Joint Statement on Honey Adulteration

Apimondia, BeeLife, EPBA, COPA-COGECA

To date, there is no single measure effective enough to control the problem of fraud in the honey sector. The international market will therefore require diversified actions at all levels of authority. A strategic plan needs to be put in place that coordinates the various players. A vulnerability assessment of the market chain must be urgently carried out to identify the different factors that contribute to honey fraud. As we understand, the best way to protect the honey supply chain is to combine organizational and administrative measures with appropriate analysis and controls as indicated by the vulnerability assessment.

A. Honey: Legal framing, knowledge of different types of honey and monitoring of production.

Legislation

A clearer, unique and universal conceptual framework for what we call "honey" is needed.
With exceptions (EU, Canada, Australia…) honey standards are not compulsory. Moreover, there is a lack of uniformity in the quality and authenticity control methods between different national standards. However, the documents cited below are much more aligned with the natural characteristics of food produced exclusively by bees than other honey legislations (e.g. China).

Current legislation and international standards
While the definition of honey in CODEX Standard (CODEX STAN 12_1981) gives a useful conceptual framework for the product, it includes only old analytical techniques for detecting fraud. This point is currently discussed. The Honey Directive (2001/110/EC, amended by (EU)2024/1438) is also based on CODEX definitions but provides more detailed quality parameters. Certain points are currently discussed on the EU Honey Platform. In 2021, the US Pharmacopeia published the USP Honey Identity Standard in the Food Chemicals Codex. A Honey Expert Panel formed in 2018 was responsible for its preparation. Since 2019 within the ISO, a working group dedicated to honey, prepared an ISO Standard - Honey Specification. The work took the internationally recognized definition of Honey in the Codex alimentarius as baseline. However, work is still ongoing at present.

To ensure that the international trade of honey meets the most recently drawn up and accepted criteria of the main importing countries (the US and the EU), the products that do not meet these criteria must be withdrawn from the market quickly.

Knowledge of the different honey types

The constitution of a validated database containing a maximum number of quality and authenticity criteria (samples must be taken directly from the hives or we must know exactly the origin and they must not be transformed), ideally linked to a reference honey bank of authentic, non-adulterated honeys is needed. These honeys must come from all the important producing countries and must be produced through good beekeeping practices (e.g. avoiding the introduction of artificial feeding residues).

Requirements for a honey database:
- The sample collection must adequately cover the main geographical and botanical origins, considering seasonal variations to allow the exact knowledge of any natural occurrence of a proposed adulteration marker. The number of samples must be sufficient to achieve the necessary level of the confidence in the results. - The honey samples should be linked to a standardized international form presenting data related to honey (E.G. time to harvest, geodata…). - The collection of samples should always be continued. - The database itself should not be publicly accessible. However, the statistical service that should be built on this database should be available to all official and private laboratories for the evaluation of their honey analyses. - Beekeeping experts should be directly involved in the control and management of this honey database.

Honey constitutes a very complex matrix, and more information is needed on:

- pollen in honey (very important for monofloral honeys): density, sizes, spectrum and natural variability.
- naturally occurring sugars in honey, including those present even at trace levels (EU project "Harm Honey").
- heating indicators (HMF, enzymes, etc.) for the determination of acceptable decrease in quality, also considering the possible effects of climate change.

Current situation
The private laboratory sector has developed comprehensive databases to validate its analyses. The largest of these appears to be Bruker's database for NMR technique.

Monitoring of honey production

To detect economic anomalies and to determine critical control points, a comprehensive view of the situation in different honey-producing and exporting countries is necessary, both from a production and commercial point of view:

- National socioeconomic situation (political stability, economic situation, corruption index, etc.);
- Course of the annual honey season in the major production regions (climate events);
- Environmental conditions (presence of pesticides, etc.) and health conditions, including the presence of pests and predators that may impact production. Evolution of the number of hives and hives owned by beekeepers for whom honey production is an important source of income;
- Beekeeping techniques used to produce honey (feeding products, methods, etc.);
- Cost of production/hive for stationary and migratory beekeeping operations;
- Number of intermediaries and transparency of the supply chain from the beekeeper to the consumer or exporter;
- Market prices in the country, price formation, and trade policies (duties, antidumping measures, etc.)

To date, only general data has been transmitted to the FAO. The above-mentioned information and data should be centralized through the creation of a global honey observatory, an ambitious but essential goal.

B. Honey Fraud

Legislation

FAO CODEX

In November 2024, CAC47 (Codex Alimentarius Commission 47) adopted the Guidelines on the prevention and control of food fraud and will meet in 2026 for final approval.

The European Union

The EU developed specific legislation on Food Fraud (an intentional act of non-compliance) with the violation of the rules referred to in Article 1(2) of Regulation (EU) 2017/625.

Current situation in EU
Honey has been considered a safe commodity, so the sector is not highly regulated from a food safety perspective. Due to this fact, very few controls were done before 2022. A decision was taken in the EU to focus on Vulnerability Assessment of Critical Control Points (VACCP). VACCP is like HACCP but about vulnerability to food fraud at each step of the production and market chain. The EU coordinated action "From the Hives" was put in place in 2021 ("Coordinated performance of official controls" Regulation EU 2019/1873). Additionally, the EU changed the burden of proof; the country exporting to the EU having to demonstrate that the exported honey is compliant with the EU legislation (Authenticity certification Regulation EU 2022/36).

The United States

The United States Code (U.S.C.) §342 (USCODE, 2011), by Title 21 – Food and Drugs, Chapter 9 – Federal Food, Drug and Cosmetic (FD&C) Act, Subchapter IV provides the legal frame for food fraud in the US.

Current situation in the US

The US has implemented an anti-dumping system aimed at preventing honey sold at prices below its production cost from entering its market. In this situation the greatest challenge has always been verifying the country of origin of honey and establishing whether the product falls within the scope of the anti-dumping order. ICP-MS methodology has been used to test the origin of honey and to create a map of the major transshipment points. More recently, authorities incorporated NMR plus sugar profile testing to improve the work done with ICP-MS.

The Expert Panel formed by the US Pharmacopeia will be soon publishing the Honey Fraud Mitigation Guidance in the Food Chemicals Codex.

Generally, seeking regulatory changes is a long and difficult process. This does not mean it should not be pursued, but we should be aware that it is a long-lasting procedure with scarce short-term results to prevent fraud. Governments are often too slow to act, while fraudsters are very fast. While legislative aspects are an essential basis for action, other equally important and more rapid measures such as inspections, analyses and audits should not be neglected.

Modes of fraud

Although the various forms of fraud in the honey market are well known, one must always keep an eye out for possible changes by following literature, conducting internet searches and listening to whistleblowers and experts.

Modes of Fraud:

- Violation of the definition of honey by adding foreign elements (sugar syrups, pollen, dyes, enzymes…), or by removing natural constituents (filtration of pollen, use of resins to lighten the color, etc.), or by using artificial processes to replace the work of bees (vacuum dehumidification …);
- Falsification of administrative documents;
- Mislabelling the geographical or botanical origins;
- Intentional labelling errors (weight, address, etc.).

Control authorities and laboratories must have a comprehensive knowledge of the process used by the fraudsters (technologies to produce syrups, use of multiple raw materials, multiple adulteration modes …) to characterize markers. New adulteration modes or materials constantly appear and may change the presence of markers. The detection strategy must always be adapted to recognize the evolving nature of fraud.

The access of fraudsters to relevant information (control plans, international syrup data base with the markers…) must be restricted to avoid or at least to limit measures to circumvent controls by fraudsters.

To enable the sector to better demonstrate the negative impact of fraud on beekeeping and therefore on pollination services, it needs also better data collection on the beekeeping sector.

Current situation
In the US, GFSI Food Fraud Requirement collect data from public sources to make the fraud searchable and trackable. It includes incidences of fraud and inference records - inferred due to other sources of information, probably knowledge, subject matter expertise. The Food Fraud Database was initially created at USP but is now held by FoodChainID. In the EU, the Alert and Cooperation Network (ACN) facilitate the exchange of administrative information and cooperation between Member States on official controls in the agri-food chain (incidents of cross-border nature only).

Knowledge of the supply chain and fraudsters

It is important to map the supply chain with the countermeasures (see the work done by the European Commission in annex).

In reference to the vulnerability assessment, it is also necessary to identify and typologize the fraudsters and the fraud events (occasional, occupational) and it is also important to evaluate supplier practices (supplier verification processes) (historical data).

EU legislation
All countries exporting honey to the EU are now required to provide a positive list of exporters (Listing of establishment Regulation EU 2022/2292). If, during an official inspection, a shipment is found not to comply with the requirements of the EU Honey Directive, the exporter can be flagged in the Member States' information system so that further shipments from the same exporter to other Member States are also subject to mandatory inspection. The fraudsters and all operators are subject to systematic controls so they cannot avoid the measures. Once suspicious, flags are lifted only after 10 satisfactory results.

C. Traceability

Traceability is an essential element to fight against adulteration. A traceability system that follows the honey from its production site to the consumer must be proposed ideally at international level. All the relevant data enabling the correct characterization of the product must be defined. By combining traceability with mass balances, the authorities can recognize the addition of large quantities of syrup to honey. A minimum list of criteria (date, quantity, botanical origin if monofloral, place of harvest, …) for ensuring good traceability must be defined at an international level. There are several existing examples around the world (e.g. Argentina…). In case a problem is detected (excess or decrease of quantities) a control measure must be trigged (administrative, audit or analytical).

Current situation
A relevant honey exporting country, **Argentina,** has developed an online traceability system for exported honey linked to the tax administration system. This country exports nearly all its honey and this tool must be used by all the beekeepers producing honey intended for export. Authorities control the system. All steps are registered, and the honey drums are specifically labeled. **In the EU**, a **specific legislation** exists (Regulation (EC) No. 178/2002): Operators are responsible for providing information regarding the transit of the food (source and destination) as indicated in Article 3 of R (EU) No. 931/2011. The amended Honey Directive will make it mandatory to state the exact origin of every honey on the label. In addition, the percentage of the individual origins must be stated on the label. Some **cooperatives** already record all information relating to the honey produced by their members, including details such as the beekeeper, the location of the apiary, the date of harvest, and the quantity produced, as well as the botanical origin. In some cases, consumers can access this information, e.g. via QR-codes. Some **international companies** are offering their clients to use a block-chain based traceability system. **In the US,** a significant part of packers, intermediaries (retail, food service) and consumers recognize and value quality certifications and authenticity testing, sometimes as risk-mitigation and sometimes as an ethical position. Additional certifications (GenuHoney™, or USDA Process Verified) are accepted and are sometimes incorporated into product specifications.

To improve the traceability:

- All beekeepers who sell their honey in drums should **register** with a **unique centralized national system** and, if possible, at an international level **provide essential information on all their honey batches**. In parallel, all non-producing companies that market honey, reselling it in drums or jars, should also be registered in a single centralized national system and, if possible, at international level and contribute essential information on all their honey batches.
  It seems necessary to at least harmonize the application of **customs terminology** at international level and the specific regulations on the **origin of honey**, as well as the **monitoring of intra- and extra- market (e.g. EU or US…) mixtures**.
- A **real time digital registering system for all the operators** must be used apart from beekeepers who sell all their honey directly to consumers.
- For honeys produced and imported into the EU, each honey marketed under an identification other than that of the harvesting beekeeper must have an identifier linked to a block-chain traceability system enabling the competent authorities to trace the entire history of the honey back to the harvesting beekeepers or operators in the case of imported honeys. Any personal information that may be included in the traceability system will only be accessible to consumers with the prior agreement of the producers of the batch or batches in question.
- A system like an adapted version of the EU system **TRACE** or equivalent must be used.
- A **standardized labelling for drums** (drum labelling and related documents) can be very helpful (Include honey in Annex III of Regulation (EC) No. 853/2004).
- The use of QR codes is a good way to make consumers aware of the traceability efforts implemented for honey.
- Pollen is a natural constituent of honey and one of the best tools to characterize its botanical and geographical origins. This is another reason why pollen must not be removed from honey. To benefit from this tool, **validated methodology must be used**

at international level. In a short future A.I. can play a major role, but experts with a large international knowledge need to be trained.

- A simplified system to give a fingerprint (like NIR) of all the starting batches must be put in place to correctly check the integrity of honey at each point from the beekeeper to the consumers.

D. Effective control tools against fraud

Analytical methods

Nowadays, many methods (single-marker and screening methods) exist to detect adulteration. Therefore, a risk-based testing strategy is required which does not rely on a single method to detect adulteration but rather employs a suitable combination of methods, including the so-called screening methods and the occasional and strategical usage of targeted methods.

Current situation

CODEX only recognizes 13C-EA-IRMS (AOAC 998.12) for the detection of foreign C4 sugars (>7 % = adulterated).

A standard has recently been published for LC-IRMS by CEN (EN 17958:2024), more sensitive than the official test. It is very important to agree on the decision limits for this method.

The Joint Research Center (EU Commission) is working on further developing of improved, harmonized and scientifically accepted analytical methods to increase the capability of official control laboratories to detect honey adulterated with sugar syrups. The lab currently works on LC-HRMS interlaboratory validation of markers of adulteration, standardization and regulatory alignment, and on the optimization of 1H-NMR for the detection of mannose.

Laboratories established different databases for 1H-NMR of different quality. The biggest one is Bruker's Honey Profiling database. This database has more than 28,500 samples with metadata from a broad range of honeys. There are more than 50 countries, 100 monofloral honey types as well as a multitude of different polyfloral mixtures plus different seasons, production years, blends and production methods. This NMR method can also give information on the botanical and geographical origins of the most common honey types.

HPAEC-PAD, a more accessible analysis used for more than 20 years for honey, is dedicated to oligo- & polysaccharides and detects 1% or above presence of corn syrup. However, no ring trials have been performed yet.

DNA method especially the metagenomic and bulk sequencing are provided recently by certain laboratories. However, like for HPAEC-PAD, no ring trials have been performed yet.

Other new techniques are always in development like Orbitrap HR-MS Based Metabolomic, proteomics…

An additional problem arises when a new marker is described in the literature. Fraudsters quickly develop technologies to remove the marker from the syrup. Hence, the disclosure of a new analytical marker may result in a quick reduction in the lifespan of the detection method. This risk can be reduced by:

- not revealing the physical/chemical nature of the marker (which however must be available for confidential assessment in audits or court use), or
- increasing the number of potential markers.
- the use of modern screening methods capable of detecting several markers in one analysis.

Methods based on profile analysis are much more difficult to circumvent.

Requirements for the development of new methods to detect adulteration in honey:
• The lab must achieve accreditation through an independent accreditation body and participate in ring-trials, e.g. ISO 17025. • The limits of detection/quantification and uncertainty of measurement for interpretation of the results must be fixed. • The results must be supported by a sufficient number of authentic non degraded and fully traceable samples with their metadata. Conclusions must be drawn with care. • Thresholds must be established to differentiate between residues resulting from normal bee feeding in accordance with good beekeeping and residues from excessive intentional feeding to increase the honey yield. An updated collection of syrups used to dilute fraudulently honey and syrups used for bee feeding is needed (for spiking experiments).

Audits

While lab testing can be very helpful for the detection of syrup in honey or the occurrence of false declared origins, it has much more limitations to detect fraud linked to the production process, like vacuum dehumidification. Audits can verify if good beekeeping and packing practices are applied.

What can be done?

- Verify stakeholders; check for fake accounts; define geo-referenced harvest locations.
- Mapping of beekeepers and their apiaries.
- Ensure correctness of administrative documents/ internal reports.
- take samples and analyze existing databases.
- Check for the absence of elements (specific equipment, products, etc.) linked to fraud and used, for example, to dilute the honey and/or extract excess water and/or reduce the HMF level and/or add specific elements naturally present in honey (pollen, enzymes, etc.).

It is important to define specific guidelines for the auditors. US Pharmacopeia's Honey Fraud Mitigation Guidance is a very good tool to put in place a strong honey antifraud program. Audits in the honey sector are not so common, and the auditor are confronted to a lot of global challenges:

- Auditors lack of industry specific knowledge about fraudulent practices applied to honey.
- There are special geographical areas of concern. Struggle to keep up with different parts of the world.
- Lack of definition about best practices on current detection methods. This lack of knowledge means that companies cannot be audited on recognized best practices.

Current situation regarding the auditing process:

- Sometimes it is not possible to spend much time on VACCP[1].
- Currently most audits require a traceability exercise and mass balance but without considering fraud.

E. A global strategy

The fight against honey adulteration involves a series of actions carried out by those involved in the honey production chain. Depending on where you are in the chain, the actions will mainly relate to data generation, controls or defining what needs to be defined and controlled. Here under is a table showing the different levels of the chain and the actors involved.

Basic steps	Information needed	Complementary information	s implicated							
			beekeepers	beekeeping associations	operators	laboratories	Audiors	Customs	national autorities	international autorities
Honey	definition								X	X
	composition	link to the botanical origin	X			X			X	X
	analyses	linked to the compound detected, validated				X			X	X
	database	At least most common hoeny on the market	X	X		X				X
	code of identification	international classification						X	X	X
Beekeeper	Identification	Localisation, hives…	X	X			X	Xe	X	
	Process of production	good beekeeping practice guide	X	X			X		X	
	Feeding	good beekeeping practice guide	X	X			X		X	
	Identification	labeling + sample (simplify analyse)	X			X	X		X	X
	Documenttaion	place (bot origin), date, quantity…)	X				X		X	X
Operator(s)	Identification							Xe	X	Xe
	Process of production	Techniques used…			X		X			
	Input and output	Origin of drums and detail of output (type, quantity…)			X		X			
	Storage	Identification, quantity			X		X			
	Identification of drums	labelling, documentation, analyses			X	X	X	Xe	X	Xe
Controls	Documenttaion	related to purchases and sales			X		X	Xe	X	X
	Authenticity	related to the honey				X		Xe	X	X
	Adulteration	related to the honey				X		Xe	X	X
	Traceability	related to the honey	X		X		X	Xe	X	Xe
Xe = only for exported honey										

Given the complexity of the actions and the number of people and organizations involved, it would be very useful to set up an international task force on honey fraud, involving international bodies and beekeepers.

Some other elements must also be considered to define a continuous way of working:

[1] Vulnerability Assessment and Critical Control Points

1. Define and characterize at least the most prevalent honey types on the market and harmonize the rules already present in different countries.
2. Identify potential fraud types, process flows and “innovations”.
3. Assess the evolution of the supply chains complexity and map them out (from production to consumer).
4. Review weaknesses (hot spots) and prioritize them based on the controls and the frauds.
5. Analyze regularly the different geographic origins of honey (political stability, economic conditions, climatic events)
6. Monitor market prices, formation of prices, trade policies (duties, antidumping measures).
7. Typologize fraudsters and fraud events (occasional, occupational).
8. Evaluate supplier practices (supplier verification processes) (historical data).
9. Consider mitigation strategies and optimize the use of resources for results (counter-measures, control systems, monitoring practices, verification tools like supplier audits, authentication methods, laboratory analyses, marketplace monitoring, investigations, traceability systems, mass balances, ingredients tracing, regulatory compliance, training and awareness)
10. Record and analyze incidents.
11. Review and reassess regularly all these points

A collective effort must be made to establish an international framework for combating adulteration. To this end, it is essential that all stakeholders be directly involved and commit to doing everything possible to ensure that this document does not remain a dead letter.