Technical Round Table on Honey Authentication

JRC-Geel, Belgium

25 January 2018

Meeting Report

March 2018
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Executive Summary

This report presents the outcome of the technical round table on honey authentication, which was held in Geel (BE) on 25th January 2018. The purpose of the meeting was to collect the opinion of a broad representation of stakeholders of the honey supply chain on the current challenges to authenticate honey, to identify the gaps in available tools and knowledge and identify ways of filling those gaps. In a highly participatory manner the most common forms of honey fraud were discussed and needs for addressing them in an effective manner identified. Among them were the lack of analytical methods to detect the addition of certain types of sugar (syrup) and non-authorised processing of honey such as (ultra)filtration, inappropriate used of bee feeding with sugar (syrup) and resin treatment and effective infrastructures for the validation of analytical methods and the provision of quality assurance tools, i.e. reference materials and proficiency testing rounds. Most important appeared the need for modernised purity criteria of honey that have to go beyond the basic quality requirements laid down in current EU legislation. Such criteria could take the form of an electronic collection of chemical fingerprints against which a suspect sample can be compared for assessing its authenticity and/or correctness of label declaration.

In particular the Round Table suggested that the following actions should be undertaken:

- A critical review of the current definition of identity and purity criteria of honey is necessary;
- Acceptance / rejection criteria for authenticating honey are needed;
- An appropriate analysis of the vulnerability of the honey supply chain should be done and an improved traceability system implemented;
- Screening methods should be developed to economise testing;
- Analytical methods to detect emerging fraud cases should be developed and already existing methods have to be validated;
- A mechanism for providing quality assurance tools should be established;
- Chemical and biological characteristics of genuine honeys (including blends), bee feeding products, and products from inappropriate practices should be generated and stored in a publicly available database.

A coordinated effort involving all stakeholders of the honey supply chain and competent authorities will be necessary to create an efficient mechanism for delivering the required tools and infrastructures.
Introduction


European apiculture is a niche sector of agricultural production and is dominated by nonprofessional beekeepers. Overall, EU honey production has been increasing slowly with annual variations depending on climatic conditions. However, keeping this level of production is becoming harder for beekeepers due to the challenges they face in terms of bees’ health and environmental constraints. Despite being the world’s second largest honey producer, the EU is a net importer of honey as domestic production only covers around 60% of consumption. The main supplier of honey imported into the EU is China, followed by Ukraine and countries in Latin America.

The European Commission has regularly been informed of the presence on the market, in a potentially significant proportion, of honey that may not meet the composition criteria laid down by the Council Directive 2001/110/EC and/or that is not the result of the production process required by the legal definition of honey. Moreover, despite the progress realised so far, scientific knowledge concerning honey chemistry and technology lags behind the inventiveness of dishonest operators. Therefore the development of efficient anti-fraud methods is necessary in order to avoid disturbance of the market and the deterioration of the image of honey.

Thirty-three experts (Annex 1) working in the field of honey authentication were invited by the Directorate-General Joint Research Centre (DG JRC) to discuss the currently most challenging issues related to honey quality and authentication and to prioritise actions for solving them.

The main objectives of the technical round table were: i) to evaluate the capabilities and limitations of currently used methods to monitor honey authenticity, and ii) to collect input for setting up a roadmap to improve the currently used technology for authenticating honey. For reaching these objectives it is appropriate to joint efforts at European and international levels, to involve all key players, and evaluate the advantages / disadvantages of the official methods and of emerging methods that, ideally, should be faster, cheaper, and more robust and be accepted worldwide.

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Setting the scene

Three presentations summarised the state-of-the-art for detecting adulteration of honeys with exogenous sugars and for identifying the geographical and botanical origins of honeys.

A. Maquet (DG JRC) summarised the results of honey authenticity testing by liquid chromatography-isotope ratio mass spectrometry (LC-IRMS).

In 2015 the European Commission organised an EU coordinated control plan (Commission Recommendation C (2015) 1558) to assess the prevalence on the market of honey adulterated with sugars and honeys mislabelled with regard to their botanical source or geographical origin. All 28 Member States plus Norway and Switzerland participated in the plan. They collected over 2000 samples of honey at all stages of the supply chain. The coordinated control plan foresaw a three tiered approach for the analysis of the collected honey samples:

- All samples were analysed by the Member States for sensory characteristics and pollen profiles to check compliance with relevant provisions of the EU Honey Directive (2001/110/EC);
- Compliant samples were then submitted to sugar analysis;
- The samples which passed all these checks (or seemed suspicious) were then sent to the JRC for testing by LC-IRMS.

Member States submitted to the JRC, 893 samples of honey which they had found to be compliant during tests in Tier 1 and Tier 2. By using LC-IRMS the JRC found that 14% of the samples tested were suspicious of containing added sugar. This was further broken down according to the declared geographical origin, point of collection (i.e. producer, packager or retailer) and type of honey. Overall, the results indicated that the practice of adding sugars to honey occurs within the EU and in third countries.

The applied technique (analytical method together with the decision criteria) has not been validated in multi-laboratory studies conducted at the international level. It relies on empirically determined benchmark purity criteria, taken from the published literature so that the selection of honeys used to set the benchmark may influence the compliance decision. Further action is thus necessary to establish the robustness of the results required for evidence in enforcement action.

A. Charlton (Fera Ltd, UK) presented the potential of Nuclear Magnetic Resonance (NMR) to detect honey adulteration as a complimentary approach. NMR spectroscopy has been successfully used to identify biomarkers of botanical and geographical origin for European honey. The accurate and rapid measurement of methylglyoxal, a biomarker of Manuka honey, using quantitative NMR was also reported. Thus the potential of NMR to detect adulteration related to botanical and geographical origin is promising.

3 https://ec.europa.eu/food/safety/official_controls/food_fraud/honey_en
Concerning the detection of sugar adulteration, a thorough investigation highlighted that current databases of honey NMR spectra may not be representative of the international honey market and should take into account variation due to seasonality and permitted practises such as blending. Interpretation of NMR spectra of immature honeys and blends seem to be problematic due to ambiguity about permitted practises. It is therefore recommended to validate the methods of analysis for honey (particularly NMR, LC-IRMS and DNA based pollen tests), to ensure the quality of the honey database, to establish more transparent criteria for deciding whether a honey is adulterated and to improve the understanding of honey production within and particularly outside of the EU.

G. Kaklamanos (DG JRC) introduced the main aspects of a targeted and untargeted mass spectrometry based metabolomics workflow to detect honey adulteration. Ultra-High-Performance Liquid Chromatography coupled to High-Resolution Quadrupole-Orbitrap Mass Spectrometry (UHPLC-Q-Orbitrap), can be applied to detect the oligosaccharide and polysaccharide profile of honey samples (targeted metabolomics) and to indicate addition of sugar-based adulterants or malpractices of bee feeding. Preliminary threshold levels were estimated for a few oligosaccharides, which could be used as markers for detecting honey adulteration. An untargeted metabolomics approach combined with advanced multivariate data analysis seemed to allow the discrimination of honey samples of different geographical and / or botanical origin.

After the overview on the state-of-the-art and challenges in detecting honey adulteration, the participants were invited to indicate what measures are efficient and what areas would need improvement or action regarding the fight against honey adulteration (Annex 2).

The existing analytical methods for basic quality control of honey, the efforts to start harmonizing them, some databases and the current legal framework was considered as appropriate. The motivation of the entire honey sector to collaborate was also stressed.

The currently unresolved issues highlighted by the participants could be grouped in four main categories:

- **Infrastructure needs**
  Participants mainly stressed that coordinated and robust sampling and testing campaigns should be organized. Openly accessible and trustworthy databases and expert networks were also mentioned as being important.

- **Types of fraud**
  Participants mainly stressed the need for a better definition of honey authenticity; more specifically, questions related to acceptable bee feeding practices and industrial processing of honey were raised.

- **Analytical tools**
  The main topics concerned the validation of existing and new methods through ring trials, the improvement of the methods (accuracy, application domain, data fusion), the availability of emerging methods (e.g. NMR, High Resolution Mass Spectrometry - HRMS), the
harmonization of analytical methods and the validation of the decision criteria for purity and authenticity.

- **Legislation**
  Some participants suggested also providing more detailed provisions for honey authenticity in the relevant EU legislation.
Outcome of World Café Discussions

A participatory approach was used to engage the participants in group work to answer the following questions:

- **Types of fraud**
  - Where in the honey supply chain is the risk of adulteration highest?
  - What types of fraud are most frequently observed?

- **Appropriate analytical tools**
  - What kind of analytical tools do we have to tackle honey adulterations?
  - What are the limitations of these tools?
  - What should be improved?

- **Infrastructure needs**
  - Which infrastructures are needed to tackle honey adulterations?
  - Are sufficiently standardized / harmonised analytical methods available?
  - Are the required quality assurance tools (e.g. proficiency tests, reference materials) available?
  - Are database available?

After harvesting the answers / suggestions participants prioritized the issues that should merit actions from policy makers.

Concerning the types of fraud in the honey sector and where they most frequently occur in the supply chain, participants felt that honey imported to the EU does not always comply with purity benchmarks, but a lack of detailed statistics makes a comparison to other food supply chains difficult. It was therefore generally agreed that there is a knowledge gap about where in the supply chain fraudulent manipulations occur. However, the importance of identifying the most vulnerable stage in the supply chain and to better focus honey control activities to those stages was stressed. As a solution, blockchain technology coupled with sharing of analytical fingerprints was suggested as a way to trace honey from the beehive to the consumers and to control its quality.

The identified fraud types were prioritized into five major classes. It has been noted that in reality class boundaries may have varying geometries as honey can be adulterated in several ways.

1. **Addition of sugar**
   Addition of sugar was identified as the most frequently occurring type of fraudulent manipulation. Exogenous sugar can originate from inappropriate bee feeding and / or from a direct addition of sugar / syrup to honey, and the difficulty in differentiating the origin was pointed out. Honey from sugar fed bees was mostly considered a malpractice, whereas the
addition of sugar / syrups was considered fraud. A list of possible bee feeding materials and sugars / syrups used for adulteration could be a useful starting point for analytical control.

2. Mislabelling
Mislabelling with respect to botanical- and geographical origin, mono-floral vs. poly-floral honey, and blossom vs. honeydew honey was highlighted as the second most important type of fraud. The practice of adding pollen or monofloral honey to ultrafiltered honey and then labelling it as a monofloral honey was highlighted as a fraudulent practice that is difficult to identify. Additionally, a lack of EU regulatory limits for the relative amount of specific pollen types in monofloral honey impedes regulatory follow up. A regulated minimum content of pollen from a specific plant species in monofloral honey was suggested. Others suggested guidelines on the interpretation of the EU honey Directive; notably with respect to pollen content.

3. Resin treatment / ultrafiltration (followed by blending)
Addition of pollen to ultrafiltered honey or the dilution of good quality honey with ultrafiltered honey was discussed. Some participants reported that natural honey constituents such as pollen and different enzymes are added back to filtered honey to match the characteristic of genuine honey, and that these products are sold at different prices depending on e.g. the enzyme activity of the adulterated honey. Synthetic resins are illegally used to remove unwanted substances (antibiotics, pesticides, etc.) from honey; a potential health issue with the use of resins may result.

4. Bee feeding
Bee feeding is widespread and accepted; however, feeding has to stop when nectar flow starts. Some carry over is practically unavoidable and should be considered in the analytical control. There was a discussion about the possibility to standardize bee feeding practices, which is difficult due to climatic differences between EU countries.
To aid the analytical control of exogenous sugar in honey, it was suggested that bee feeding material could be co-sampled when honey is collected in the national honey control programmes.

5. Immature honey
It was generally agreed that immature honey is not properly defined in legislation, and a guidance document is needed. It was argued that it might be difficult in some countries to reach < 20% moisture before harvest as a result of a humid climate. The discrimination between industrially dried immature honey and mature honey is an analytical challenge.

Concerning the appropriate analytical tools, their limitations and the needed improvements to tackle honey adulteration, a wide variety of techniques already exists at different stages of development / implementation in the concerned laboratories. Participants mentioned the following techniques:
• **Conventional analysis:** physicochemical analysis (e.g. *pH*, *moisture*, *colour*, *electrical conductivity* and *hydroxymethylfurfural* - HMF), foreign enzymes analysis (*amylase*), rheological analysis, melissopalynology and sensory analysis (*colour*, *aroma* and *flavour*). Most of them are official and harmonised methods.

• **Isotopic measurement techniques:** Elemental Analysis - Isotope Ratio Mass Spectrometry (EA-IRMS) as an official method and LC-IRMS as a benchmark method.

• **Separation techniques** (official and harmonised methods): sugar profiling by High Performance Liquid Chromatography (HPLC) or Gas-Liquid Chromatography (GLC) (low cost, readily available screening tool).

• **Spectrometric techniques:** LC-HRMS for targeted and untargeted metabolomics, LC-MS/MS for marker detection and GLC-MS for aroma profiling.

• **Spectroscopic techniques:** Fourier Transform Infrared (FTIR) or Near-Infrared (NIR) (screening tool) spectroscopy and NMR for targeted and untargeted metabolomics.

• **Trace elements:** profiling by Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

• **Molecular Biology:** DNA barcoding and Next Generation Sequencing.

• **Statistical tools:** chemometrics, data fusion of non-targeted methods, multiplexing data from different techniques and decision tree approaches.

• **Other:** biosensors.

Other topics mentioned during the discussions concerned sample preparation (*should be simplified*); conflicting results when using different assays for the determination of diastase activity (*Schade* vs. *Phadebas* assays); establishing ranges of electrical conductivity for botanical origin; limitations on the dynamic range and signal overlapping in some methods; need for definition of analytical/quality parameters for non-targeted methods (*limit of detection, limit of quantification and specificity*); and specific concerns related to NMR spectroscopy (*sensitivity at low concentration levels, lack of resolution – signal overlapping and need for “expert interpretation”*), influence of commercial treatment (e.g. *filtering*) on certain characteristics of honey (e.g. *NMR profile*).

The experts highlighted the following limitations and consequently needs for improvements: harmonisation, availability of databases, networking and quality assurance tools. As these areas of activities were also clearly reported by the participants in the next and last topic "Infrastructure needs", they will be summarised in that paragraph.

The poor cost effectiveness of the available set of analytical methods was criticized as several methods are currently necessary for comprehensive purity checking of honey, which increases the overall cost and requires investments that many official laboratories have difficulties to fund. Moreover, loss of credibility of non-harmonised tests due to different data interpretation and contradicting testing results provided by several laboratories for the same sample prevent such tests from being widely accepted.

It was noted that guidance on using complementary analytical methods and contextual awareness in data interpretation would provide confidence in testing outcomes. In this regard, it should be recognized that analytical results are not the only criteria for decision making, but other factors such as, price, traceability, etc., need to be taken into account for triggering legal action/enforcement.
The **needed infrastructures** to tackle honey adulteration were divided in four main areas: regulation, databases, quality assurance tools and networking *(Annex 3)*.

1. **Regulation**
   - International agreements are necessary for a better definition of honey, bee feeding, bee feeding products, harvesting, Good Manufacturing Practice (GMP); some could be integrated in the EU Honey Directive (2001/110/EC).
   - Improved traceability programmes are needed. The potential of Blockchain for improving traceability and control in the honey sector should be investigated.
   - Improve and multiply borders control in particular at the main ports where non-EU honeys enter the EU (e.g. Antwerpen / Rotterdam / Valencia, etc...).
   - Acceptance / rejection criteria for honey should be put in place as well as a foreign supplier certification system to prevent fraud and control better the quality of products.
   - Need for monitoring plans along the whole supply chain to improve the control effectiveness (in particular at the beekeeping and honey reselling stage) including Commission audits.

2. **Databases**
   - Databases storing information of compositional characteristics of honey need to be representative, trustworthy, and accessible (not only to EU official control lab; open access).
   - A clear definition is required on what exactly is 'authentic' honey in order to decide which samples can be used to populate the databases.
   - Difficulty for getting authentic honey, especially from non-EU countries (harmonisation of limits, e.g. moisture level when harvested) and to trace them throughout the food chain (from producer to retailer).
   - Access to authentic samples is a critical point for populating databases: sufficient samples (not only honey reflecting worldwide production but also bee feeding products, sugar syrups, and products from inappropriate practices) and in sufficient amounts should be collected directly from beekeepers or from suppliers by a person qualified for sampling. This is an expensive process (several years of production from the same sites should be foreseen) and will require putting in place local networks.
   - Metadata is important and should include information regarding botanical/geographical origin, bee species, season / year of production, storage practices, bee feeding practices, processing characteristics, blending practices, composition, filtering, etc.
   - Already existing initiatives for sharing data: Food Industry Intelligence Network (FIIN) in UK, a network of technical leaders to share knowledge on food authenticity and traceability, or the European Reference Centre for Control in the Wine Sector (ERC-CWS) and its EU wine database.
3. **Quality assurance tools (harmonisation / standardisation, reference materials, proficiency testing, etc.)**

- Reference materials are needed for sugar syrups, adulterated / non adulterated honey (e.g. TUBITAK certified reference material for carbon isotope ratios in honey), treated honey ((ultra)filtration, resin treatment).
  The main issue with regard to honey reference materials will be the shelf life of the reference material (only one year for certain parameters – the stability of some sugars could also be an issue (i.e. trisaccharides / oligosaccharides).
- Standardised methods are needed. Some methods are mature enough for already organising proficiency tests, in particular for EA/LC-IRMS. This work should lead to the harmonisation of acceptance limits for authentic honey accepted by all control laboratories and possibly to the standardisation of the method.
- Harmonised approaches by authorities within EU-28: definition of monofloral honey; melissopalynology including interpretation of results; set-up limits / threshold levels for bee feeding; statistics and compliance criteria (agreement on confidence levels); guidance on recovery correction and application of measurement uncertainty.

4. **Networking**

- Coordination by an independent body (EU Commission / other EU body) is needed to better inform / train official control laboratories in terms of developing guidelines for sampling and analytical methods (e.g. selection of methods to support legislation); and identifying Reference Laboratories.
- Network of competent laboratories equipped with state-of-the-art analytical techniques. Several good initiatives already exist such as the German National Reference Centre for Authenticity and Integrity of the Food Chain and the UK virtual network hosted by LGC (composed of 14 participating laboratories).
- Enhance and facilitate networking and communication (e.g. webpages, electronic working groups, physical meetings, feed into Virtual Authenticity Network, involving Food Authenticity Centres of Expertise).
- Network needs also to be extended at the international level: exchanges of experience and stakeholder collaboration.
- Gain knowledge from already existing networks (e.g. Sure-Global-Fair - SGF in fruit juices).
- Need of a referee (independent authority) in case of dispute (related to methods and results).
- Funding is very important. National initiatives could contribute (e.g. UK may be able to obtain some national funding) but there would be a need to join forces.
Conclusions and recommendations

All participants agreed that there is an urgent need to initiate actions to better control the honey sector.

A critical review of the current definition of identity and purity criteria of honey is necessary. It was acknowledged that adapting the EU Honey Directive would also require action at the FAO/WHO Codex Alimentarius level to revise the respective Codex honey standard (STAN 12-1981). Alternatively, complementary purity standards as well as corresponding analytical methods could be created via Standard Developing Organisations such as the International Organization for Standardization (ISO) or the International Honey Commission (IHC). Clearer product definitions are needed in particular for monofloral honeys, bee feeding and industrial practices such as resin treatment, drying of immature honey and (ultra)filtration in order to enable regulatory compliance testing by control authorities.

Acceptance / rejection criteria for authenticating honey are needed. A survey among Member States' competent authorities should be conducted to canvass national provisions and practices beyond the EU Honey Directive to authenticate honey. The outcome of this task should be a guidance document on good practices as well as currently used decision criteria concerning honey authentication. Lack of such agreed criteria impedes regulatory follow up and in some Member States investments into infrastructure to fight honey adulteration.

An appropriate analysis of the vulnerability of the honey supply chain should be done and an improved traceability system implemented. Close monitoring of honey production statistics and trade flow data combined with a vulnerability model of the honey supply chain is a pre-requisite for informing auto-control actions by private stakeholders as well as targeted controls by the competent authorities. Blockchain technology seems to be a promising way to improve product traceability and transparency along the supply chain but unfortunately its application to fight food fraud is still in its infancy.

Screening methods should be developed to economise testing. Generally, the laboratories are well equipped for detecting conventional honey frauds and particularly for basic quality controls (moisture, electrical conductivity, etc); however, there is a need for screening tools to cope with the huge amount of samples to be tested in an economically feasible manner. Moreover, as several analytical methods are needed for confirming the genuineness of a honey sample, a general screen for singling out suspicious samples for further testing will improve the cost effectiveness of the control system.

Analytical methods to detect emerging fraud cases should be developed and already existing methods should be validated. Participants identified a need for methods to detect the addition of industrially dried immature honey and/or (ultra)filtered honey to extend genuine honey; addition of pollen and or enzymes to (ultra)filtered honey; intentional overfeeding bees with sugar (syrups). Several modern spectroscopic methods which are already in use by service providers or research institutions have to be validated and standardised so that they can be used for official control purposes. The scope of a method shall be clearly described as well as the application of complementary methods for confirming a suspicious result.
A mechanism for providing quality assurance tools should be established. Reference materials and proficiency testing schemes are needed to provide evidence that methods are correctly applied by laboratories and for establishing trust in testing results by all involved parties.

Chemical and biological characteristics of genuine honeys (including blends), bee feeding products, and products from inappropriate practices should be generated and stored in a publicly available database. This process would require obtaining samples by authorised personnel from carefully selected honey producers. The (bio)chemical and biological composition of those samples and their characteristic fingerprints obtained by modern analytical techniques have to be generated by competent laboratories and the resulting data stored in an appropriate database. Private sector mentioned that the authenticity of a sample will have to be defined beforehand. As databases already exist, there was a discussion on the need to rebuild a new one; alternatively, the possibility to effectively share the information under which conditions should be investigated. The database should be (openly) accessible and for reasons of trustworthiness and neutrality it should be created and curated by an independent institution. It was noted that the validation of the information contained in the database will be a prerequisite for its use in official control activities.

The way forward. A concerted action including all stakeholders of the honey supply chain is needed to fight adulteration and malpractices in the honey sector in order to protect the reputation of European beekeepers and honey packers as well as basic consumer rights. As several tasks have to be initiated in parallel; therefore, effective coordination by a body independent of national and commercial interest will be needed. Participants suggested that at the technical level the DG JRC should be entrusted with this task while for political decisions existing expert groups already coordinated by DG AGRI shall take the lead. Collaboration among European stakeholders and between them and international players is a key element in a future action plan. In Europe, DG SANTE and DG AGRI, the competent authorities of the Member States and their national apiculture programmes, industry, beekeeper associations and consumer association are players that shall contribute to the implementation and execution of an action plan. In addition, reaching out to the international level by involving Standard Developing Organisations such as ISO and IHC for setting specifications and standardising test methods as well as to several honey exporting countries for getting access to authentic honey samples will complement activities at the European scale and enlarge the understanding on constraints and needs related to the control of honey authenticity.

The success of such an action plan will only be possible if appropriate resources are provided and the work is carried out in a well-coordinated manner by a network of relevant stakeholders. Initiatives started by competent authorities in the Member States or other stakeholder are welcome but need to be embedded in a wider network in order to avoid non-harmonised standard setting that could in the end create barriers to the free movement of goods in the Internal Market.
Acknowledgements

JRC would like to thank all participants for their contributions during the Round Table discussion.

In order to stay updated on the development of further actions on honey adulteration as well as on the documents provided during the technical round table please consult the following link:

Annex 1. List of participants.

<table>
<thead>
<tr>
<th>First Name</th>
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<th>Nationality</th>
<th>Organisation</th>
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<tbody>
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<td>Filippo</td>
<td>ABRUZZO</td>
<td>ITA</td>
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<td>Vadims</td>
<td>BARTKEVICS</td>
<td>LVA</td>
<td>Institute of Food Safety - Animal Health and Environment &quot;BIOR&quot;</td>
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<tr>
<td>Patricia</td>
<td>BEAUNE</td>
<td>FRA</td>
<td>Famille Michaud Apiculteurs / FEEDM</td>
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<td>Gudrun</td>
<td>BECKH</td>
<td>DEU</td>
<td>IHC (respectively QSI)</td>
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<td>Klaus</td>
<td>BECKMANN</td>
<td>DEU</td>
<td>Intertek Food Services GmbH</td>
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<td>Viktorija</td>
<td>BELSAK</td>
<td>SVN</td>
<td>Administration of the Republic of Slovenia for Food Safety- Veterinary Sector and Plant Protection</td>
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<td>Cynthia</td>
<td>BENITES</td>
<td>FRA</td>
<td>Copa-Cogeca</td>
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<td>Etienne</td>
<td>BRUNEAU</td>
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<td>Copa-Cogeca + CARI</td>
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<td>CABANERO</td>
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<td>Adrian</td>
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<td>Fera Science Ltd</td>
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<td>Selvarani</td>
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<td>ELFLEIN</td>
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<td>Eurofins Food Integrity Control Services (also member of IHC)</td>
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<td>Valeo Foods (via Fera; UK Honey Assoc.)</td>
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<td>Matrinita (via Mr Quaglia; FEEDM)</td>
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<td>OBEL</td>
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<td>SCHWARZINGER</td>
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<td>Research Center for Bio-Macromolecules - University of Bayreuth</td>
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<td>TITERA</td>
<td>CZE</td>
<td>Vyzkumny ustav vcelarsky (Bee Research Institute)</td>
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<td>Michael</td>
<td>WALKER</td>
<td>GBR</td>
<td>Laboratory of the Government Chemist- LGC</td>
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<td>John</td>
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<td>Jorge</td>
<td>SORRIBES</td>
<td>ESP</td>
<td>ASEMIEL-ANIMPA</td>
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Annex 2. Mind map of areas for improvement of control in the honey sector.