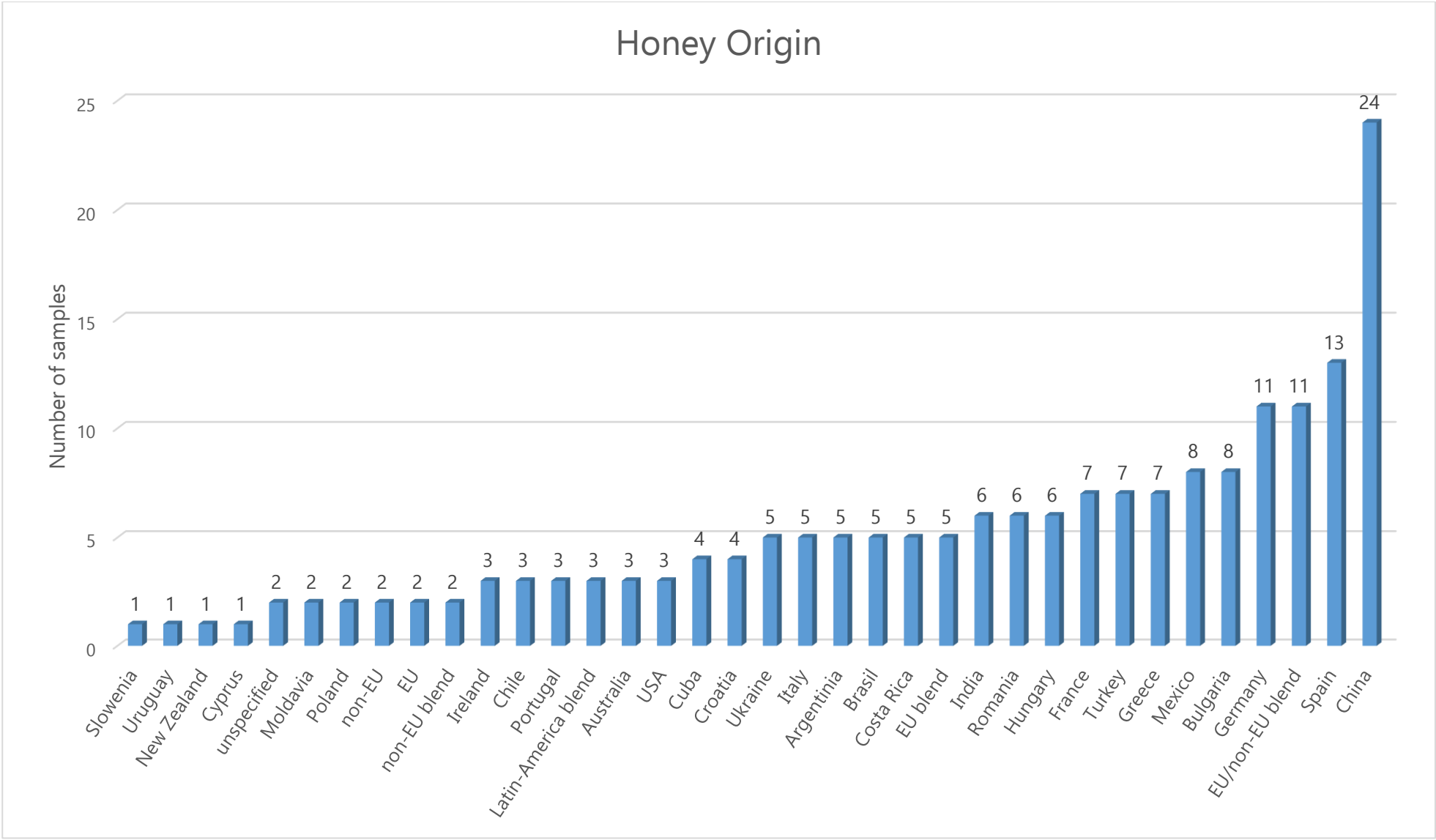

Figure 2: *Detailed overview of countries of origin.*

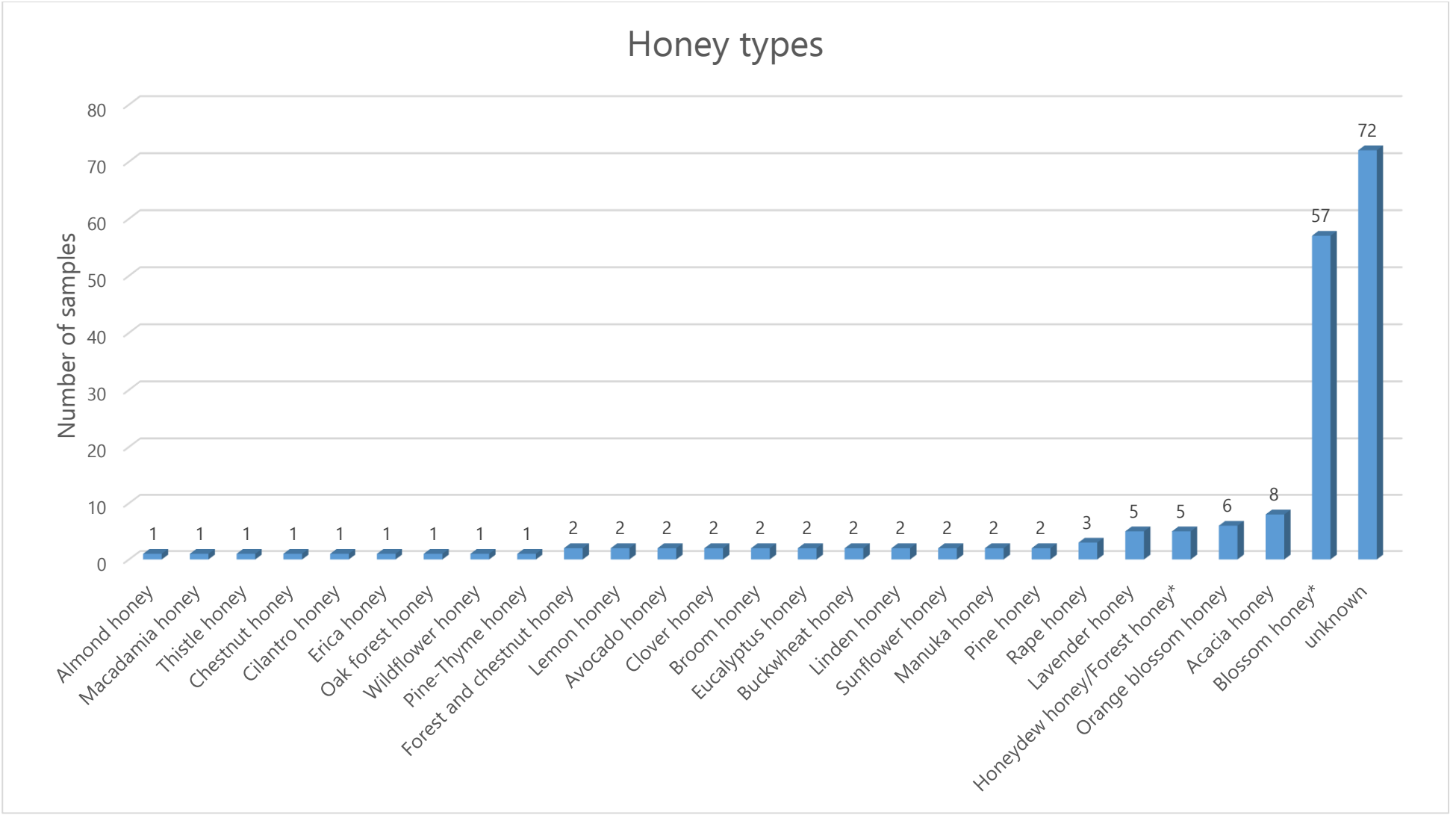

Figure 3: *Honey types. *No more precise information about the species or blends of different types.*

3. Analysis

The analytical scope for this pilot monitoring study was divided among the EURL-AO and EURL-SRM. The EURL-AO and its routine laboratory hosted at the CVUA Freiburg focus on MRM compounds in commodities of animal origin. In contrast, the focus of the EURL-SRM is on analytes (pesticides and metabolites) not amenable to multiresidue methods, many of which are polar and thus of high interest for honey. The EURL-SRM is hosted at the CVUA Stuttgart, the routine laboratory of which covers a very broad scope of pesticide residues in food of plant origin. Both MRM and SRM pesticides are included in this scope. In order to cover a most possibly large scope, it was decided that the full scope the EURLs and their routine labs is covered in this project. In the case of overlapping scope, only one of the two data sets (typically the most trust-worthy/least interfered) was considered for evaluation.
The EURL-AO analysed all 187 samples, the EURL-SRM analysed 175 samples. Some of the analytes were included in the scope as the project was running and were thus analysed in less samples. The same applies to analytes not covered by the routine scope such as antibiotics and copper.

3.1 Extraction and instrument methods

EURL AO

EURL AO used the SweEt-method for sample preparation to extract GC amenable pesticides and the QuEChERS-method for LC amenable pesticides. The methods are linked in the EURL Method Finder List (AO-M08 and AO-M09) and on CIRCA BC (Link). The final extracts were analysed for GC amenable pesticides on a GC-Orbitrap MS/MS (Q-Extractive) from Thermo Fischer Scientific and for LC-amenable pesticides on a UHPLC-Q-TOF (9030) from Shimadzu. The instrument conditions as well as the full scope are given in the validation reports for LC and GC, which are also available on CIRCA BC.

EURL SRM

Sample preparation was conducted following the QuEChERS EN 15662 and the QuPPe method [6][7]. In both procedures, 5 g of honey were weighed into a 50 mL centrifugal tube and extracted [6][7]. For method details, refer to EN 15662 [6] or to QuPPe-PO Version 12.3 [7].

The final extracts were measured on 16 different LC-MS/MS and one GC-MS/MS (***Table 1***) instrument methods using matrix-matched or matrix-based calibration with at least three calibration points. In addition, one quantitative LC-ToF and one quantitative GC-Orbitrap method were employed. In total, 723 compounds were analysed by methods enabling direct quantification.
Prior to the second phase of the study in 2023 and 2024, the scope was enlarged to cover further compounds, especially antibiotics and polar metabolites. The following methods were introduced for this purpose: LC-MS/MS-ESI(+)-8, LC-MS/MS-ESI(+)-9, LC-MS/MS-ESI(+)-10 and LC-MS/MS-ESI(-)-4, see ***Table 1***. Only 81 of the samples were analysed by these methods during the second phase (see also No. of samples analysed in ***Table 2***).
Additionally, the samples were also measured by GC- and LC-based screening methods involving high resolution MS. Screening by LC-ToF was run both in ESI-positive and negative mode). GC-screening was run on a GC orbitrap (see ***Table 1***). The GC-screening method covered 802 compounds, thereof 88 compounds that were also quantified with QC-Orbitrap.

The ESI pos. LC-ToF-screening covered 1001 compounds, thereof 544 compounds that were also quantified in other methods, see ***Table 1***. The ESI neg. LC-ToF-screening method covered 441 compounds, thereof 153 compounds that were also quantified in other methods from ***Table 1***. In total, the scope covered 1447 compounds, thereof 723 compounds that were quantified. About 1370 compounds were covered by the scope of the screening methods, thereof about 724 compounds were only covered by screening methods.
Similarly, to the MS/MS methods, the scope of the screening methods was enlarged for the second phase of the study to include more metabolites. In 2022, 26 compounds were included in the ESI positive LC-ToF-screening and 20 compounds in the ESI negative LC-ToF-screening. In 2023, 63 compounds were included in the ESI positive LC-ToF-screening and 48 compounds in the ESI negative LC-ToF-screening.
An overview on the methods used by the EURL-SRM for this study is given in ***Table 1*** including links to individual documents describing parameters for each method. A list of the full scope and the used methods is given in a Supplementary Excel-file. Twelve samples were not analysed by the EURL-SRM (all from China).

Table 1: *Overview on methods used by the EURL-SRM for the honey pilot monitoring project.*

Method Code and Link	Instrument	Column	Ioni-zation	Extraction	Clean-up
LC-MS/MS-ESI(+)-1	Agilent Infinity II w. AB Sciex QTrap 6500+	Phenomenex Aqua 5µm C18 125 Å	ESI pos.	QuEChERS	none
LC-MS/MS-ESI(+)-3	Agilent Infinity II w. AB Sciex QTrap 6500+	Phenomenex Synergi 4µm Hydro-RP; 150x2 mm	ESI pos.	QuEChERS	none
LC-MS/MS-ESI(+)-4	Agilent Infinity II w. AB Sciex QTrap 6500+	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI pos.	QuEChERS	PSA
LC-MS/MS-ESI(+)-5	Agilent Infinity II w. AB Sciex QTrap 6500+	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI pos.	QuEChERS	PSA
LC-MS/MS-ESI(+)-7	Agilent Infinity II w. AB Sciex QTrap 5500	Acquity UPLC BEH Amide 2 x 100 mm 1.7 µm	ESI pos.	QuPPe[2]	none
LC-MS/MS-ESI(+)-8	Shimadzu Nexera 40 w. AB Sciex QTrap 5500+	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI pos.	QuEChERS	none
LC-MS/MS-ESI(+)-9	Shimadzu Nexera 40 w. AB Sciex QTrap 5500+	Agilent Poroshell zHILIC 2.1x100mm, 2µm	ESI pos.	QuPPe	none
LC-MS/MS-ESI(+)-10	Shimadzu Nexera 40 w. AB Sciex QTrap 5500+	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI pos.	QuPPe	none
LC-MS/MS-ESI(+)-11	Waters I-Class w. AB Sciex QTrap 5500	Waters APPC, 130Å, 5 µm, 2.1 mm x 100 mm	ESI pos.	QuPPe[3]	none
LC-ToF- ESI(+)-12	Bruker maxis Compact	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI pos.	QuEChERS	PSA
LC-ToF-ESI(+)-Screening	Bruker maxis Compact	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI pos.	QuEChERS	PSA
LC-MS/MS-ESI(-)-1	Agilent Infinity II w. AB Sciex QTrap 6500+	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI neg.	QuEChERS	none
LC-MS/MS-ESI(-)-2	Agilent Infinity II w. AB Sciex QTrap 6500+	Thermo Hypercarb 100x2.1 mm 5µm	ESI neg.	QuPPe[4]	none
LC-MS/MS-ESI(-)-4	Shimadzu Nexera 40 w. AB Sciex QTrap 5500+	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI neg.	QuEChERS	none
LC-MS/MS-ESI(-)-5	Waters I-Class w. AB Sciex QTrap 5500	Waters APPC, 130Å, 5 µm, 2.1 mm x 100 mm	ESI neg.	QuPPe[5]	none
LC-MS/MS-ESI(-)-6	Waters I-Class w. AB Sciex QTrap 5500	Waters APPC, 130Å, 5 µm, 2.1 mm x 100 mm	ESI neg.	QuPPe[6]	none
LC-ToF-ESI(-)-Screening	Bruker maxis Compact	Acquity BEH C18, 2.1x100 mm, 1.7 µm	ESI neg.	QuEChERS	none
GC-MS/MS-1	Agilent 7890B w. 7010	Agilent DB-5MS + 10m Duragard (30 m; 0.25 mm ID; 0.25 µm)	EI pos.	QuEChERS	PSA
GC-Orbitrap-2	Thermo Fisher Scientific Trace 1310 w. THE-Exactive	Agilent DB-5MS 30 m, 0.25 mmID, 0.25 µm	EI pos.	QuEChERS	PSA
GC-Orbitrap-Screening		Agilent DB-5MS 30 m, 0.25 mmID, 0.25 µm	EI pos.	QuEChERS	PSA

[2] Corresponds to QuPPe M4.2 [7]
[3] Corresponds to QuPPe M10 [7]
[4] Corresponds to QuPPe M1.3 [7]
[5] Corresponds to QuPPe M1.6 [7]
[6] Corresponds to QuPPe M1.7 [7]

3.2 Method validation

Prior to the monitoring project, the EURL AO and EURL SRM each performed validation studies to ensure that the compliance with existing MRLs for honey can be controlled.

EURL AO

The validation studies of EURL AO covered GC- and LC amenable pesticides of MRM compounds. For GC amenable pesticides, the SweEt-method was used for sample preparation combined with GC-Orbitrap for quantification of 231 pesticides. For LC amenable pesticides, the QuEChERS-method was used for sample preparation combined with LC-Q-TOF for quantification of 390 pesticides. Six different honey samples were used for the validation (blossom honey, forest honey, fir honey, summer blossom honey, coffee blossom honey, forest blossom honey). For calibration, a five-point procedural calibration was used for GC amenable pesticides and a three-point procedural calibration was used for LC amenable pesticides. The LOQ (*limit of quantification*) was determined as the lowest spike level for which the acceptance criteria according to SANTE/11312/2021 [2] were met. In total, 87 % of GC amenable pesticides (202 out of 231) were validated successfully. LOQs ranged between 0.5 µg/kg and 10 µg/kg. 29 GC amenable pesticides could not be validated successfully. Of these, 23 pesticides could be detected, but the validation criteria according to SANTE/11312/2021 [2] were not fulfilled. Moreover, 62 % of the LC amenable pesticides (241 out of 390) were validated successfully. LOQs ranged between 1 µg/kg and 10 µg/kg. 149 pesticides could not be validated successfully. Of these, 45 pesticides could be detected, but the validation criteria according to SANTE/11312/2021 [2] were not fulfilled. 104 pesticides could either not be detected at all or it was not possible to identify them due to the peak shape or the overlapping of the peaks of some analytes with similar retention times.
The validation reports of EURL AO can be found on CIRCABC for LC and GC amenable compounds.

EURL SRM

Method validation was performed in honey following the QuEChERS EN 15662 method and the QuPPe method, see above [6][7]. For each method, 5 g of honey were spiked at the respective level (n=5) and extracted following QuEChERS or QuPPe [6][7]. Two-point bracketing matrix-based calibration at 60% and 120% of the envisaged level was used. Validation criteria for evaluation of the results followed SANTE/11312/2021 [2]. As for each measurement method, different clean-up levels were used, validation packages were combined accordingly (for clean-up level see ***Table 1***). In order to avoid adverse effects due to too many compounds in one spiking mixture, validation studies were divided into several packages with a maximum of approx. 200 compounds for each package. Results of method validation for target transitions of MS/MS methods and of most intensive fragments of HRMS methods will be shown in the Supplementary Excel-file at a later point.
A basic validation was envisaged for all QuEChERS amenable compounds at 2 µg/kg. Where validation at 2 µg/kg was not successful, validation was repeated at a different (higher) level in case the compound was deemed being relevant in honey.
Similarly, a basic validation was envisaged for all QuPPe amenable compounds at 10 µg/kg. Where validation at 10 µg/kg was not successful, validation was repeated at a different (higher) in case the compound was deemed being relevant in honey. A few compounds were also validated at levels < 10 µg/kg.

4. Results

For compounds for which residue levels were encountered the results of the pilot monitoring study are summarized in ***Table 2***.

Table 2: *List of all positive results in alphabetical order. Method Code: MRM = Multi Residue Method, for other method codes see in the* ***Table 1****, median was calculated if No. of findings was ≥ 5. Compounds with at least one MRL exceedance are marked in orange.*

Compound	No. of samples analysed	No. of findings (in % of all) (EU/non-EU/blends)	No. of findings ≥ LSVL (in % of all)	LSVL in µg/kg	Median ≥ LSVL in µg/kg	Median of all quantified in µg/kg	Max. results in µg/kg (country code origin)	MRL in µg/kg	No. of findings > MRL	Method code	Comment
2,4-D	175	52 (30%) (11/36/5)	14 (8%)	2	3	1	10 (IN)	50*	0	LC-MS/MS-ESI(-)-1	*2,4-D (sum of 2,4-D, its salts, its esters and its conjugates, expressed as 2,4-D)
3,5,6-Trichlor-2-pyridinol (TCPy)	175	3 (2%) (2/1/0)	0 (0%)	2	-	-	2 (IT, MX)	-	-	LC-MS/MS-ESI(-)-1	metabolite, for further information see ***Table 4***
4-Chlorobenzoic acid	175	4 (2%) (0/4/0)	0 (0%)	2	-	-	1* (IN)	-	-	LC-MS/MS-ESI(-)-1	*semiquantitative; for further information see ***Table 4***
Acetamiprid	175	54 (31%) (31/14/9)	23 (13%)	2	6	1	43 (RO)	50	0	LC-MS/MS-ESI(+)-5	+1 screening positive
Acetamiprid metabolite (IM-2-1)	175	11 (6%) (7/3/1)	0 (0%)	2	-	1	1* (PL)	-	-	LC-MS/MS-ESI(+)-5	*semiquantitative
Alachlor	187	2 (1 %) (2/0/0)	0 (0 %)	5	-	-	1 (HR)	10	0	MRM	
Aldicarb-sulfone	187	1 (0.5 %) (1/0/0)	0 (0%)	5	-	-	0.5 (IT)	10*	0	MRM	*Aldicarb (sum of aldicarb, its sulfoxide and its sulfone, expressed as aldicarb)
Amitraz Metabolite: N-(2,4-Dimethylphenyl)formamide	187	22 (12 %) (15/5/2)	0 (0 %)	-*	-	26	63 (PT)	200**	0	MRM	*not validated ** Applies to the sum: *"Amitraz (amitraz including the metabolites containing the 2,4-dimethylaniline moiety expressed as amitraz)"*
Amitraz Metabolite: N-(2,4-Dimethylphenyl)-N-methylformamidine	187	40 (21 %) (18/17/5)	0 (0 %)	-*	-	9	118 (CN)	200**	0	MRM	see also N-(2,4-Dimethylphenyl)formamide
Ammelide	161	17 (11%) (11/6/0)	2 (1%)	20	-	10	23 (PT)	-	-	LC-MS/MS-ESI(-)-2	for further information see ***Table 4***
Anthrachinon	175	1 (1%) (1/0/0)	0 (0%)	2	-	-	1* (RO)	20	0	GC-Orbitrap-2	*semiquantitative; +1 screening positive
Azinphos-methyl	187	1 (0.5%) (0/1/0)	0 (0 %)	-*	-	-	0.5 (UY)	50	0	MRM	*not validated
Azoxystrobin	175	8 (5%) (7/0/1)	2 (1%)	2	-	1	6 (PL)	5	1	GC-MS/MS-1	+2 screening positive
Azoxystrobin Metabolite: 2-Hydroxybenzonitrile	81	4 (5%) (1/3/0)	3 (2%)	-*	-	-	8 (CL)	-	-	LC-MS/MS-ESI(-)-4	*not validated; estimated LOQ 5 µg/kg
BAC-C12	187	28 (15 %) (13/12/4)	1 (1 %)	5	-	1	7 (HU)	100*	0	MRM	* Applies to the sum: Benzalkonium chloride (mixture of alkylbenzyldimethylammonium chlorides with alkyl chain lengths of C8, C10, C12, C14, C16 and C18)

Compound	No. of samples analysed	No. of findings (in % of all) (EU/non-EU/blends)	No. of findings ≥ LSVL (in % of all)	LSVL in µg/kg	Median ≥ LSVL in µg/kg	Median of all quantified in µg/kg	Max. results in µg/kg (country code origin)	MRL in µg/kg	No. of findings > MRL	Method code	Comment
BAC-C16	187	2 (1 %) (1/1/0)	0 (0 %)	1	-	-	7 (UA)	100*	0	MRM	*see BAC-C12
BAC-C18	187	2 (1 %) (1/0/1)	0 (0 %)	1	-	-	1 (ES)	100*	0	MRM	*see BAC-C12
Bendiocarb	187	3 (2 %) (2/0/1)	2 (1 %)	5	-	-	26 (HR)	-	0	MRM	
Benthiavalicarb isopropyl	187	1 (1 %) (0/1/0)	1 (1 %)	1	-	-	2 (NZ)	50*	0	MRM	* Applies to the sum: Benthiavalicarb (Benthiavalicarb-isopropyl(KIF-230 R-L) and its enantiomer (KIF-230 S-D) and its diastereomers(KIF-230 S-L and KIF-230 R-D), expressed as benthiavalicarb-isopropyl) (A)
Benzoic acid	175	2 (1%) (2/0/0)	0 (0%)	-*	-	-	32,500 (ES)	-	0	LC-ToF- ESI(-)-SCREENING	*not validated; estimated LOQ 5 µg/kg
Bifenthrin	175	3 (2%) (0/3/0)	1 (1%)	2	-	-	3 (CR)	50	0	GC-MS/MS-1	
Biphenyl	187	21 (12 %) (8/11/2)	0 (0 %)	5	-	0.9	2 (TR)	10	0	MRM	
Boscalid	175	5 (3%) (4/0/1)	3 (3 %)	2	-	-	6 (DE)	150	0	LC-MS/MS-ESI(+)-3	
Bromide	175	171 (98%) (80/79/12)	65 (37%)	500*	825	421	2839 (BR)	50	156	SRM	*validation at lower level not feasible due to too high background levels
Carbendazim	175	37 (21%) (15/16/6)	6 (3%)	2	3	1	7 (RO)	1000	0	LC-MS/MS-ESI(+)-5	+3 screening positive
Chlorate	175	85 (49%) (45/33/7)	9 (5%)	10	18	3	260 (blend)*	50	2	LC-MS/MS-ESI(-)-6	*blend from IN, AR, BR, USA
Chlorfenvinphos (cis- und trans-)	187	2 (1 %) (2/0/0)	2 (1 %)	0.5	-	-	1 (PT)	10	0	MRM	
Chlormequat	175	3 (2%) (3/0/0)	3 (2%)	2	-	-	5 (HU)	50	0	LC-MS/MS-ESI(+)-7	
Chlorpyrifos	187	1 (1 %) (0/1/0)	0 (0 %)	1	-	-	0.5 (USA/Utah)	10	0	MRM	
Chlortoluron	187	5 (3 %) (3/2/0)	3 (2 %)	1	-	1	5 (TR)	-	0	MRM	
Ciprofloxacine	175	4 (2%) (0/4/0)	3 (2%)	-*	-	-	17 (IR)	-	-	LC-MS/MS-ESI(+)-10	*not validated; estimated LOQ 1 µg/kg; antibiotic
Clofentezin	175	1 (1%) (1/0/0)	0 (0%)	2	-	-	0.5 (ES)	50	0	LC-MS/MS-ESI(+)-3	
Cloparalid	175	1 (1%) (1/0/0)	1 (1%)	20	-	-	44 (ES)	150	0	LC-MS/MS-ESI(-)-1	
Clothianidin	175	1 (1%) (0/1/0)	0 (0%)	2	-	-	1 (USA)	50	0	LC-MS/MS-ESI(+)-5	
Copper	75	75 (100%) (43/27/5)	62 (83%)	80	171	171*	4996 (MX)	-	-	elemental analysis	*LSVL = LOQ
Coumaphos	187	54 (29 %) (39/ 11/4)	38 (20 %)	1	2	2	17 (HR)	100	0	MRM	
Coumaphos-alcohol	175	2 (1%) (2/0/0)	0 (0%)	5	-	-	3* (HR)	-	-	LC-ToF-ESI(+)-12	*semiquantitative
Coumaphos-oxon	175	2 (1%) (1/1/0)	1 (1%)	2	-	-	3* (HU)	-	-	LC-ToF-ESI(+)-12	*semiquantitative
Cyanuric acid	175	160 (91%) (81/66/13)	103 (59%)	20	35	27	227 (MX)	-	-	LC-MS/MS-ESI(-)-2	
Cyproconazole	175	2 (1%) (2/0/0)	0 (0%)	2	-	-	1* (ES)	50	0	LC-MS/MS-ESI(+)-4	*semiquantitative
Daminozide	175	1 (1%) (1/0/0)	0 (0%)	2	-	-	3 (BG)	60	0	LC-MS/MS-ESI(+)-7	
Deltamethrine	175	-	-	2	-	-	screening positive (HU)	50	0	GC-MS/MS-1	+1 screening positive (EU); not quantified
Denatonium benzoate	187	1 (1 %) (0/1/0)	0 (0 %)	5	-	-	2 (BR)	50	0	MRM	
Dicrotophos	175	1 (1%) (0/1/0)	0 (0%)	2	-	-	0.5* (IR)	**	-	LC-MS/MS-ESI(+)-3	*semiquantitative **not approved
Difenoconazole	175	2 (1%) (2/0/0)	0 (0%)	2	-	-	2 (PL)	50	0	LC-MS/MS-ESI(+)-5	
Diflubenzuron	175	1 (1%) (0/1/0)	0 (0%)	2	-	-	1 (USA)	50	0	LC-MS/MS-ESI(+)-5	

Compound	No. of samples analysed	No. of findings (in % of all) (EU/non-EU/blends)	No. of findings ≥ LSVL (in % of all)	LSVL in µg/kg	Median ≥ LSVL in µg/kg	Median of all quantified in µg/kg	Max. results in µg/kg (country code origin)	MRL in µg/kg	No. of findings > MRL	Method code	Comment
Dimethachlor	175	1 (1%) (1/0/0)	0 (0%)	2	-	-	1* (IT)	50	0	LC-MS/MS-ESI(+)-1	*semiquantitative
Dimethyl-naphthalene, 1,4-	187	2 (1 %) (1/1/0)	0 (0 %)	5	-	-	0.9 (USA/Utah)	50	0	MRM	
Dimethoate	175	1 (1%) (1/0/0)	1 (1%)	2	-	-	2 (ES)	10	-	LC-MS/MS-ESI(+)-3	+1 screening positive
Dimethoate-O-desmethyl	175	5 (3%) (3/1/1)	0 (0%)	5	-	2	2 (ES)	-	-	LC-MS/MS-ESI(-)-2	
Dimethyl-phosphate	175	3 (2%) (1/2/0)	2 (1%)	10	-	-	71 (MX)	-	-	LC-MS/MS-ESI(-)-6	
Dimoxystrobin	187	5 (3 %) (4/0/1)	3 (2 %)	1	3	2	3 (DE)	50	0	MRM	
Dioxacarb	175	3 (2%) (3/0/0)	1 (1%)	2	-	-	3 (ES)	-*	-	LC-MS/MS-ESI(+)-5	*not approved
Diphenamid	187	2 (1 %) (0/1/1)	0 (0 %)	5	-	-	3 (IN, VI)	-	-	MRM	
Diphenylamin	187	2 (1 %) (1/1/0)	1 (1 %)	5	-	-	9 (CN)	50	0	MRM	
Enrofloxacin	81	1 (1%) (0/1/0)	1 (1%)	-*	-	-	2484 (IR)	-	-	LC-MS/MS-ESI(+)-10	*not validated; estimated LOQ 2 µg/kg; antibiotic
Ethephon metabolite (Hydroxyethylphosphonic acid (HEPA))	175	7 (4%) (0/6/1)	7 (4%)	20	108	108	510 (CR)	-	-	LC-MS/MS-ESI(-)-2	metabolite of ethephon
Ethofumesate, 2-keto	175	1 (1%) (1/0/0)	0 (0%)	5	-	-	1* (PL)	50**	0	GC-Orbitrap-2	*semiquantitative; ** Applies to the sum: Ethofumesate (Sum of ethofumesate, 2-keto–ethofumesate, open-ring-2-keto-ethofumesate and its conjugate, expressed as ethofumesate)
Fenhexamid	175	1 (1%) (0/1/0)	1 (1%)	2	-	-	3 (CL)	50	0	LC-MS/MS-ESI(+)-5	
Fenpyrazamine	187	1 (1 %) (1/0/0)	0 (0 %)	1	-	-	0.5 (FR)	50	-	MRM	
Fenuron	187	1 (1 %) (1/0/0)	0 (0 %)	-*	-	-	0.7 (DE)	-	-	MRM	*not validated
Flonicamid	187	8 (4 %) (7/1/0)	8 (4 %)	0.5	2	2	4 (ES)	50	-	MRM	
Fluazifop	175	16 (9%) (13/1/2)	4 (2%)	2	-	3	7 (RO)	50*	0	LC-MS/MS-ESI(-)-1	* Applies to the sum: Fluazifop-P (sum of all the constituent isomers of fluazifop, its esters and its conjugates, expressed as fluazifop)
Fludioxonil	175	2 (1%) (1/1/0)	0 (0%)	2	-	-	1* (CL, DE)	50	0	GC-MS/MS-1	*semiquantitative
Flumequin	175	1 (1%) (0/1/0)	1 (1%)	-*	-	-	4 (IR)	-	-	LC-MS/MS-ESI(-)-5	*not validated; estimated LOQ 1 µg/kg; antibiotic
Flumorph	187	1 (1 %) (1/0/0)	1 (1 %)	1	-	-	1 (FR)	-		MRM	
Fluopyram	175	7 (4%) (6/1/0)	1 (1%)	2	-	1	8 (PL)	50	0	GC-Orbitrap-2	+1 screening positive
Fluopyram Metabolite 3-Chloro-5-(trifluoromethyl)picolinic acid	81	1 (1%) (1/0/0)	0 (0%)	-*	-	-	1** (PL)	-	-	LC-MS/MS-ESI(-)-4	*not validated; estimated LOQ 5 µg/kg; **semiquantitative
Flupyradifurone	187	1 (1 %) (0/1/0)	1 (1 %)	1	-	-	3 (USA/ California)	2000*	0	MRM	*not yet applicable (applicable from 30/04/2025)
Fluvalinate, tau- (I-II)	187	7 (4 %) (4/3/0)	5 (3 %)	1	1	1	6 (USA/Utah)	50*	0	MRM	* Applies to the sum: Fluvalinate (sum of isomers) resulting from the use of tau-fluvalinate (F)
Fosetyl	175	5 (3%) (4/1/0)	1 (1%)	20	-	13	20 (IT)	500*	0	LC-MS/MS-ESI(-)-2	* Applies to the sum: Fosetyl-Al (sum of fosetyl, phosphonic acid and their salts, expressed as fosetyl)
Fosetyl metabolite (Phosphonic acid)	175	175 (100%) (82/80/13)	17 (10%)	50	126	10	1616 (AU)	500*	1	LC-MS/MS-ESI(-)-5	*see fosetyl

Compound	No. of samples analysed	No. of findings (in % of all) (EU/non-EU/blends)	No. of findings ≥ LSVL (in % of all)	LSVL in µg/kg	Median ≥ LSVL in µg/kg	Median of all quantified in µg/kg	Max. results in µg/kg (country code origin)	MRL in µg/kg	No. of findings > MRL	Method code	Comment
Glyphosate	175	28 (16%) (11/14/3)	14 (8%)	20	31	24	306 (DE)	50	4	LC-MS/MS-ESI(-)-2	
Glyphosate metabolite (Aminomethylphosphonic acid (AMPA))	175	16 (9%) (4/10/2)	1 (1%)	5	-	2	11 (USA)	-	0	LC-MS/MS-ESI(-)-2	metabolite of Glyphosate
Haloxyfop	175	2 (1%) (0/1/1)	0 (0%)	2	-	-	1* (CN)	50**	0	LC-MS/MS-ESI(-)-1	*semiquantitative; ** Applies to the sum: Haloxyfop (Sum of haloxyfop, its esters, salts and conjugates expressed as haloxyfop (sum of the R- and S- isomers at any ratio)) (R),(F)
Hexazinone	175	1 (1%) (1/0/0)	0 (0%)	2	-	-	1* (RO)	-**	-	GC-Orbitrap-2	*semiquantitative; **not approved
Imazapyr	175	1 (1%) (1/0/0)	0 (0%)	5	-	-	1*	50	0	LC-MS/MS-ESI(-)-1	*semiquantitative
Imidacloprid	175	8 (5%) (3/4/1)	2 (2%)	2	-	1	5 (FR)	50	0	LC-MS/MS-ESI(+)-5	
Imidacloprid Metabolite (6-Chloro-nicotinic acid)	81	4 (5%) (4/0/0)	2 (2%)	-*	-	-	3 (ES)	-	-	LC-MS/MS-ESI(-)-4	*not validated; estimated LOQ 2 µg/kg
Indoxacarb	175	1 (1%) (0/1/0)	1 (1%)	2	-	-	3 (IN/VI)	50*	0	LC-MS/MS-ESI(+)-3	* Applies to the sum: Indoxacarb (sum of indoxacarb and its R enantiomer) (F)
Iprodione (glycophene)	175	3 (2%) (1/2/0)	0 (0%)	2	-	-	1* (CR)	50	0	GC-MS/MS-1	*semiquantitative
Iprodione metabolite (RP 30228)	175	1 (1%) (0/1/0)	0 (0%)	5	-	-	1* (CR)	-	-	GC-Orbitrap-2	*semiquantitative; metabolite of iprodione
Matrine	175	8 (5%) (0/7/1)	3 (2%)	5	-	3	19 (blend)*	-**	2	LC-MS/MS-ESI(+)-7	*blend of EU/non-EU honey; **not approved
MCPA	175	4 (2%) (3/1/0)	0 (0%)	2	-	-	2 (DE)	-	-	LC-MS/MS-ESI(-)-1	
Melamine	175	76 (43%) (39/30/7)	28 (17%)	50		5	109 (ES)	-	-	LC-MS/MS-ESI(+)-7	
Mepiquat	175	41 (23%) (31/5/5)	9 (5%)	2	5	1	24 (USA)	50	0	LC-MS/MS-ESI(+)-7	
Metalaxyl	175	6 (3%) (6/0/0)	0 (0%)	2	-	1	1* (ES)	50	0	GC-MS/MS-1	+1 screening positive; *semiquantitative;
Metribuzin-desamino	175	1 (1%) (1/0/0)	0 (0%)	2	-	-	2 (RO)	-	-	GC-Orbitrap-2	metabolite of metribuzin
Metribuzin-desamino-diketo	175	1 (1%) (1/0/0)	1 (1%)	2	-	-	7 (RO)	-	-	GC-Orbitrap-2	metabolite of metribuzin
Mevinphos	187	1 (1 %) (1/0/0)	0 (0%)	1	-	-	0.7 (BG)	-		MRM	
Molinate	187	1 (1 %) (1/0/0)	0 (0 %)	-*	-	-	0.8 (ES)	50	0	MRM	*not validated
Morpholine	175	1 (1%) (0/1/0)	1 (1%)	20	-	-	22 (IN/VI)	-	-	LC-MS/MS-ESI(+)-7	
Myclobutanil	187	1 (1 %) (0/1/0)	0 (0 %)	1	-	-	0.9 (CU)	50		MRM	
Nicotine	175	38 (22%) (16/20/2)	2 (1%)	10	-	6	20 (IN)	50	0	LC-MS/MS-ESI(+)-7	
Novaluron	187	1 (1%) (0/1/0)	0 (0%)	5	-	-	1 (USA/California)	50	0	MRM	
Oxymatrine	175	7 (4%) (0/7/0)	4 (2%)	5	-	7	157 (CN)	-*	-	LC-MS/MS-ESI(+)-7	*not approved
Parathion-methyl	187	9 (5 %) (5/2/2)	0 (0 %)	1	-	0.6	0.6 (TR)	10	-	MRM	

Compound	No. of samples analysed	No. of findings (in % of all) (EU/non-EU/blends)	No. of findings ≥ LSVL (in % of all)	LSVL in µg/kg	Median ≥ LSVL in µg/kg	Median of all quantified in µg/kg	Max. results in µg/kg (country code origin)	MRL in µg/kg	No. of findings > MRL	Method code	Comment
Pebulat	175	1 (1%) (1/0/0)	0 (0 %)	-*	-	-	2 (FR)	-**	-	LC-ToF-ESI(+)-12	*not validated; estimated LOQ 2 µg/kg **not approved
Pendimethalin	187	1 (1 %) (1/0/0)	0 (0 %)	1	-	-	0.7 (ES)	50	0	MRM	
Pentachlorophenol (PCP)	175	4 (2%) (3/1/0)	1 (1%)	2	-	-	3 (FR)	-*	-	LC-MS/MS-ESI(-)-1	*not approved
Perchlorate	175	162 (93%) (77/74/11)	93 (53%)	1	3	3	27 (CN)	-	-	LC-MS/MS-ESI(-)-6	
Permethrin, trans-	187	1 (1 %) (0/1/0)	0 (0 %)	0.5	-	-	0.6 (IR)	-	-	MRM	
Phenylphenol, 2-	187	63 (34 %) (19/42/2)	0 (0 %)	-*	-	3	11 (ES)	50**	-	MRM	*not validated ** Applies to the sum: 2-phenylphenol (sum of 2-phenylphenol and its conjugates, expressed as 2-phenylphenol) (R),(F)
Phenylphenol, 2-, -glucoside	175	1 (1%) (0/1/0)	1 (1%)	-*	-	-	51 (CR)	50**	0	LC-ToF-ESI(+)-12	*not validated; estimated LOQ 5 µg/kg ** Applies to the sum: see 2-phenylphenol
Phthalimide	187	31 (17 %) (13/15/3)	0 (0 %)	5	-	0.9	3 (IN)	50*	-	MRM	* Applies to the sum: Folpet (Sum of folpet and phtalimide, expressed as folpet)
Piperonylbutoxide	187	5 (3 %) (2/3/0)	2 (1 %)	1	-	0.6	2 (NZ)	-	-	MRM	
Pirimicarb-desmethyl	187	1 (1 %) (0/1/0)	1 (1 %)	1	-	-	1 (IN)	50*	-	MRM	* Applies to the sum: Pirimicarb (Sum of pirimicarb and desmethyl pirimicarb, expressed as pirimicarb)
Propargite	187	5 (3 %) (1/4/0)	0 (0 %)	5	-	1	3 (CN)	50	0	MRM	
Propoxur	175	-	-	2	-	-	screening positive (AU)	50	-	LC-MS/MS-ESI(+)-5	+1 screening positive (non-EU); not quantified
Prothioconazol-desthio	175	3 (2%) (3/0/0)	0 (0 %)	2	-	-	1* (RO)	50**	0	LC-MS/MS-ESI(+)-4	*semiquantitative; ** Applies to the sum: Prothioconazole: prothioconazole-desthio (sum of isomers) (F)
Pyracarbolid	187	1 (1 %) (1/0/0)	0 (0 %)	1	-	-	0.5 (FR)	-	-	MRM	
Pyraclostrobin	175	3 (2%) (1/1/1)	0 (0%)	2	-	-	2 (BG)	50	0	LC-ToF-ESI(+)-12	
Pyrethrin Metabolite (3-Phenoxybenzoic acid; 3-PBA)	81	3 (2%) (1/2/0)	0 (0%)	-*	-	-	-**	-	-	LC-MS/MS-ESI(-)-4	*not validated; estimated LOQ 2 µg/kg; **not quantified; for further information see ***Table 4***
Pyrethrin Metabolite (3-Phenoxybenzaldehyde; 3-PBAld)	175	1 (1%) (0/0/1)	1 (1%)	1	-	-	1 (blend)*	-	0	GC-Orbitrap-2	*blend of EU/non-EU honey; for further information see ***Table 4***
Pyrimethanil	175	1 (1%) (0/1/0)	1 (1%)	2	-	-	6 (CR)	50	0	GC-MS/MS-1	
Spirotetramat Metabolite BYI08330-mono-hydroxy	187	2 (1 %) (1/0/1)	0 (0 %)	5	-	-	1 (DE)	-*	-	MRM	*not included in the residue definition of spirotetramat
Spiroxamine	175	3 (2%) (2/1/0)	0 (0%)	2	-	-	1* (blend)**	50	0	LC-MS/MS-ESI(+)-5	*semiquantitative; **blend of honeys from EU
Streptomycin	161	1 (1%) (0/1/0)	0 (0%)	-*	-	-	5 (IR)	-	-	LC-MS/MS-ESI(+)-9	*not validated; estimated LOQ 8 µg/kg; antibiotic
Streptomycin, dihydro-	161	9 (6%) (3/6/0)	8 (5%)	-*	-	10	629 (IR)	-	-	LC-MS/MS-ESI(+)-9	*not validated; estimated LOQ 4 µg/kg; antibiotic
Tebuconazole	175	12 (7%) (10/2/0)	1 (1%)	2	-	1	5 (PL)	50	0	LC-MS/MS-ESI(+)-5	

Compound	No. of samples analysed	No. of findings (in % of all) (EU/non-EU/blends)	No. of findings ≥ LSVL (in % of all)	LSVL in µg/kg	Median ≥ LSVL in µg/kg	Median of all quantified in µg/kg	Max. results in µg/kg (country code origin)	MRL in µg/kg	No. of findings > MRL	Method code	Comment
Tepraloxidim	187	1 (1 %) (0/1/0)	0 (0 %)	-*	-	-	3 (BR)	100*	0	MRM	*not validated ** Applies to the sum: Tepraloxydim (sum of tepraloxydim and its metabolites that can be hydrolysed either to the moity 3-(tetrahydro.pyran-4-yl)-glutaric acid or to the moiety 3-hydroxy-(tetrahydropyran-4-yl)-glutaric acid, expressed as tepraloxydim
Tetracycline	81	4 (5%) (1/3/0)	1 (1%)	-*	-	-	19 (BG)	-	-	LC-MS/MS-ESI(+)-10	*not validated; estimated LOQ 10 µg/kg; antibiotic
Tetracycline, epi-	81	3 (4%) (1/2/0)	1 (1%)	-*	-	-	5 (BG)	-	-	LC-MS/MS-ESI(+)-10	*not validated; estimated LOQ 5 µg/kg; antibiotic
THPI (Tetrahydrophthalimide)	187	2 (1 %) (1/1/0)	0 (0 %)	-*	-	-	16 (CL)	50**	0	MRM	*not validated **Captan (Sum of captan and THPI, expressed as captan)
Thiabendazole	175	1 (1%) (0/1/0)	0 (0%)	2	-	-	1* (MX)	50	0	LC-MS/MS-ESI(+)-5	*semiquantitative
Thiacloprid	175	40 (21%) (27/7/6)	14 (8%)	2	4	1	58 (PL)	200	0	LC-MS/MS-ESI(+)-5	
Thiacloprid-amide	175	1 (1%) (1/0/0)	0 (0%)	2	-	-	2 (PL)	-	-	GC-Orbitrap-2	
Thiamethoxam	175	6 (3%) (2/4/0)	0 (0%)	2	-	1	2* (MX)	50	0	LC-MS/MS-ESI(+)-5	*semiquantitative
Thymol	175	15 (9%) (11/4/0)	15 (9%)	5	20	20	120 (CR)	-	-	GC-Orbitrap-2	
Triazole acetic acid	161	18 (11%) (12/6/0)	4 (2%)	20	-	12	29 (HU)	-	-	LC-MS/MS-ESI(+)-11	
Triazole lactic acid	161	1 (1%) (0/1/0)	0 (0%)	20	-	-	6 (BR)	-	-	LC-MS/MS-ESI(+)-11	
Trifluoroacetic acid (TFA)	175	139 (79%) (70/58/11)	71 (40%)	50	108	67	755 (MX)	-	-	LC-MS/MS-ESI(-)-5	
Trimethoprim	175	1 (1%) (0/1/0)	0 (0%)	-*	-	-	2 (IR)	-**	-	LC-ToF-ESI(+)-12	*not validated; estimated LOQ 5 µg/kg **antibiotic
Trimethyl-sulfonium	175	17 (10%) (8/6/2)	1 (1%)	2	-	2	4 (MX)	-	-	LC-MS/MS-ESI(+)-7	
Trinexapac	175	1 (1%) (0/1/0)	1 (1%)	2	-	-	13 (CR)	50*	0	LC-MS/MS-ESI(-)-1	*Trinexapac (sum of trinexapac (acid) and its salts, expressed as trinexapac)

The following compounds were found in traces: Ametoctradin, Bentazone, Carbaryl, Carbetamide, Carbofuran, Clethodim, Cyhalothrin -lambda, Cymiazole, DEET, Dichlorbenzamide, 2,6-, Dimethomorph, Ethirimol, Fenobucarb, Fenpyroximate, Fenthion-oxon-sulfoxide, Fipronil, Fludioxonil Metabolite (CGA 192155), Flutriafol, Fluxapyroxad, Icaridin, Imazalil, Isoprocarb, Kresoxim-methyl, Malaoxon, Metaflumizone, Metalaxyl Metabolite (CGA 108905), Methiocarb-sulfoxide, Metolachlor S, Methoxyfenozide, 2-Methyl-4-isothiazolin-3-on (MIT), Napropamide, Neburon, Oxadiazon, Pirimiphos-methyl, Propham, Prosulfocarb, Pyrethrin Metabolite (Chrysanthemic acid (+)-trans), Pyraclostrobin-desmethoxy, Pyroproxyfen, Quizalofop, Spinosad, Spirotetramat, Trifloxystrobin, Zoxamide.

The following compounds were identified in HRMS-screening but not quantified (origin): Pyroquilon 1x (CL), Fluvalinate-anilino acid 1x (GR), Fluopyram-benzamide (M25) 4x (FR, HU, DE, PL), Chloridazon-pyrazone 1x (BG), 5-Chlor-2-methyl-4-isothiazolin-3-on (CMIT) 1x (IN).

An overview of the origin, the type and the residue findings in the organic honey samples is given in ***Table 3***. In every organic honey sample, at least seven compounds were found. In one sample from Romania 26 different compounds could be detected. But for none of them an MRL exceedance could be observed.

Table 3: *Overview of organic honey samples.*

Origin	Type	Compound residue
Bulgaria	Thistle honey	1,2,4-triazole acetic acid, Bromide, Cyanuric acid, Fluazifop, Glyphosate, Melamine, Nicotine, Perchlorate, Phosphonic acid, Piperonyl-butoxide, Thiacloprid, TFA
Bulgaria	Honeydew honey	2,4-D, 4-Chlorobenzoic acid, Acetamiprid, Bromide, Chlorate, Chlortoluron, Coumaphos, Cyanuric acid, Dihydrostreptomycin, Melamine, Mepiquat, Mevinphos, Perchlorate, Phosphonic acid, Tetracycline, epi-Tetracycline, Thiacloprid, Trimethylsulfonium, TFA, Traces of DEET
Mexico	Blossom honey	2,4-D, Bromide, Cyanuric acid, Phthalamide, Perchlorate, Phosphonic acid, TFA
Bulgaria	Cilantro honey	Bromide, Chlorate, Cyanuric acid, Coumaphos, Daminozide, Perchlorate, Phosphonic acid, Pyraclostrobin, Pyraclostrobin-desmethoxy, Quizalofop, Thiacloprid, TFA
Non-EU blend (Mexico/Nicaragua)	Blossom honey	Bromide, Cyanuric acid, HEPA, Perchlorate, Phosphonic acid, Spiroxamine, TFA
Italy	Blossom honey	1,2,4-triazole acetic acid, Acetamiprid, Aldicarb-sulfone, Bromide, Chlorate, Cyanuric acid, Fluazifop, Metalaxyl, Perchlorate, 2-Phenylphenol, Phosphonic acid, Phthalamide, Tebuconazole, TFA
Italy	Acacia honey	Acetamiprid, Bromide, Cyanuric acid, Metalaxyl, Perchlorate, Phosphonic acid, Spiroxamine, Dimethomorph, TFA
Romania	Rape honey	Acetamiprid, Acetamiprid-IM-21, Anthraquinone, Azoxystrobin, BAC-C12, Bromide, Boscalid, Carbendazim, Chlorate, Coumaphos, Cyanuric acid, Dimoxystrobin, Fluazifop, Fluopyram, Fluvalinate-tau, Hexazinone, Mepiquat, Metribuzin-desamino, Metribuzin-desamino-diketo, Perchlorate, 2-Phenylphenol, Phosphonic acid, Tebuconazol, Thiacloprid, TFA
Greece	Forest honey	2,4,6-Trichlorophenol, 4-Chlorobenzoic acid, Bromide, Chlorate, Coumaphos, Cyanuric acid, N-(2,4-Dimethylphenyl)formamide, N-(2,4-Dimethylphenyl)-N-methylformamidine, 2-Phenylphenol, Fluvalinate-anilino acid, Melamine, Mepiquat, Nicotine, Perchlorate, Phosphonic acid, TFA
Mexico	Blossom honey	4-Chlorobenzoic acid, Bromide, Cyanuric acid, traces of DEET, Perchlorate, Phosphonic acid, TFA, Trimethylsulfonium
Germany	Blossom honey	Azoxystrobin, Boscalid, Carbendazim, Chlorate, Cyanuric acid, DEET, Dimoxystrobin, Melamine, Mepiquat, Perchlorate, Phosphonic acid, TFA
Brazil	unknown	2,4-D, AMPA, BAC-C12, Bromide, Chlorate, Cyanuric acid, Melamine, Perchlorate, 2-Phenylphenol, Phosphonic acid, Phthalamide, TFA

5. Compound details

The honey samples in this monitoring program were analyzed for a large number of compounds. Background information, mostly on compounds that were encountered in the samples but also of selected additional compounds of potential relevance can be found in **Table 4**.

Table 4: *Background information concerning selected compound that were encountered in the samples analyzed or that are known to be of potential apicultural relevance.*

Compound	Related compounds within the scope of this study	Category	Character-istics	Relevance in	EU Approved as PPP	Comment	Findings within this study
2-Methyl-4-isothiazolin-3-on (MIT)		biocide	intermediate polarity		not listed		
2,4-D		SRM	intermediate polarity	honey	approved	herbicide, phenoxyacetic acid herbicide	**x**
3,5,6-Trichlor-2-pyridinol (TCPy)	metabolite of triclopyr, chlorpyrifos, chlorpyrifos-methyl	metabolite, SRM	intermediate polarity				**x**
4-Chlorobenzoic acid	metabolite of Valifenalate, DDT; maybe also metabolite of Myclobutanil, Hexythiazox, Chlorfenapyr, Mandipropamid, Cyproconazole, Fenarimol, Uniconazole, Dimethomorph, Dicofol, Fenvalerate, Thiobencarb, Pencycuron	metabolite, SRM	intermediate polarity			degradation product of PCBs	**x**
5-Chlor-2-methyl-4-isothiazolin-3-on (CMIT)		biocide	intermediate polarity		not listed		**x**
Acetamiprid	IM-2-1 = N-desmethyl acetamiprid	MRM	Polar	honey	approved	neonicotinoid	**x**
Acetamiprid IM-2-1	metabolite of Acetamiprid	metabolite	Polar	honey	parent approved	parent neonicotinoid	**x**
Alachlor			intermediate polarity		not approved	herbicide	**x**
Aldicarb	Aldicarb-sulfone, Aldicarb-sulfoxide		Low polarity	wax, pollen	not approved	insecticide	
Aldicarb-sulfone	metabolite of Aldicarb	metabolite	Low polarity		parent not approved	parent insecticide	**x**
Aldicarb-sulfoxide	metabolite of Aldicarb	metabolite	intermediate polarity		parent not approved	parent insecticide	
Amitraz	Amitraz, DMF, DMPF (4-Amino-3-methylbenzoic acid; 2,4-Dimethylaniline (2,4-Xylidine)	SRM	highly lipophilic	wax, pollen	not approved	veterinary drug for varroa mites	
Amitraz metabolite DMF (2.4-Dimethylphenyl-formamide)	metabolite of Amitraz	metabolite, SRM	rather polar	honey, wax, pollen	parent not approved	parent veterinary drug for varroa mites	**x**
Amitraz, metabolite DMPF (N-2,4-Dimethylphenyl-N-methylformamidine)	metabolite of Amitraz	metabolite, SRM	rather polar		parent not approved	parent veterinary drug for varroa mites	**x**

Compound	Related compounds within the scope of this study	Category	Character-istics	Relevance in	EU Approved as PPP	Comment	Findings within this study
Ammelide		SRM	Highly Polar		not listed	Can originate from various sources. Formed as intermediate during the gradual transformation of melamine to cyanuric acid. Reported as a metabolite of various triazine pesticides incl.: cyromazine, anilazine and terbuthylazine, prometryn, simazine, atrazine, ametrin, cyanazine.	**x**
Ampicillin		SRM	Polar			antibiotic	
Anthrachinon			Lipophilic			can result from incomplete burning from the use of bee smokers	**x**
Azoxystrobin	2-Hydroxybenzonitrile		Intermediate polarity		approved	fungicide	**x**
Azoystrobin: 2-Hydroxybenzonitrile	metabolite of Azoxystrobin	metabolite			parent approved	parent fungicide	**x**
Benzalkonium chloride		SRM	Intermediate polarity		not approved	Biocide; (mixture of alkylbenzyldimethylammonium chlorides with alkyl chain lengths of C8, C10, C12, C14, C16 and C18)	**x**
Bifenthrin			very lipophilic	wax, pollen	not approved	pyrethroids, insecticide	**x**
Biphenyl					not approved		**x**
Boscalid	Boscalid: M510F01; Boscalid: M510F47		Lipophilic		approved	fungicide	**x**
Bromide	reaction product of fumigant methylbromide	SRM	Highly polar		not approved (Methylbromide)	Also originating from irrigation water and soil. Counter ion of certain quarternary ammonium compounds e.g. benzalkonium, Didecyl Dimethyl Ammonium (DDA), diquat and paraquat.	**x**
Carbendazim / Benomyl (sum)	2-Aminobenzimidazole; Thiophanate-methyl; 5-OH-carbendazim		Rather polar	honey, pollen, wax	not approved	fungicide	**x**
Carbofuran	Benfuracarb (degrades to Carbofuran)		Rather polar	pollen	not approved	insecticide	
Clopyralid		SRM	Rather polar	honey	approved	herbicide	
Chlorate		SRM	Highly polar	honey	not approved	Formerly used as herbicide, nowadays mainly originating from chlorinated water that is often used to irrigate fields or for washing harvested products or the equipment that is used for processing or storage of agricultural products.	**x**
Chlorfenvinphos			Lipophilic	honey, pollen, wax	not approved	veterinary drug for varroa mites, insecticide	**x**
Chlormequat		SRM	Hihly polar		approved	growth regulator	**x**
Chlorpyrifos	Chlorpyrifos-desethyl; Chlorpyrifos-oxon; TCPy; Chlorpyrifos: 2,3,5-Trichloro-6-methoxypyridine; Diethyl phosphate		Lipophilic	honey, pollen, wax	not approved	insecticide, organophosphate insecticide	**x**
Chlorpyrifos-methyl	TCPy; Chlorpyrifos-methyl-desmethyl; Chlorpyrifos-methyl-oxon		Lipophilic	honey, pollen, wax	not approved	insecticide, organophosphate insecticide	
Ciprofloxacin		SRM	Polar			antibiotic	
Copper		elemental analysis			approved	heavy metal	**x**
Coumaphos	Coumaphos-oxon, Coumaphos-alcohol, Coumaphos-deschloron		Lipophilic	honey, pollen, wax	not approved	veterinary drug for varroa mites, insecticide	**x**

Compound	Related compounds within the scope of this study	Category	Character-istics	Relevance in	EU Approved as PPP	Comment	Findings within this study
Coumaphos oxon (Coroxon)	metabolite of Coumaphos	metabolite	Lipophilic	wax	parent not approved	parent veterinary drug for varroa mites, insecticide	**x**
Coumaphos-alcohol (Chlorferone)	metabolite of Coumaphos	metabolite		wax	parent not approved	parent veterinary drug for varroa mites, insecticide	**x**
Cyanuric acid		SRM	Highly polar	honey	not listed	Compound originating from multiple sources, e.g.: **Triazine pesticides** (incl. the herbicides terbuthylazine, atrazine, cyanazine, the fungicide; anilazine and the insecticide cyromazine). From the above only terbuthylazine is currently in use within the EU. Cyromazine has lost EU-approval in Dec. 2019. **Cyanamide-based fertilizers**. Cyanamide contained in fertilizers may convert to melamine through trimerization, which can further hydrolyze to cyanuric acid. **Urea-based fertilizers or feed**: especially at high temperatures urea loses ammonia converting to isocyanic acid (HNCO), which trimerises to cyanuric acid. **Mono-, Di- and Trichloro-isocyanurates**: Used as disinfectants, algaecides and bactericides. They are used in sanitation liquids and bleaching agents as well as in swimming pools (pool-tabs) to retard the loss of chlorine in chlorinated water. In water, they gradually convert to cyanuric acid. Natural formation of cyanuric acid has also been reported (e.g. in humus).	**x**
Cyhalothrin, -lambda	Cyhalothric acid-lambda (Bifenthrin / Cyhalothrin metabolite); 4-OH-PBA; 3-PBA; 3-PBAld		very lipophilic	wax, pollen	approved	pyrethroids, insecticide	
Cyproconazole				pollen	not approved	fungicide	**x**
DEET (*N,N*-Diethyl-*meta*-toluamide)	DEET-desethyl, DEET-omega-carboxylic acid		lipophilic	wax	not listed	insect repellent	**x**
Deltamethrin (cis-deltamethrin)	4-OH-PBA; 3-PBA; 3-PBAld		lipophilic	wax, pollen	approved	pyrethroids, insecticide	**x**
Dimethoate	Dimethoate-carboxylic acid (Metabolite III); Dimethoat-carboxylic acid-methyl-ester; Dimethoate-O-desmethyl (Metabolite X); Dimethoate-O-desmethyl-isodimethoate (Metabolite XII); Omethoate		polar	honey	not approved	insecticide, acaricide	**x**
Dimethomorph			intermediate polarity	pollen, wax	not approved	fungicide	
Dimoxystrobin	Dimoxystrobin metabolite 505M09			wax	not approved	fungicide	**x**
Diphenylamine	N-Nitroso-diphenylamine			pollen	not approved		**x**
Enrofloxacin					not listed	antibiotic	**x**
Ethephon metabolite (Hydroxyethylphosphonic acid (HEPA))	metabolite of ethephon	SRM	highly polar		parent approved	parent plant growth regulator	**x**
Fenazaquin	4-hydroxyquinazoline (4-QHQ)				approved	veterinary drug for varroa mites	

Compound	Related compounds within the scope of this study	Category	Character-istics	Relevance in	EU Approved as PPP	Comment	Findings within this study
Fenazaquin: 4-hydroxyquinazoline (4-QHQ)	metabolite of fenazaquin	metabolite			parent approved	parent veterinary drug for varroa mites	
Fenhexamid				pollen, wax	approved	fungicide	**x**
Fipronil	Fipronil-sulfone (MB46136); Fipronil-desulfinyl; Fipronil-sulfide; Fipronil-amide			pollen, wax	not approved	insecticide	**x**
Flonicamid					approved	insecticide	**x**
Fluazifop	Fluazifop-butyl, Fluazifop-P-butyl, Fluazifop: CGA 142110 (2-Hydroxy-5-(trifluoromethyl)pyridine)	SRM		Honey, pollen	approved	herbicide	**x**
Fludioxonil	Fludioxonil Metabolit CGA 192155, Fludioxonil-carboxylic acid	metabolite	lipophilic		approved	fungicide	**x**
Fludioxonil Metabolite (CGA 192155)	metabolite of Fludioxonil	metabolite			parent approved	parent fungicide	**x**
Fluopyram	Fluopyram-benzamide (M25); Fluopyram Metabolite 3-Chloro-5-(trifluoromethyl)picolinic acid; PAA (2-Pyridineacetic acid)			honey, pollen	approved	fungicide, nematicide	**x**
Fluopyram-benzamide (M25)	metabolite of Fluopyram	metabolite			parent approved	parent fungicide, nematicide	**x**
Fluopyram Metabolite 3-Chloro-5-(trifluoromethyl)picolinic acid	metabolite of Fluopyram	metabolite			parent approved	parent fungicide, nematicide	**x**
Flumethrin	4-Fluoro-3-phenoxybenzaldehyde; 4-Fluoro-3-phenoxybenzoic acid; Flumethrin-acid		very lipophilic	wax, pollen	not listed	veterinary drug for varroa mites, pyrethroid, insecticide	
Flumequin		SRM	polar			antibiotic	
Fluvalinate (incl tau)	4-OH-PBA; 3-PBA; 3-PBAld; Fluvalinate-anilino acid; 2-Chloro-4-(trifluoromethyl)aniline (Haloaniline)		very lipophilic	wax, pollen	approved	veterinary drug for varroa mites, pyrethroid, insecticide	**x**
Fosetyl	Phosphonic acid	SRM	highly polar		approved	fungicide (converts to phosphonic acid, which is the active component)	**x**
Fosetyl metabolite (Phosphonic acid)	metabolite of Fosetyl	SRM, metabolite	highly polar		parent approved	Fungicide, used as such and also formed as a metabolite of fosetyl. Phosphonate-based water-softening agents (e.g. ATMP. HEDP, DTPMP), that are used in cleansing agents contain some residual phosphonic acid, which may lead to small (rather insignificant) contamination of food, e.g. when in contact with surfaces that were not sufficiently rinsed after washing. However, there will be individual MRLs for fosetyl and phosphonic acid from April 2025, as residues may result from other products of agricultural relevance than the use of the fungicide fosetyl [8]. In the frame of this process and after a reasoned opinion by EFSA, the MRL of phosphonic acid in honey was increased from 500 µg/kg (currently; as sum of fosetyl) to 100,000 µg/kg (no sum) applicable from 29 April 2025 [8]. Formation of phosphonic acid and derivatives thereof, such as HEPA, through the reduction of	**x**

Compound	Related compounds within the scope of this study	Category	Character-istics	Relevance in	EU Approved as PPP	Comment	Findings within this study
						phosphates within the anaerobic environment in intestines of ruminants and other animals is likely.	
Glyphosate	Aminomethylphosphonic acid (AMPA), N-acetyl-glyphosate, N-acetyl-AMPA	SRM	highly polar		approved	herbicide	**x**
Glyphosate metabolite (Aminomethylphosphonic acid (AMPA))	metabolite of Glyphosate	SRM, metabolite	highly polar		parent approved	parent herbicide	**x**
Haloxyfop		SRM	intermediate polarity		not approved	herbicide, phenoxyacetic acid herbicide	**x**
Imidacloprid	Imidacloprid-3-hydroxy; Imidacloprid-5-hydroxy; Imidacloprid-olefin; 6-Chloronicotinic acid; Desnitro-imidacloprid (M09); 6-Chloropyridine-3-methanol (M28; imidacloprid-CHMP)		polar	honey	not approved	neonicotinoid	**x**
Imidacloprid metaboltie (6-Chloronicotinic acid; imidacloprid-6-CNA)	metabolite of Imidacloprid, Flupyradifurone, Acetamiprid	metabolite		honey	parent not approved	parent neonicotinoid	**x**
Iprodione (glycophene)	Iprodione metabolite (RP 30228), Iprodione-des-(N-isopropylcarboxamid)				not approved	fungicide, nematicide	**x**
Iprodione metabolite (RP 30228)	metabolite of Iprodione				parent not approved	parent fungicide, nematicide	**x**
Kasugamycin			polar			antibiotic	
Malathion	Malaoxon		intermediate polarity		approved	insecticide, organophosphate insecticide	
Matrine	Oxymatrine	SRM	Polar	honey	not approved	Natural quinolizidine alkaloid, that is considered (together with oxymatrine) as the active ingredient of biopesticides based on extracts of certain plants of the *Sophora* family. Registered in various countries in Asia, Africa and South America. There were cases of illegal addition of *Sophora* root extracts in fertilizers in Italy. Together with oxymatrine, often found in so-called "acacia honey" from China, which mostly originated from flowers of *Sophora* plants. *Sophora* extracts are also used in traditional Asian medicine and cosmetics. Co-harvesting of licorice and *Sophora* roots results in a considerable contamination of licorice and licorice products with matrine (and oxymatrine).	**x**
MCPA	MCPA glucoside, MCPA-2-ethylhexyl, MCPA-butoxyethyl, MCPA-methyl,	SRM	intermediate polarity		approved	herbicide, phenoxyacetic acid herbicide	**x**
Melamine	metabolite of cyromazine (pesticide and veterinary drug)	SRM	Highly polar		not listed; regulated as contaminant in Reg. (EC) 1881/2006/EC	May also originate from cyanamide fertilizers (trimerization of cyanamide) and from urea fertilizers, where it is formed through trimerisation of urea to triuret and subsequent elimination of ammonia and carbon dioxide. Melamine hydrolyses to cyanuric acid via ammeline and ammelide. Melamine is widely used for the synthesis of melamine-formaldehyde resins that are employed in synthetic surfaces of furniture, textiles, and kitchenware as well as	**x**

Compound	Related compounds within the scope of this study	Category	Character-istics	Relevance in	EU Approved as PPP	Comment	Findings within this study
						in moulding and packaging materials. Also used as a fire-retardant.	
Mepiquat	Mepiquat-4-OH	SRM	Highly polar		approved	Growth regulator. Similar to chlormequat, mepiquat has been reported to be formed as a natural processing contaminant through maillard-like reactions, e.g. during roasting of coffee and barley grain.	**x**
Metalaxyl	CGA 107955; CGA 108905; CGA 108906; CGA 62826 (Metalaxyl Free Acid); CGA 67869 (Metalaxyl-O-desmethyl); CGA 94689; 2,6-Dimethylaniline		Rather polar		approved	fungicide	**x**
Metalaxyl Metabolite (CGA 108905)	Metabolite of Metalaxyl CGA 108905				parent approved		**x**
Metolachlor, -S	Metolachlor-sulfonic acid (Metolachlor-ESA); Metolachlor-oxalimic acid CGA 351916 (Metolachlor-OA); S-Metolachlor CGA 357704; S-Metolachlor CGA 368208; S-Metolachlor CGA 37735; S-Metolachlor CGA 50267; S-Metolachlor CGA 50720; S-Metolachlor NOA 413173		intermediate polarity	pollen, wax	not approved	herbicide	
Nicotine		SRM	Highly polar		not approved	Non-approved insecticide. Nicotine originating from tobacco may contaminate food at all stages of food production, through air, soil and human contact. Crops experiencing intensive human contact during harvest or processing are particularly affected.	**x**
Norfloxacin		SRM	Polar			antibiotic	
Oxolinic acid		SRM	Polar			antibiotic	
Oxymatrine	Matrine	SRM	Polar	honey	not approved	residues in honey due to co-blossoming of *Sophora* flowers with acacia, which naturally contain Oxymatrine. See comment on Matrine.	**x**
Oxytetracycline		antibiotics			not approved	antibiotic	
Oxytetracycline, -epi	Oxytetracycline isomer	antibiotics			not approved	antibiotic	
Parathion	Paraoxon; 4-Nitrophenol		Lipophilic	pollen, wax	not approved	insecticide, organophosphate insecticide	
Parathion-methyl	Paraoxon-methyl; 4-Nitrophenol		Lipophilic	pollen, wax	not approved	insecticide, organophosphate insecticide	**x**
Perchlorate		SRM	Highly polar	honey	not listed; regulated as contaminant in Reg. (EC) 1881/2006/EC	Persistent and ubiquitous environmental contaminant. Mainly originating from fertilizers, maybe also formed as a byproduct of disinfection of drinking water. Temporarily inhibits the intake of iodine in the thyroid gland. A contamination of honey by cleaning of equipment for honey harvest is thus conceivable.	**x**
Permethrin	4-OH-PBA; 3-PBA; 3-PBAld		Highly lipophilic	wax, pollen	not approved	pyrethroid, insecticide	**x**

Compound	Related compounds within the scope of this study	Category	Character-istics	Relevance in	EU Approved as PPP	Comment	Findings within this study
Phenylphenol, 2- (OPP)	2-phenylphenol-glucoside	SRM		wax, pollen	approved	fungicide (post-harvest treatment of citrus fruits), biocide, preservative	**x**
Phenylphenol, 2-, glucoside	metabolite of 2-phenylphenol	SRM			parent approved	parent fungicide, biocide, preservative	**x**
Piperonylbutoxid		synergist	Lipophilic	wax, pollen	not yet assessed	insecticidal effect as a synergist for pyrethroids and pyrethrins	**x**
Pirimicarb	Pirimicarb desmethyl; Pirimicarb desmethyl formamido; Pirimicarb-desamido; Pirimicarb-desamido-desmethyl; Pirimicarb-ADHP (2-Amino-5,6-dimethyl-4-hydroxypyrimidine)			wax	approved	insecticide	
Pirimicarb-desmethyl	metabolite of Pirimicarb	metabolite			parent approved	parent insecticide	**x**
Pirimiphos-methyl	Pirimiphos-methyl-desmethyl; Pirimiphos-methyl-N-desethyl; Pirimiphos-methyl-oxon; Primiphos-ethyl; Pirimiphos: 2-(Diethylamino)-6-methyl-1H-pyrimidinol; Pirimiphos: 2-Amino-4-hydroxy-6-methylpyrimidin	metabolite		honey	approved	insecticide	
Propargite	Cyclohexanol-2-(4-tert-butyl-phenoxy) (tBPC)		highly lipophilic	wax	not approved	veterinary drug for varroa mites, acaricide, miticide	**x**
Pyraclostrobin	Pyraclostrobin-desmethoxy	MRM	highly lipophilic	wax	approved	fungicide	**x**
Pyrethrins	Pyrethrin I and II; Cinerin I and II, Jasmolin I and II; Chrysanthemic acid (+)-trans	MRM				pyrethrins, insecticide	
Pyrethrin/Pyrethroid Metabolite (Chrysanthemic acid (+)-trans)	metabolite of pyrethrins/pyrethroids	metabolite	intermediate polarity	honey		parent pyrethroid, insecticide	**x**
Pyrethrin/Pyrethroid Metabolite (3-Phenoxybenzoic acid; 3-PBA)	metabolite of pyrethrins/pyrethroids; degradation product of Fluvalinate, Cyhalothrin, Cypermethrin, Fenpropathrin, Fenvalerate, Flucythrinate, and maybe also Permethrin, Halfenprox, Deltamethrin	metabolite		honey			**x**
Pyrethrin/Pyrethroid Metabolite (3-Phenoxybenzaldehyde; 3-PBAld)	metabolite of pyrethrins/pyrethroids; metabolite of Cyhalothrin, Fenvalerate, Permethrin, Cypermethrin and others	metabolite		honey			**x**
Pyrethrin/Pyrethroid Metabolite (4-OH-PBA; 3-(4-hydroxy) phenoxybenzoic acid)	metabolite of pyrethrins/pyrethroids; metabolite of pyrethroid insecticides such as: Deltamethrin, Permethrin, Cypermethrin, Fenvalerate, Decamethrin	metabolite	intermediate polarity	honey			
Pyrimethanil	Pyrimethanil-4-hydroxy (M605F002; SN614276); Pyrimethanil: 4,6-dimethyl-2-(phenylamino)pyrimidin-5-ol (M605F003; SN614277); Pyrimethanil: 2-amino-4,6-dimethylpyrimidine	MRM	intermediate polarity	pollen, wax	approved	fungicide	**x**

Compound	Related compounds within the scope of this study	Category	Character-istics	Relevance in	EU Approved as PPP	Comment	Findings within this study
Roxythromycin		SRM	polar			antibiotic	
Sarafloxacin		SRM	polar			antibiotic	
Spinosad	Spinosad A, Spinosad D	MRM			approved	insecticide	
Spirotetramat	Spirotetramate-enol; Spirotetramate-enol-glucoside; Spirotetramate-mono-hydroxy; Spirotetramate-keto-hydroxy	MRM			not approved	insecticide, acaricide, miticide	
Spirotetramat Metabolite: mono-hydroxy							**x**
Spiroxamine	Spiroxamine-carboxylic acid	MRM			aproved	fungicide	**x**
Streptomycin		antibiotics			not approved	antibiotic	**x**
Streptomycin, dihydro-		antibiotics			not listed	antibiotic	**x**
Tebuconazole	Tebuconazole-hydroxy	MRM	lipophilic	wax, pollen	approved	fungicide	**x**
Tetracycline		antibiotics			not listed	antibiotic	**x**
Tetracycline, epi-	Tetracycline isomer	antibiotics			not listed	antibiotic	**x**
Thiacloprid	Thiacloprid-amide, Thiacloprid-sulfonic acid	MRM	rather polar	honey	not approved	neonicotinoid	**x**
Thiacloprid-amide	metabolite of Thiacloprid	metabolite	rather polar		parent not approved	parent neonicotinoid	**x**
Thiamethoxam	Thiamethoxam-CGA 353968; Thiamethoxam-CGA 355190; Thiamethoxam: 1-Methyl-3-nitroguanidine; Clothianidin	MRM	polar	honey	not approved	neonicotinoid	**x**
Thymol		MRM		honey	approved	veterinary drug for varroa mites, biocide, fungicide; natural monoterpenoid phenol	**x**
Trifloxystrobin	Trifloxystrobin acid (CGA 321113)	MRM	lipophilic	wax, pollen	approved	fungicide	
Trifluoroacetic acid (TFA)	metabolite of PFAS (polyfluoralkyl active substances)	SRM, metabolite	highly polar		not listed	A metabolite of a multitude of pesticides, veterinary and human drugs. Also metabolite of many widely used fluorochemicals, such as Fluoropolymers, e.g. Teflon®, flame retardants, impregnation agents for fabrics, fluorinated refrigerants and blowing agents, such as 1,1,1-trifluoroethane and 2,3,3,3-tetrafluoropropene and 1,3,3,3-tetrafluoropropene. Very persistent in the environment and an ubiquitous contaminant with some regional hotspots including in surface waters and in groundwater. Classified as a PFAS.	**x**
Trimethylsulfonium	counter-ion of Glyphosate	SRM	highly polaer			counter-ion of Glyphosate; also known as trimethylsulfonium cation	**x**
Tylosin A		SRM	polar			antibiotic	
Validamycin		SRM	polar			antibiotic	
Valifenalate	Valifenalate: β-4-Chlorophenylalanine; Valifenalate-acid (IR 5839); Valifenalate: 4-Chlorobenzoic acid	MRM				fungicide	

6. Summary

Between 2022 and 2024, the EURL SRM and EURL AO performed a pilot monitoring study to get an overview on the pesticide residues found in honey on the European marked.
Therefore, 187 honey samples were analysed for MRM and SRM compounds including pesticides, metabolites, antibiotics and copper.
48 % of the samples originated from non-EU countries, with the majority of them from China followed by Mexico, Turkey and India. 44 % of the samples originated from EU countries, with the majority of them being from Spain followed by Germany, Bulgaria, Greece and France. 6 % of the samples were blends from EU- and non-EU countries while the origin of 1 % of the samples was not specified.
55 % of the samples were classified as blossom honey, 6 % as forest honey (or honeydew honey) and for 39 % of the samples the classification of the honey type was specified.
Around 6 % of the honey samples were advertised as organic, which roughly represents the market share of organic honey in the EU market. In all organic samples at least seven compounds were detected.
In 166 cases, MRL exceedances could be observed, with most of them being related to the non-establishment of reasonable MRLs. The most frequent MRL exceedances (165) were encountered in the case of bromide. While the current MRL is set at 50 µg/kg, the median of all quantified levels was at 421 µg/kg. Bromide is a natural element, and thus naturally present in honey. Natural background levels are generally considered when setting MRLs however this was obviously overlooked in the case of honey. DG-SANTE is aware of this problem and the MRLs will be eventually updated. Surveillance and enforcement of the current MRL is in our opinion not reasonable as long as the MRL is not adjusted.
A similar situation applies to copper, which is also an ubiquitous element. Copper was found in all analysed samples (N= 75) within this study. The median of all quantified levels was 171 µg/kg. At the time of the study no specific MRL was set for copper and the default MRL of 0.01 mg/kg formally applied. An MRL considering the background levels will be soon established.
Other compounds with MRL exceedances were azoxystrobin (1x), chlorate (2x), glyphosate (4x) and matrine (2x).

Phosphonic acid and copper were determined in all samples. Further compounds with a frequency of findings > 80% were: Bromide, cyanuric acid, perchlorate, and TFA. As expected, most compounds found within this study in honey have a rather polar character. Compounds with a frequency of findings in the range between 20% and 80% were: 2-phenylphenol, 2,4-D, acetamiprid, coumaphos, amitraz Metabolite- N-(2,4-Dimethylphenyl)-N-methylformamidine, carbendazim, chlorate, melamine, mepiquat, nicotine, and thiacloprid.
Traces of pesticides or their metabolites or other contaminants were found in all analysed samples and none was residue free.

7. References

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Annex

Table A1.1: *List of Samples*

Country	Type	No. of samples	Comments
Argentina	Unspecified	5	
Australia	Manuka honey	1	
	Macadamia honey	1	
	Unspecified	1	
Brazil	Unspecified	5	One organic sample
Bulgaria	Cilantro honey	1	Organic
	Forest honey	1	Organic
	Thistle honey	1	Organic
	Unspecified	5	
Chile	Forest honey	1	
	Unspecified	2	
China	Buckwheat honey	1	
	Unspecified	23	
Costa Rica	Blossom honey	5	
Croatia	Blossom honey	1	
	Blossom honey with lavender aroma	1	
	Chestnut honey	1	
	Linden honey	1	
Cuba	Unspecified	4	
Cyprus	Blossom honey	1	
France	Blossom honey	5	
	Lavender Honey	2	
Germany	Acacia honey	2	
	Blossom honey	8	One organic sample
	Rape honey	1	
Greece	Blossom honey	3	
	Blend of blossom honey, herbs honey, conifers honey and thyme honey	1	
	Forest honey	1	
	Lavender honey	1	
	Orange blossom honey	1	
	Blend of pine honey and thyme honey	1	
Hungary	Acacia honey	1	
	Unspecified	5	
India	Blossom honey	1	

Country	Type	No. of samples	Comments
	Unspecified	5	
Iran	Blossom honey	3	
Italy	Acacia honey	1	Organic
	Blossom honey	1	Organic
	Blend of forest honey and chestnut honey	2	
	Lemon honey	1	
Mexico	Avocado honey	1	
	Blossom honey	2	Organic
	Unspecified	5	
Moldavia	Blossom honey	1	
	Sunflower honey	1	
New Zealand	Manuka Honey	1	
Poland	Phacelia honey	1	
	Whitethorn honey	1	
Portugal	Blossom honey	2	
	Lavender honey	1	
Romania	Rape honey	2	One organic sample
	Unspecified	4	
Slovenia	Forest honey	1	
Spain	Almond honey	1	
	Avocado honey	1	
	Blossom honey	1	
	Broom honey	2	
	Erica honey	1	
	Eucalyptus honey	1	
	Lavender honey	1	
	Lemon honey	1	
	Oak forest honey	1	
	Orange blossom honey	3	
Turkey	Acacia honey	1	
	Blossom honey	5	
	Pine honey	1	
Ukraine	Unspecified	5	
Uruguay	Eucalyptus honey	1	
USA	Clover honey	1	
	Orange blossom honey	1	
	Wildflower honey	1	
EU (unspecified origin)	Linden honey	1	
	Sunflower honey	1	

Country	Type	No. of samples	Comments
Non-EU (unspecified origin)	Blossom honey	1	
	Pine honey	1	
EU blend	Blossom honey	1	Greece/Bulgaria
		1	Italy/Austria
	Blend of Acacia and blossom honey	1	Hungary/Romania
	Forest honey	1	Spain/Greece
Non-EU blend	Blossom honey	1	Mexico/Nicaragua
	Clover honey	1	India/Vietnam
	Unspecified	1	USA/Argentina/Brazil/India
EU/non-EU blend	Acacia honey	2	
	Blossom honey	2	
		1	Hungary/Ukraine
		1	Italy, Ruanda, Hungary, Moldavia
		1	Spain/Argentina/Uruguay/Ukraine
	Blend of Blossom honey and citrus honey	1	
	Blossom honey with comb	1	
	Buckwheat honey	1	
	Orange blossom honey	1	
	Unspecified	1	Spain/Portugal/Poland/Argentina
Latin America blend	Blossom honey	1	Chile/Mexico/Uruguay
		1	
Unspecified origin	Blossom honey	1	
	Unspecified	1	