

OP-221 [Beekeeping Technology and Quality]
Title: Advancing Bee Product Quality and Authenticity Assessment with NMR Technology

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Background/PURPOSE:

Ensuring the quality and authenticity of bee products is essential for consumer trust and market value. This presentation aims to showcase the advancements in Nuclear Magnetic Resonance (NMR) technology, specifically the FoodScreener with Honey-Profiling and Advanced Chemical Profiling, as a reliable method for assessing these parameters.

Problem Description:

Bee products, particularly honey, face challenges related to adulteration and quality assurance. Traditional methods may not detect all forms of adulteration, and there is a need for a more comprehensive and validated approach to ensure product integrity.

METHODOLOGY:

The FoodScreener employs NMR technology to analyze the chemical composition of bee products. This method involves preparing samples by adding a buffer and adjusting their pH. Samples are placed on a sample changer, and acquisition is started. A report is then generated with the results. The process is non-destructive and provides a detailed chemical fingerprint of the product. Additionally, NMR combined with Advanced Chemical Profiling offers a simple workflow for quickly measuring quantitative parameters in bee products, enhancing its efficiency and practicality.

Results and CONCLUSION: Recent advancements in NMR have significantly improved its efficiency in assessing the quality of bee products. The results demonstrate the potential to detect dilution with syrups, which are designed to mimic authentic honey. Furthermore, NMR is the only method capable of detecting adulteration even without having measured the syrup or adulterant before, as it is not targeted to a specific adulterant. These findings support the use of NMR as a robust tool for quality control in the bee product industry.

Practical Implications for Beekeepers:

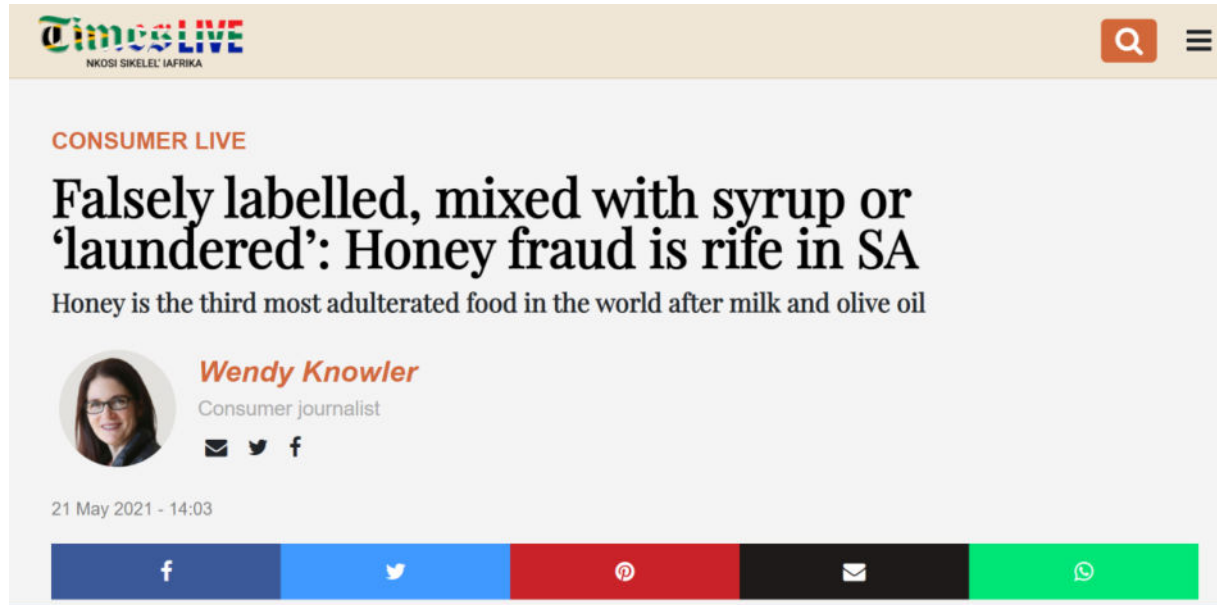
For beekeepers, adopting advanced NMR technology means enhanced product credibility and marketability. By ensuring the authenticity and quality of their products, beekeepers can build consumer trust and potentially command higher prices. Additionally, the rapid and accurate assessment of quantitative parameters can help beekeepers make informed decisions about their production processes and product offerings.

Advancing Bee Product Quality and Authenticity Assessment with NMR Technology

A collection of natural products including two coconuts, a bundle of green leaves tied with twine, a wooden bowl with honey and a honey dipper, a halved avocado, a small white jar, and a sprig of eucalyptus leaves, all arranged on a light surface.

Dr Markus Link
International Key Account Manager
Bruker BioSpin GmbH & Co. KG

Adulteration of Honey is a Serious Problem



<https://www.timeslive.co.za/news/consumer-live/2021-05-21-falsely-labelled-mixed-with-syrup-or-laundered-honey-fraud-is-rife-in-sa/>

Honey Fraud: A threat to viability of beekeeping industry & food security

- Prof. Norberto Garcia, President of the Apimondia Scientific Commission of Beekeeping Economy, comments in this article:
- South Africa honey imports tripled from 2011 to 2020, achieving 6.000 tons, whereas 60% imported from China.
- “Chinese honey is by far the cheapest, at around \$1,14/ton, versus double that for Zambian honey \$2,38/ton.”
- “There are not enough bee colonies in China to explain huge amount of honey they are currently exporting,”
- “Local beekeepers can’t compete with the price of honey,”

The Growing Threat of Food Fraud

- In the past 4 years, a 10X increase in food fraud globally¹.
- Impact to the global economy ~40bn USD each year.¹
- Fraud impacts all areas of the supply chain from the source to distributors to consumers which breaks trust, risks to health, and global businesses

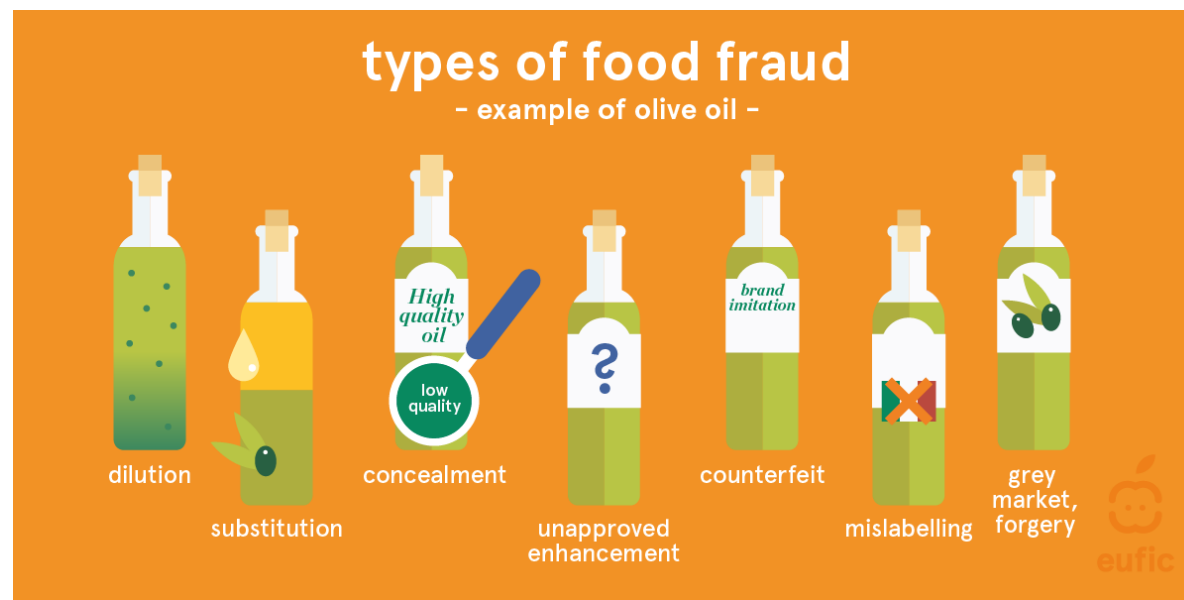


OpenAI's ChatGPT (DALL·E model), 2025

1. Eastlake, Donna. "Global food fraud surges in 2025." FoodNavigator, 16 June 2025.

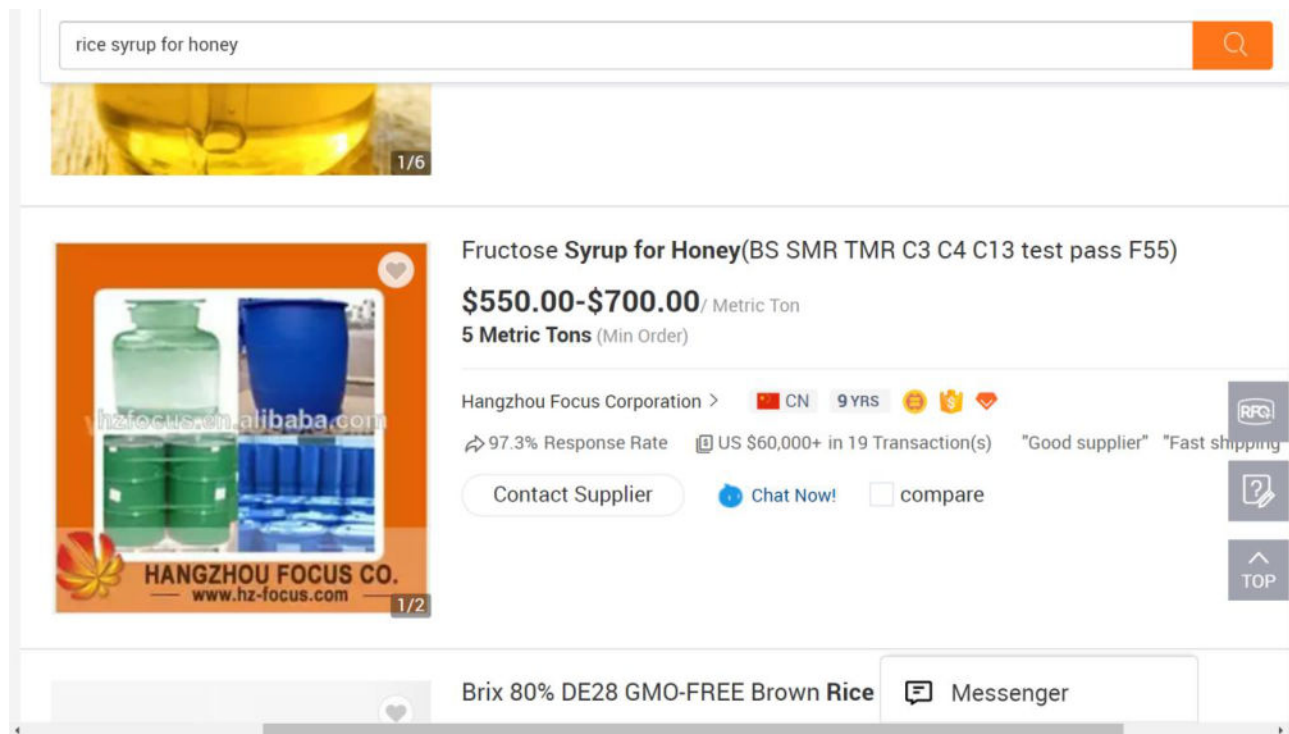
Types of Food Fraud

- Dilution
- Substitution
- Concealment
- Unapproved enhancement
- Counterfeiting
- Mislabelling, and
- Grey market.



Source: European Food Information Council (EUFIC)

Sugar Syrups for Honey (Online)

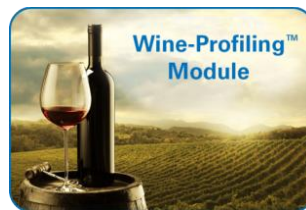


- Average price of EU honey: € 3.94-6.0 US\$/kg
- Average price of Chinese honey export: € 1.60 /kg
- Fructose Syrup € 0.55-0.70 /kg (Source: Alibaba)

Analytical Instruments for Detecting Food Fraud

Technique	Strengths	Weaknesses	Reference
FTIR, Raman, UV-Vis, NIR	• Very fast, non-destructive, minimal prep • Portable/handheld devices for on-site screening • Effective with chemometrics/AI models	• Lower specificity; overlapping signals in complex matrices • Requires calibration & spectral libraries • Not suitable for trace-level detection • Sensitive to conditions (moisture, temp, particle size)	Ellis et al., Cmprehensive Reviews in Food Science & Food Safety (2019).
HPTLC	• Low-cost, rapid, simple screening method • Minimal prep, parallel analysis of multiple samples • Easy visual fingerprinting	• Lower resolution & sensitivity vs LC/GC-MS • Semi-quantitative, requires confirmatory methods • Limited for untargeted detection • Operator-dependent reproducibility	Reich, Journal of AOAC International (2018).
LC-MS	• Extremely sensitive & selective (ppt–ppb) • Works for both targeted & untargeted metabolomics • Detects small compositional changes (phenolics, flavonoids, sugars)	• Extensive sample prep & clean-up needed • Complex data interpretation • Matrix effects (ion suppression) may affect quantitation • Cost especially for high resolution MS	Cubero-Leon et al., Analytica Chimica Acta (2021); Gunning et al., Food Chemistry (2018).
IRMS	• Gold standard for geographical origin & authenticity verification • Stable isotope ratios differentiate natural vs synthetic sources • High precision, widely validated in regulatory use (wine, honey, olive oil)	• Provides isotopic info only, not full adulterant profile • Requires reference databases • Limited scope compared to profiling tools	Camin et al., Trends in Food Science & Technology (2017).
NMR	• Untargeted holistic profiling (detects known & unknown adulterants) • Highly reproducible, quantitative, non-destructive • Minimal sample prep	• Lower sensitivity for trace-level adulterants (ppm) • Expertise required for higher field systems • Cost especially for high field systems	López-Rituerto et al. TrAC Trends in Analytical Chemistry (2019); Gallo et al. Food Chemistry (2020).

FoodScreener – NMR Profiling methods

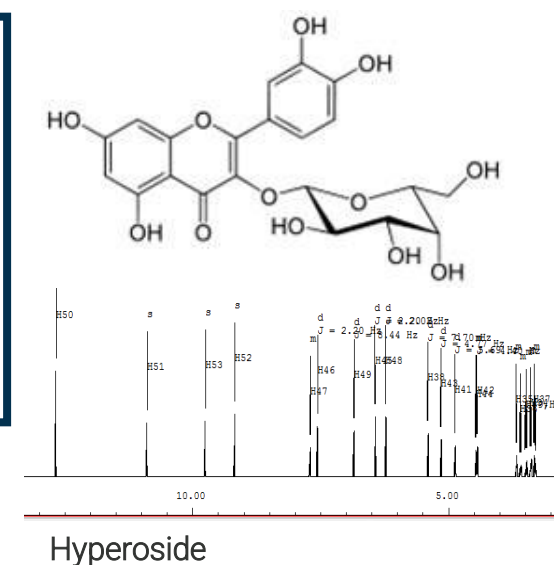
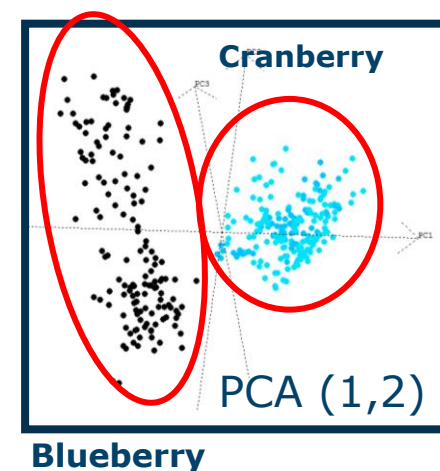
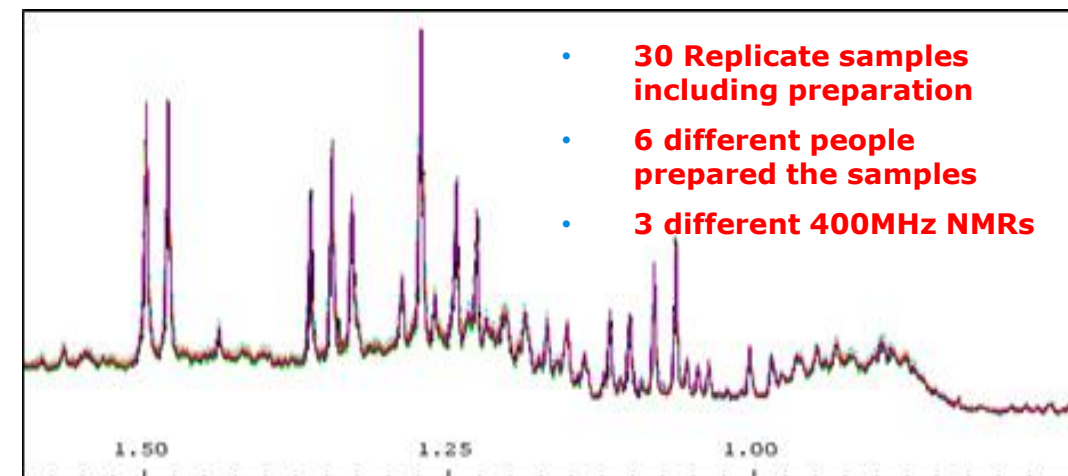


	Juice version 4.0	Wine version 4.0	Honey version 3.1	Olive oil version 2.0
Reference data base (number of samples)	~ 50.000	~ 25.000	~ 28.500	~ 4750 (400 MHz) ~ 3150 (80 MHz)
Quantifications (# compounds)	41	55	36	20
Statistical models	~ 90 models	~ 50 models	~ 15 models	3 country models quality model (extra Vergine)
Reference data (conv. analytics)	> 100.000	> 15.000	> 40.000	> 23.000



Capabilities of NMR in Complex Mixture analysis

- **Highly Reproducible (site to site)**
- **Chemical Fingerprint (Metabolomics)**– Crude extract, distinguish species and origin, impurities and adulterants
- **Chemical Identity** –Versatile databases as standards are not needed daily
- **Absolute Quantification**
 - Area under an NMR signal is proportional to number of atoms giving rise to a signal
 - Calibrated NMR, single-point long standing calibration



Quality and Authenticity of Honey

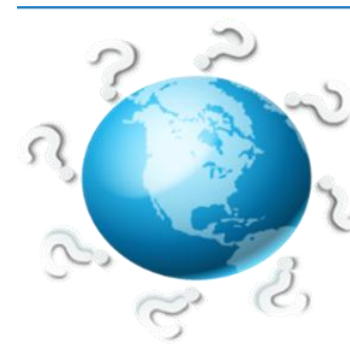
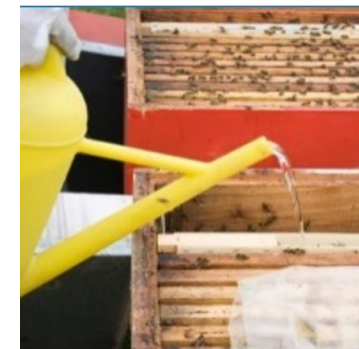
High number of adulterated products on the market

- Ranks amongst the 3 most commonly adulterated food products
- The most common type of adulteration is the dilution with sugar syrups
- Conventional methods are easy to cheat.

Most of the methods are specific to a particular type of foreign sugar.

Different types of adulterations

- Presence of foreign sugars
- Wrong declaration of origin (e.g. “transshipment”)
- Wrong declaration of variety
- Ultrafiltration and resin technology
- Unripe honey



NMR FoodScreener™

Workflow: Honey

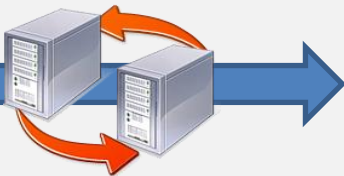


Preparation following SOP

Acquisition

Data Analysis

Results



Targeted Analysis

In the following table the results of the quantitation analysis are given. Parameters labeled with * are calculated parameters. The displayed distribution of the Honey Profiling™ NMR reference database refers to general Honey (single source). Please refer to the additional results for quantified parameters, flag and reference values on page 10.

Report:

Component	Value	Unit	LOD	min	max	Flag	Honey Profiling™
glucose + fructose	89.2	g/100g	25.0	80.0	90.0	✓	see distribution
fructose / glucose	1.04	-	-	-	-	○	see distribution
fructose	45.0	g/100g	10.0	-	-	○	see distribution
glucose	37.2	g/100g	10.0	-	-	○	see distribution
sucrose	2.2	g/100g	0.5	-	-	○	see distribution
maltose	0.6	g/100g	0.2	-	-	○	see distribution
maltotriose	5.0	g/100g	0.5	-	-	○	see distribution
xylooligosaccharides	<0.00	g/100g	1.0	-	-	○	see distribution
arabinooligosaccharides	<0.00	g/100g	1.0	-	-	○	see distribution
galactooligosaccharides	<0.00	g/100g	0.5	-	-	○	see distribution
cellulose	0.3	g/100g	0.1	-	-	○	see distribution
cellulose	<0.00	g/100g	0.05	-	-	○	see distribution

Acids:

Component	Value	Unit	LOD	min	max	Flag	Honey Profiling™
citric acid	49	mg/kg	50	-	-	○	see distribution
malic acid	<0.00	mg/kg	500	-	-	○	see distribution
succinic acid	<0.00	mg/kg	500	-	-	○	see distribution

1:4 dilution of honey

- Pipet 900 µl of diluted honey
- Automated addition of buffer solution and pH adjustment

600 µl in NMR tube

- Following standardized operation procedures
- Fully automated

- Encrypted data transfer
- Remote data analysis server

“Honey Profiling” NMR Application

- **Targeted analysis:**
 - Detection of foreign sugars
 - Quantitative determination of ingredients and of parameters related to processing and freshness
- **Untargeted analysis:**
 - Verification of the country of origin
 - Verification of monofloral varieties
 - Identification of atypical profiles
- **Comprehensive database:**
 - >28K samples from entire supply chain including adulterations



NMR FoodScreener

Modules for various foods available:
Wine, Juice, Olive Oil, Honey

Analysis Report Honey-Profiling™

Sample ID: AM-HO-Demo-2

Information/Declaration provided by customer:

Type of Sample: Honey
Type of Honey: Blossom
Botanical Variety: Acacia
Geographical Origin: France

Disclaimer: this information will affect the applicability and validity of analyses and results.

Note: it is important to fill in these information in a correct and precise manner (e.g. variety in case of monofloral honey, and country of origin). The tests applied (and therefore the results received) are different from one type of honey to the other. Bruker does not take responsibility for wrong or incomplete information given by the customer.

Measuring Date: 10-Apr-2019 16:35:19
Reporting Date: 25-Aug-2025 16:57:45, 14 pages, Version 3.1.4
Approval: **This analysis report is not yet approved.**

Results Summary

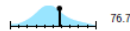
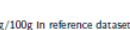
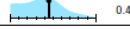
Type of Analysis	Result	Status
Origin, Type and Variety		
Botanical Variety: Acacia	Consistent	●
Country of Origin: France	Consistent	●
Test of Markers of Foreign Sugars	Pass	●
Composition and Comparison to Reference Group	Typical	●
Compliance for EU Market for		
HMF	Compliant	●
Sucrose	Compliant	●
Glucose + Fructose	Compliant	●

Targeted analysis (Blossom Honey, Acacia, France)

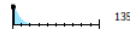
DHA and Mannose

Compound	Value	Unit	LOQ	Reference Range	Flag
mannose	<LOQ	g/100g	0.02	<0.02 g/100g in reference dataset	●
dihydroxyacetone (DHA)	<LOQ	mg/kg	5	<5 mg/kg in reference dataset	●

Sugars:

Compound	Value	Unit	LOQ	Reference Range	Flag
glucose + fructose *	71.4	g/100g	20.0	64.3  76.7	●
fructose / glucose *	1.67	-	-	1.41  1.76	●
fructose	44.7	g/100g	10.0	39.4  50.0	●
glucose	26.7	g/100g	10.0	24.1  34.0	●
sucrose	1.6	g/100g	0.5	<0.5  5.0	●
turanose	2.14	g/100g	0.2	1.0  3.2	●
maltose	2.5	g/100g	0.5	0.9  3.9	●
melezitose	<LOQ	g/100g	1.0	<1.0 g/100g in reference dataset	●
maltotriose	<LOQ	g/100g	1.0	<1.0 g/100g in reference dataset	●
gentiobiose	<LOQ	g/100g	0.3	<0.3 g/100g in reference dataset	●
raffinose	0.2	g/100g	0.1	0.1  0.4	●

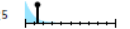
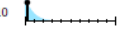
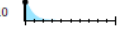
Acids:

Compound	Value	Unit	LOQ	Reference Range	Flag
citric acid	66	mg/kg	50	<50  319	●
malic acid	<LOQ	mg/kg	100	<100  135	●
quinic acid	<LOQ	mg/kg	300	<300 mg/kg in reference dataset	●

Amino Acids:

Compound	Value	Unit	LOQ	Reference Range	Flag
alanine	5	mg/kg	5	<5  16	●
aspartic acid	<LOQ	mg/kg	150	<150 mg/kg in reference dataset	●
glutamine	<LOQ	mg/kg	200	<200 mg/kg in reference dataset	●
leucine	<LOQ	mg/kg	40	<40 mg/kg in reference dataset	●
proline	191	mg/kg	150	167  532	●
valine	<LOQ	mg/kg	10	<10 mg/kg in reference dataset	●
tyrosine	<LOQ	mg/kg	50	<50 mg/kg in reference dataset	●
phenylalanine	<LOQ	mg/kg	100	<100  103	●

Indicators for Fermentation and Processing:

Compound	Value	Unit	LOQ	Reference Range	Flag
2,3-butanediol	<LOQ	mg/kg	20	<20  22	●
5-hydroxymethylfurfural (HMF)	8	mg/kg	5	<5  26	●
acetic acid	11	mg/kg	10	<10  43	●
acetoin	<LOQ	mg/kg	20	<20 mg/kg in reference dataset	●
ethanol	<LOQ	mg/kg	5	<5  253	●
lactic acid	15	mg/kg	10	<10  153	●
formic acid	11	mg/kg	5	<5  23	●
fumaric acid	<LOQ	mg/kg	5	<5  7	●
pyruvic acid	<LOQ	mg/kg	10	<10  17	●
succinic acid	11	mg/kg	5	<5  38	●

Markers:

Compound	Value	Unit	LOQ	Reference Range	Flag
3-phenyllactic acid	<LOQ	mg/kg	300	<300 mg/kg in reference dataset	●
methylglyoxal (MGO)	<LOQ	mg/kg	30	<30 mg/kg in reference dataset	●
kynurenic acid	<LOQ	mg/kg	60	<60 mg/kg in reference dataset	●
shikimic acid	<LOQ	mg/kg	80	<80 mg/kg in reference dataset	●

- Key markers with reference ranges to ensure ID/quantification matches with Acacia Honey
- Markers to determine Variety
 - Gentiobiose for Linden
 - Quinic and Shikimic acid for Honeydew
 - High Acetoin for Eucalyptus
 - Kynurenic acid for Chestnut
 - DHA/mannose varies with different varieties
 - Fructose/glucose ratio limits to indicate adulteration

Targeted analysis (Blossom Honey, Acacia, France)

Test of Markers of Foreign Sugars

(Analysis-ID: HO-TAD-01/0833)

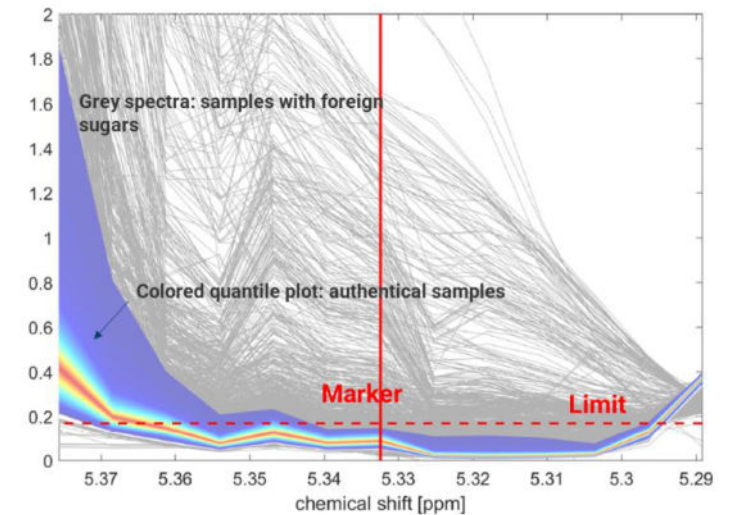
Following tests have been applied in order to detect foreign sugars:

ID	Description	Value	Graphics	Result
2	3.8113 / (1.95-2.02)	45.68		pass
3	3.9238 / (3.16-4.14)	0.0004649		pass
4	3.2890 / (1.95-2.02)	4.326		pass
5	4.0363 / (3.75-3.80)	0.00663		pass
6	5.3324 / (5.27-5.30)	0.0562		pass
7	3.0123 / (1.95-2.02)	0.03638		pass
8	3.5929	1568		pass
9	5.0745 / (4.07-4.12)	0.003399		pass
10	3.2753	201.1		pass
11	3.7490 / (1.95-2.02)	0.72		pass
13	4.1961 / (3.16-4.14)	0.0001048		pass
14	3.3135 / (5.27-5.30)	0.0186		pass
15	4.6809 / (3.65-3.73)	0.00012727		pass
16	3.7715 / (3.65-3.73)	0.04730		pass
17	5.4913 / (4.60-4.67)	0.001876		pass
18	4.6327 / (3.16-4.14)	0.0004188		pass
19	4.2569 / (1.95-2.02)	0.0898		pass
20	3.2797	143.3		pass
44	4.4077	8.37		pass
45	3.8383 / (5.27-5.30)	0.4844		pass
46	3.3004 / (5.37-5.41)	0.002477		pass
47	5.3698 / (1.95-2.02)	1.601		pass
48	3.5310 / (4.93-4.97)	15.91		pass
49	4.5729 / (3.19-3.24)	0.001887		pass
50	3.3206	70.24		pass
74	3.0951 / (5.27-5.30)	0.0240		pass
75	5.3324 / (5.27-5.30)	0.0562		pass
78	4.0551 / (1.95-2.02)	7.85		pass
84	5.3324 / (5.27-5.30)	0.0562		pass
90	2.4031 / (4.93-4.97)	0.00423		pass
127	4.2487	130.0		pass
128	5.3045 / (1.95-2.02)	0.3431		pass
129	3.5884 / (3.75-3.80)	0.004526		pass
130	4.9421 / (4.93-4.97)	0.1296		pass

ID	Description	Value	Graphics	Result
131	3.5929 / (4.07-4.12)	0.01084		pass
133	4.9433 / (4.93-4.97)	0.06700		pass
134	4.2501	55.3		pass
135	3.9156 / (4.07-4.12)	0.02842		pass
136	5.2876 / (4.07-4.12)	0.002723		pass
140	3.2852 / (4.07-4.12)	0.004996		pass
142	4.3176 / (5.27-5.30)	0.01827		pass
143	5.3371 / (5.27-5.30)	0.01465		pass
144	4.4347 / (4.07-4.12)	0.0001768		pass
155	4.1511	398.9		pass
156	3.3701 / (3.20-3.22)	0.08977		pass
157	4.1781 / (4.07-4.12)	0.0007172		pass
158	3.9283 / (5.27-5.30)	0.0736		pass
159	3.9246 / (5.20-5.25)	0.02248		pass
162	3.1784 / (5.20-5.25)	0.003675		pass
163	3.5929 / (3.16-4.14)	0.0005744		pass
166	3.6627 / (4.07-4.12)	0.03463		pass
167	3.2977 / (4.07-4.12)	0.002648		pass
168	3.3753 / (4.60-4.67)	0.1654		pass
169	3.7579 / (3.65-3.73)	0.11855		pass
170	3.8885 / (3.75-3.80)	0.05018		pass
171	4.1651 / (1.95-2.02)	4.614		pass
172	3.1637	18.931		pass
191	3.7932 / (4.07-4.12)	0.2333		pass
1000	min. fructose/glucose	1.67		pass
1001	max. fructose/glucose	1.67		pass
1002	turanose [g/100g]	2.14		pass
1003	sucrose [g/100g]	1.6		pass
1004	total sugar [g/100g]	71.4		pass
1005	proline [mg/kg]	191		pass
1006	DHA(D), mannose(M) [mg/kg]	D=0.0, M=72		pass

Result: There are no indications for the presence of foreign sugars.

- All resonances for foreign sugars are monitored especially for C3 (rice, wheat, beet) and C4 (corn and sugar cane).
- EA-IRMS approach is a long-established method can detect C4 plant sugars but not C3 sugar plants



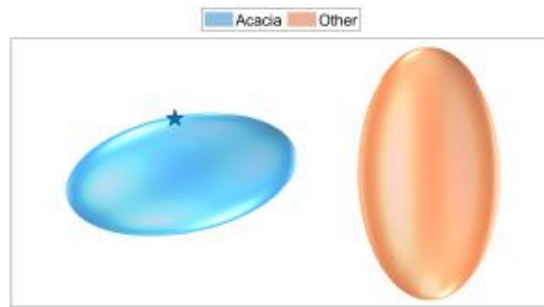
Untargeted analysis (Blossom Honey, Acacia, France)

Botanical Variety: Acacia

(Analyte ID: HS3-CC-001-10145)

This model is based on 27039 samples, thereof 1414 samples of reference group *Acacia*.

Result: Consistent with declared variety *Acacia*. The probability of consistency is 100.0%.

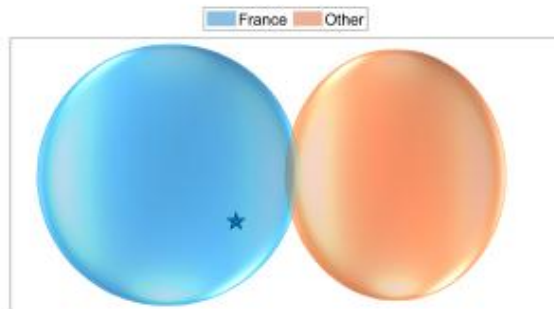


Country of Origin: France

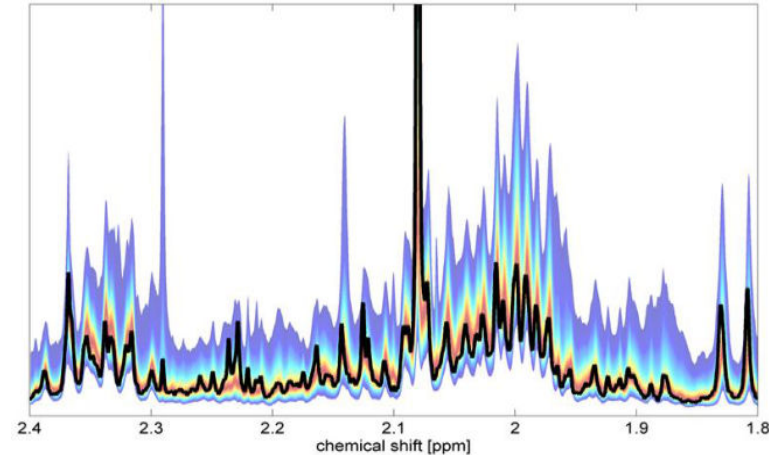
(Analyte ID: HS3-CC-102-10147)

This model is based on 24769 samples, thereof 6013 samples of reference group *France*.

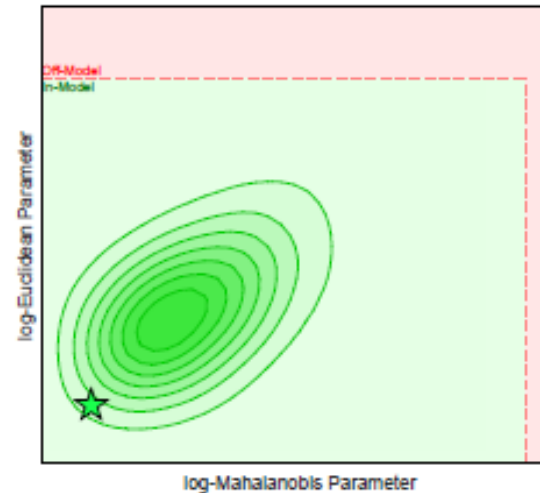
Result: Consistent with declared country *France*. The probability of consistency is 99.9%.



Compliant honey sample (black curve)



Multivariate Verification



Univariate Verification

Applied Model: *Acacia*

Result: Typical for *Acacia*.

Multivariate Verification

Applied Model: *Acacia*

Result: Typical for *Acacia*.

- Overall univariate and multivariate analysis compared to the database indicates the honey is Acacia, blossom honey in France

Techniques for „circumventing“ analyses methods

“there is a strong suspicion that a large part of the honey imported from non-EU countries and found suspicious by the JRC of being adulterated remains present and undetected on the EU market”.¹

Techniques for "circumventing" analysis methods in order not to be able to detect falsifications

- Use of sugars/syrups that are not detectable by certain methods (example: C3 sugars are not detectable by the AOAC EA-IRMS method)
- Addition or filtration of certain compounds used as markers.
- In relation to designation of origin and variety:
 - “Transshipment”
 - Pollen Manipulation: filtration of pollen grains and addition of other pollen types

Stable carbon isotope ratio analysis by EA-IRMS (AOAC method 991.41), a method that has frequently been used to detect sugar syrups made of maize starch or sugarcane, was not effective in this study. This is a clear indication that such sugar syrups are no longer used to extend honey and have been replaced by syrups made mostly from rice, wheat or sugar beet.¹

Overview of the most common methods for detection of foreign sugars

	Enzymes, SMR, SMB, TMR	EA-IRMS	EA/LC-IRMS	NMR Honey-Profiling	NMR Eurofins	HR-MS
Foreign sugars detected	1 specific syrup	C4 Type only	C3, C4	All (non-specific)		All (non-specific)
Identification of the syrup type	Yes	No	No	No		No
Quantification of the syrup content		Yes	No	No		No
Official method	No	Yes (AOAC)	No	No		No
Harmonization	-	Yes	No	Yes >90% ¹		No ~32% ²
Performance of detection³	Low	~18%	~ 15%	~ 78%	No data	No data
Adulteration rate overall⁴				~ 17%	~ 2 to 4%	
Number of reference spectra			~ 800	20800 authentic 4832 adulterated	?	Some authentic samples 100 syrups ⁵

¹ Apimondia 2019 Conference, Roundtable on adulteration.

² HR-MS Ringtrial 2022 (FEEDM)

³ Out of 3000 adulterated samples, % of samples detected as adulterated by each technique. Source : Honey Profiling 3.0 validation protocol for the detection of foreign sugars

⁴ According to QSI and Eurofins's company annual reports of 2020 and 2021

⁵ Eurofins Whitepaper: Honey authenticity testing by LC-Orbitrap-HRMS

Case Example: Adulterated Honey

NMR Honey Profiler Results

Test of Markers of Foreign Sugars

(Analysis-ID: HO-TAD-01/0833)

Following tests have been applied in order to detect foreign sugars:

ID	Description	Value	Graphics	Result
2	3.8113 / (1.95-2.02)	26.64		pass
3	3.9238 / (3.16-4.14)	0.0004018		pass
4	3.2890 / (1.95-2.02)	1.449		pass
5	4.0363 / (3.75-3.80)	0.00581		pass
6	5.3324 / (5.27-5.30)	0.0610		pass
7	3.0123 / (1.95-2.02)	0.02727		pass
8	3.5020	5.07		pass
9	5.0745 / (4.07-4.12)	0.001476		conditional fail
10	3.2753	196.5		pass
11	3.7490 / (1.95-2.02)	0.22		pass
13	4.1961 / (3.16-4.14)	0.0000718		pass
14	3.3135 / (5.27-5.30)	0.0480		pass
15	4.6809 / (3.65-3.73)	0.00010170		pass
16	3.7715 / (3.65-3.73)	0.05209		pass
17	5.4913 / (4.60-4.67)	0.001707		pass
18	4.6327 / (3.16-4.14)	0.0005005		pass
19	4.2569 / (1.95-2.02)	0.0494		pass
20	3.2797	133.9		pass
44	4.4077	6.99		pass
45	3.8383 / (5.27-5.30)	0.7649		pass
46	3.3004 / (5.37-5.41)	0.004532		pass
47	5.2608 / (1.95-2.02)	0.367		pass
48	3.5310 / (4.93-4.97)	55.61		fail
49	4.5729 / (3.19-3.24)	0.001147		conditional pass
50	3.3206	52.95		conditional pass
63	5.3934 / (5.27-5.30)	0.2190		pass
64	3.9246 / (3.65-3.73)	0.004461		pass
65	3.3168 / (3.20-3.22)	0.003238		pass
66	4.5695 / (1.95-2.02)	0.605		pass
68	3.5929 / (4.07-4.12)	0.00355		pass
69	4.6935 / (5.20-5.25)	0.0001590		pass
70	4.9781 / (4.93-4.97)	0.05215		pass
71	5.0565 / (5.37-5.41)	0.01420		pass
72	2.7810 / (4.93-4.97)	0.01874		pass
127	4.2487	43.6		pass

Statistical Comparison with the Reference Group

The models are based on 1174 *Acacia* samples in the Honey-Profiling Database.

Univariate Verification

(Analysis-ID: HS3-NTV-001-18152)

Applied Model: *Acacia*

Result: Not typical for *Acacia*.

5.559_{low} 5.568_{low}

The suffix *high* indicates that the intensity is higher than in the reference group, the suffix *low* indicates that the intensity is lower than in the reference group.

EA-IRMS and LC-MS results

Analysis	Result	Unit	Specifications	Compliance
Adulteration *s - EA/LC-IRMS (9)				
Description method EA/LC-IRMS				
Protein	-24.88	%O		
Honey	-24.28	%O		
Fructose	-24.20	%O		
Glucose	-24.33	%O		
Delta dc 13 f/g	0.13	%o	-1,00< x <1,00	
Delta dc 13 max	0.82	%o	-2,10< x <2,10	
C4	4.00	%	x <= 7	
Pourcentage oligosaccharides	Not detected		Not detected	
Adulteration *s - LC-HRMS				
Description method LC-SOP 520-09				
Addition of sugar	Not detected			

Not Detected

- A sample tested by AB Labo in France on a **Blossom honey in Acacia in China**.
- Sample was similar to the *Acacia* profile and through **EA-IRMS/LC-MS, did not detect any foreign sugars**
- Through the statistical tests of the key foreign sugar resonances, it was detected for **adulteration**

Adoption of NMR based Screening (Across Value Chain)

Industry



Commercial Labs



Government



CBP USA adopted NMR to prevent country-of-origin (COO) fraud, whereby dishonest importers evade the steep antidumping (AD) duties owed on honey imports from China by falsely claiming what is Chinese honey was produced in another country.¹



Canadian Food Inspection Agency

CFIA is using NMR in their surveillance activities as part of ongoing efforts to detect misrepresentation of honey adulterated with foreign sugars in both domestic and imported honey sold in Canada.²



¹<https://americanbeejournal.com/u-s-customs-agency-to-purchase-nmr-equipment-for-testing-of-honey-imports/>²

²<https://inspection.canada.ca/science-and-research/our-research-and-publications/report/eng/1606943368540/1606943368853>

Summary

- **Food fraud** remains prevalent in the marketplace and due to the chemical complexity, key developments in analytical technologies are required to solve this challenge
- **NMR spectroscopy** is a proven analytical methodology to combat food fraud due to its high reproducibility, easy sample preparation, and absolute quantitation capability.
- A complete methodology for food fraud is to develop a combined **targeted and untargeted approach with a comprehensive database** to understand the limit values for markers, and models to define natural variability
- Combatting food fraud will require the **harmonization on all areas of the supply chain community** to set standards, and **identity the key markers and adulterants**



OpenAI's ChatGPT (DALL-E model), 2025

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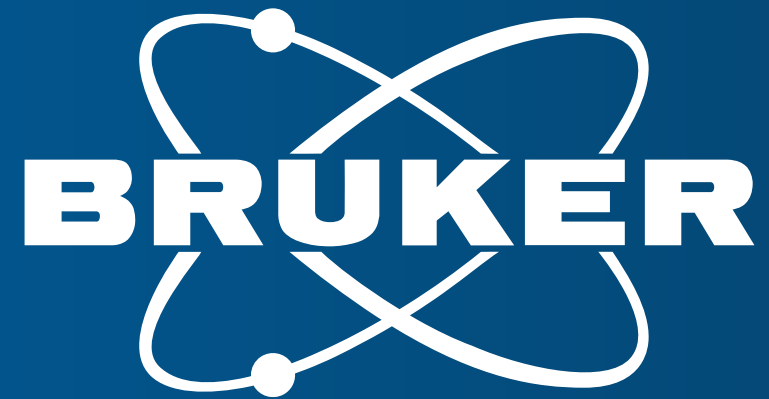
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Thank you!



Innovation with Integrity