

OP-234 [Beekeeping Technology and Quality]

Methods for Authenticity Verification of Chilean Honey: Stable Isotopic Techniques and Their Connection to Botanical Origin and Bioactive Compounds

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In recent years, honey production has been optimized, and the characterization of honey and its natural attributes has enhanced its value and differentiation. However, at the same time, the counterfeiting of bee products has increased, severely impacting the beekeeping industry and causing significant economic losses for beekeepers. Additionally, the health of consumers who ingest adulterated products is at risk, as fake products often lack a defined origin and may contain harmful residues or undesirable elements. In Chile, counterfeit honey is present and sold in informal markets, raising concerns within the beekeeping sector. Addressing this issue requires scientific tools and methodologies to certify the authenticity of Chilean honey. Moreover, exported honey must comply with strict regulatory standards imposed by destination countries.

This study provides an overview of the methodology used for processing and analyzing the $^{13}\text{C}/^{12}\text{C}$ isotopic ratios of 30 Chilean honeys from different botanical origins, assessed using IRMS-EA. Additionally, the results were correlated with the natural biological attributes of the samples to develop a comprehensive database on the authenticity, geographical origin, and bioactive molecule pattern of Chilean honey.



Comisión
Chilena de
Energía Nuclear
Ministerio de Energía

Gobierno de Chile



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What is meant by food fraud?

- Food fraud is the act of deceiving consumers about the quality, identity, or composition of food.

The aim is to obtain financial gain.

SOURCE IA



FOOD SAFETY

VOLUNTARY AND INVOLUNTARY ACTIONS

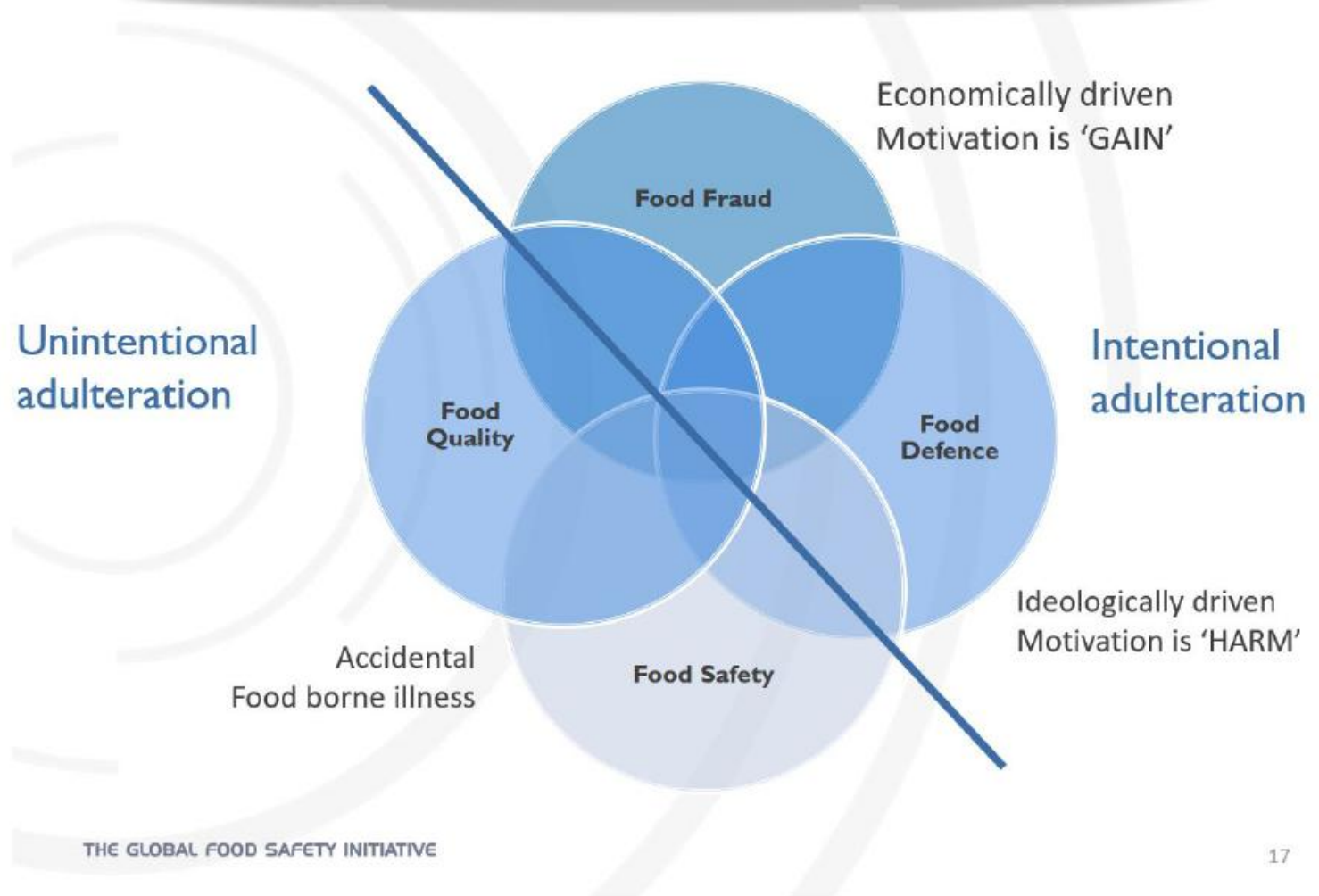


Figure 1: Food Risk Types
(GFSI Position Paper on Food Fraud, 2014)

HONEY: OFFICIAL CODEX DEFINITION



According to the Codex Alimentarius, honey is defined as the natural sweet substance produced by honeybees from the nectar of plants or from secretions of living parts of plants or excretions of plant sucking insects

CHILEAN BEE PRODUCTS



Chile produces a large quantity of bee products with interesting biological properties due to the presence of a varied endemic native flora.

HONEY – BEE PRODUCTS – BEESWAX – PROPOLIS

RELEVANT DATA

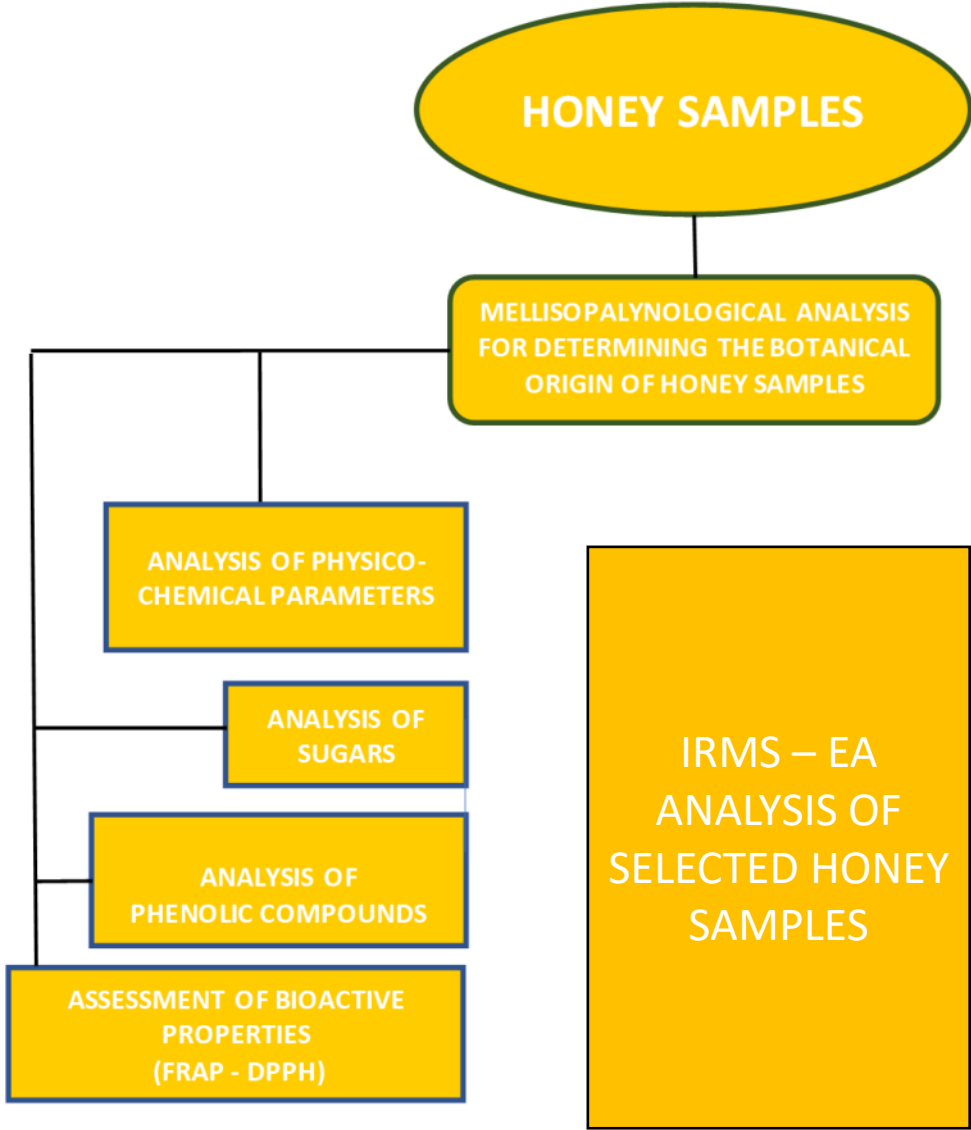
- There are at least 11.583 Chilean Beekeepers (*)
 - Upon 96% are small producers
 - They manage over 1.533.405 Beehives
- From Atacama to Chilean Patagonia
Values taken from Agriculture and Livestock Service of Chile – SAG





Southern Chile
Los Ríos Región

EXPERIMENTAL PROCEDURE



RESULTS

- % Carbohydrates
 - % Glucose – Fructose and HMF
- There are no significant differences for:
- % Ash
 - % of Humidity
 - Na content

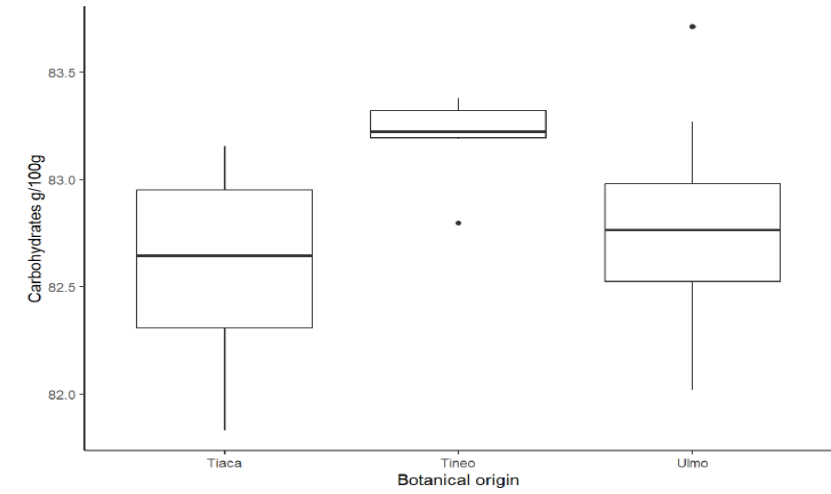
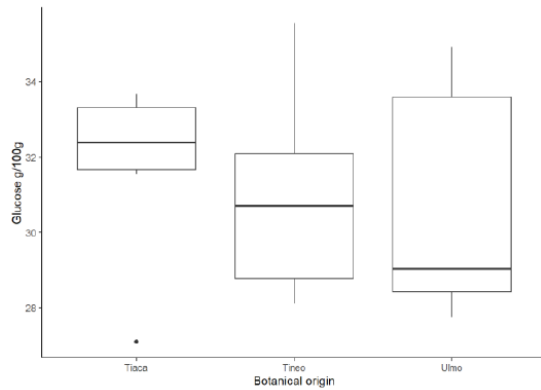
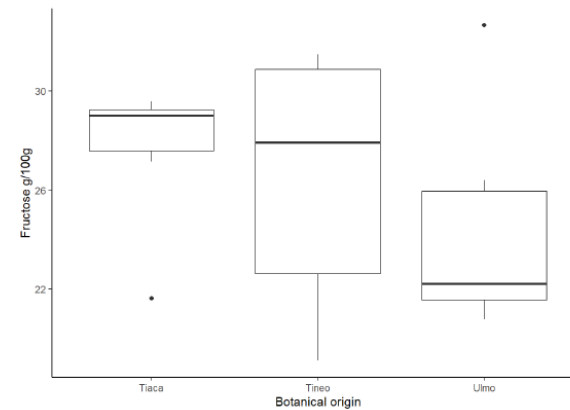


Figure 1. Total Carbohydrate content in samples considering the botanical origin of honeys.



(a)



(b)

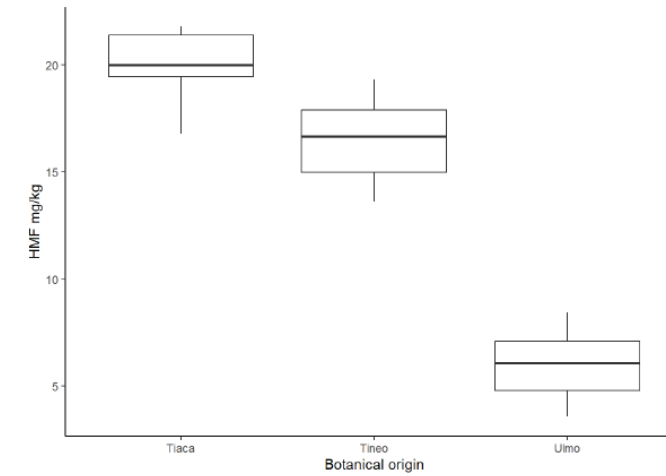


Figure 5. HMF content in monofloral honey samples.

RESULTS

- Total Phenolic Compounds Content
- Antirradical activity
- Antioxidant Power

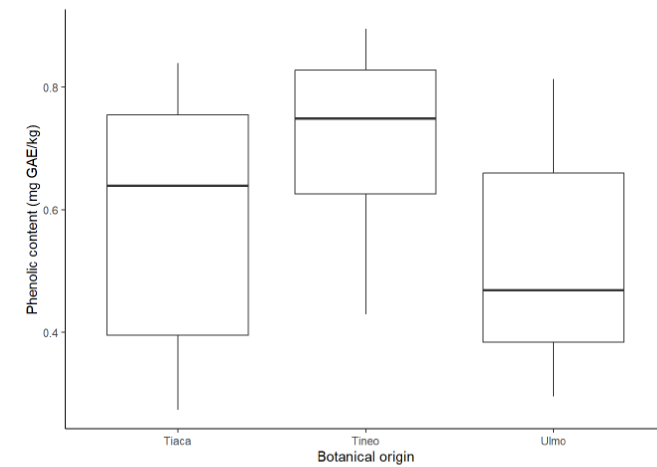
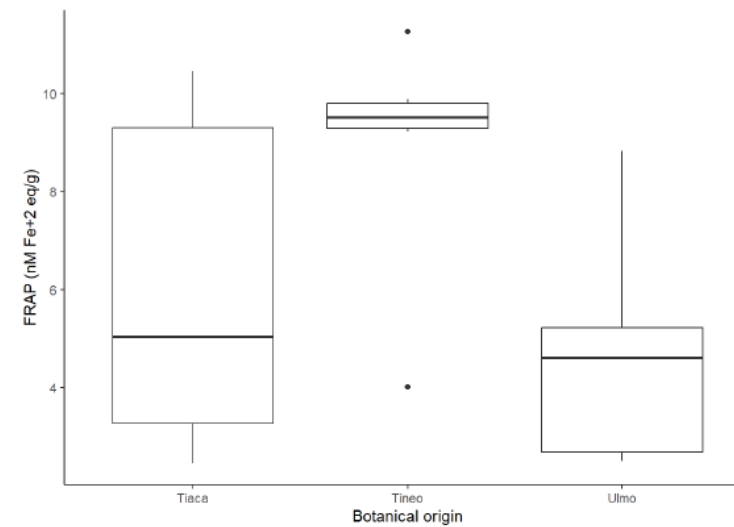
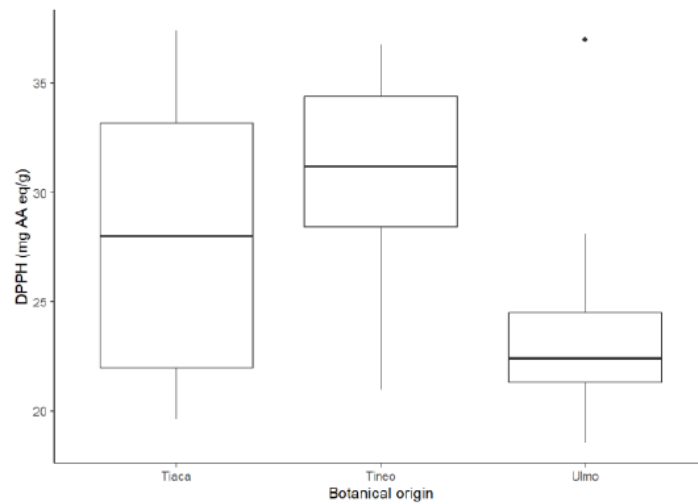


Figure 3. Total Phenolic compound content in samples regarding the botanical origin of honeys.



RESULTS

"Natural biological properties inherited from native endemic flora in honeys from Lake Ranco area of Southern Chile: A botanical and physicochemical approach"

Enrique Mejías, Carlos Gómez , Pablo Díaz and Tatiana Garrido – *Molecules* **ACCEPTED**

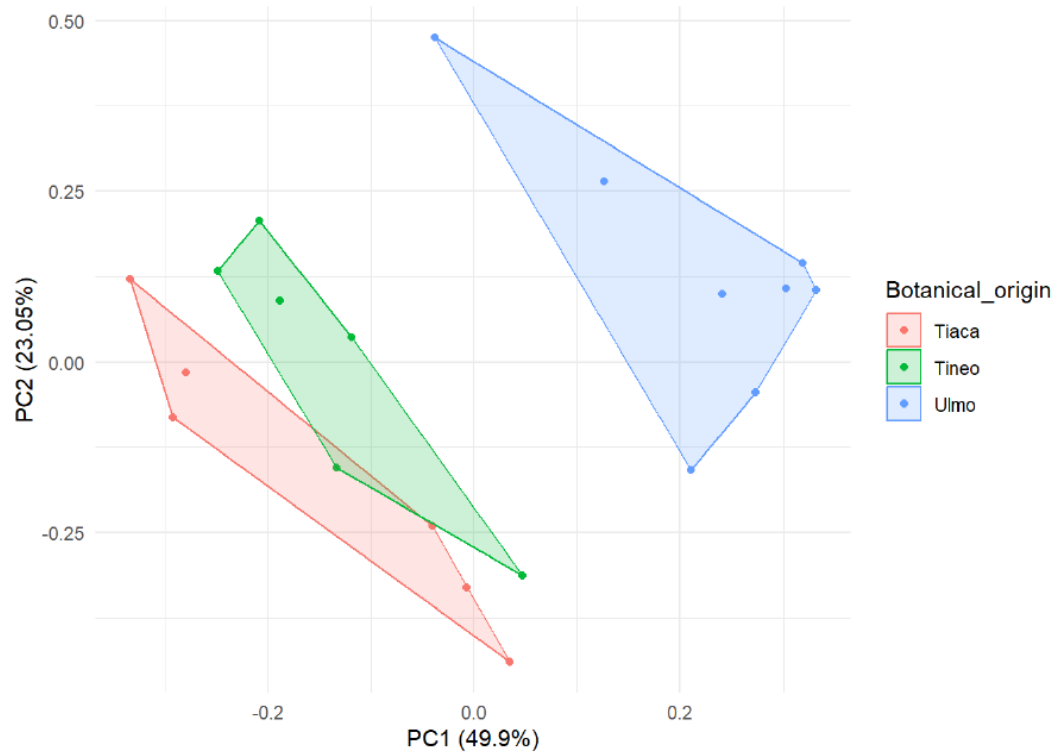


Figure 6. Principal component analysis (PCA) for monofloral honey samples.



NUCLEAR TECHNIQUES: USE AND APPLICATIONS

GRANTS – CCHEN / IAEA

CHI 5053: “National Reference System for Verification of Authenticity and Determination of Origin of Food using Nuclear Isotopic Techniques”
2022/2023

CHI 5056 “Strengthening of the National System for Verification of Authenticity and Determination of Origin of Food”.
2024/2025

Isotopic techniques
– EA-IRMS
for Food Fraud
Detection:

FAKE HONEY

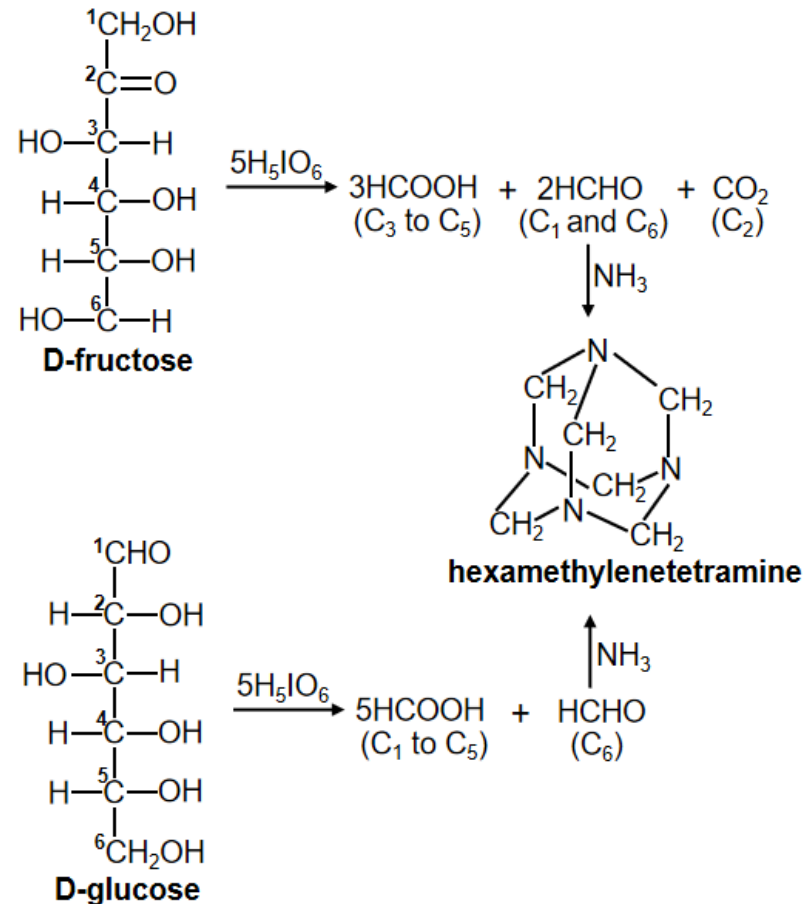


ISOTOPIC ANALYSIS

Ratios for $^{13}\text{C}/^{12}\text{C}$ found in nature
allow products to be differentiated

SYNTHESIS OF HTM
(Hexamethylenetetramine)

PRESENCE OF A CBNE
(Carbon Bond Non-Exchangeable)



Li, A., Mejías E., Kelly S., et al 2024. A new approach to detecting sugar syrup addition to honey: Stable isotope analysis of hexamethylenetetramine synthesised from honey monosaccharides (fructose and glucose). Food Chemistry 434 (2024) 137451

ISOTOPIC ANALYSIS

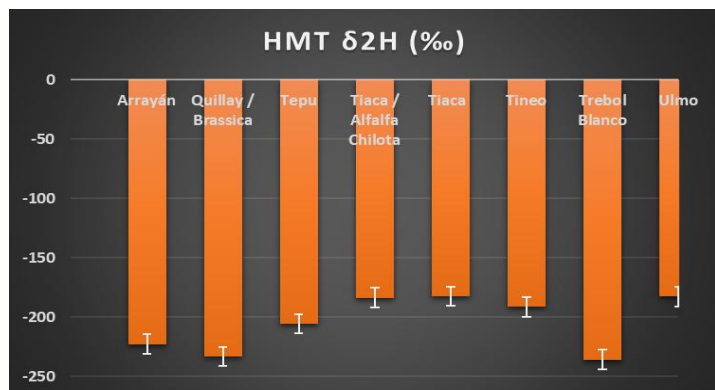
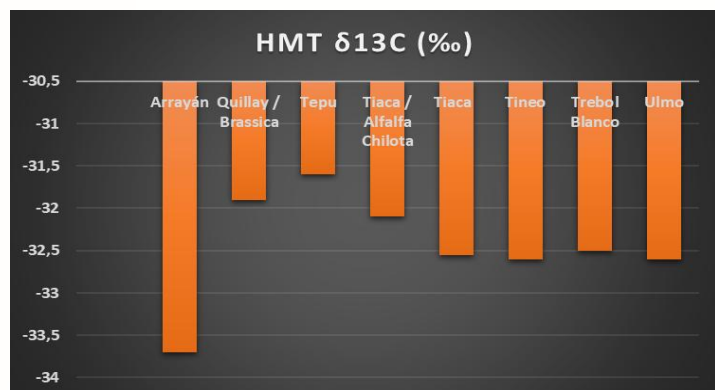
Summary of $\delta^2\text{H}$ and $\delta^{13}\text{C}$ values of HMT prepared from authentic honey and sugar

Sample types	Origin / Photosynthetic pathway	n	$\delta^2\text{H}$ (‰)				$\delta^{13}\text{C}$ (‰)			
			mean	SD	Max	min	mean	SD	max	min
Honey	New Zealand	34	-183.1	15.0	-154.9	-233.0	-31.2	0.8	-28.1	-32.5
	Chile	17	-194.5	19.4	-176.4	-235.9	-32.5	0.6	-31.6	-33.7
	Malaysia	10	-174.8	12.4	-161.9	-204.1	-33.7	0.8	-32.6	-35.3
	Vietnam (USGS82)	1	-174.3	-	-	-	-29.2	-	-	-
	Canada (USGS83)	1	-290.6	-	-	-	-30.5	-	-	-
Rice syrup	C ₃	9	-178.0	9.7	-165.1	-190.7	-33.1	1.5	-31.2	-34.5
Corn syrup	C ₄	2	-55.6	8.6	-49.5	-61.7	-16.8	2.2	-15.2	-18.4
Agave syrup	CAM	5	-32.8	9.5	-21.1	-46.6	-14.3	0.6	-13.7	-15.1

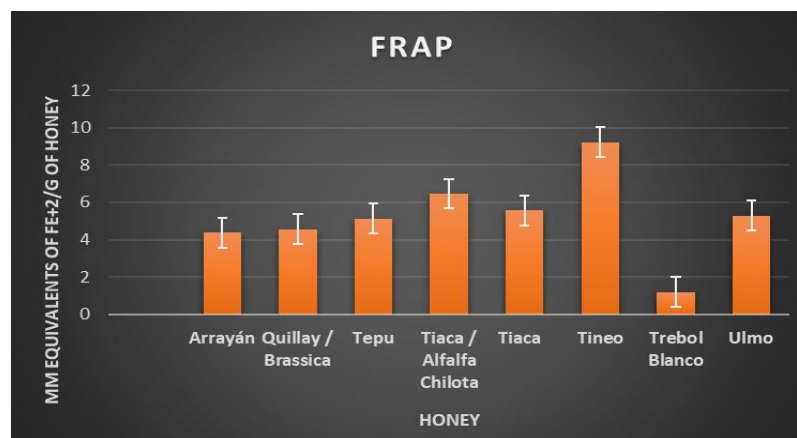
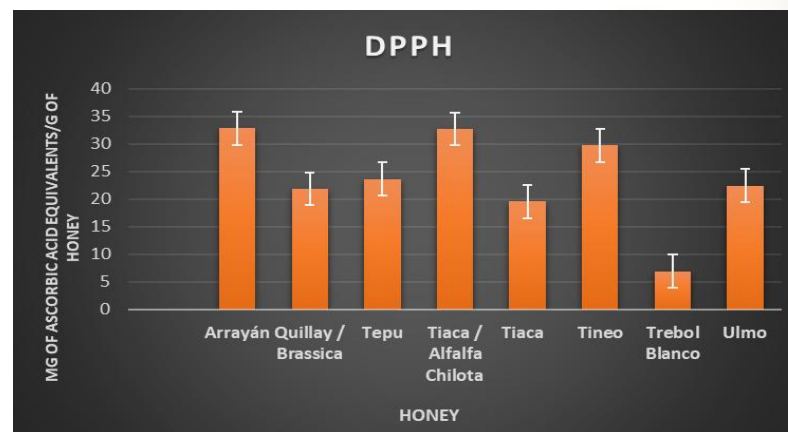
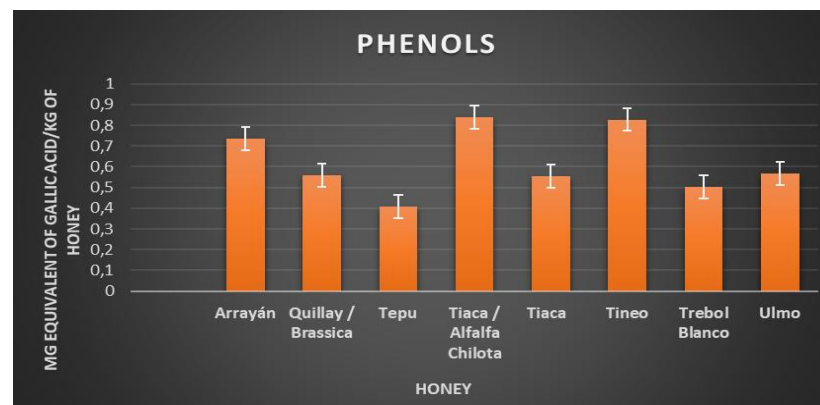


ISOTOPIC ANALYSIS

AUTHENTICITY ASSAYS
BOTANICAL ORIGIN & BIOACTIVE COMPOUNDS



**25 samples
(Monofloral honeys) Maule, Los Rios
and Los Lagos**

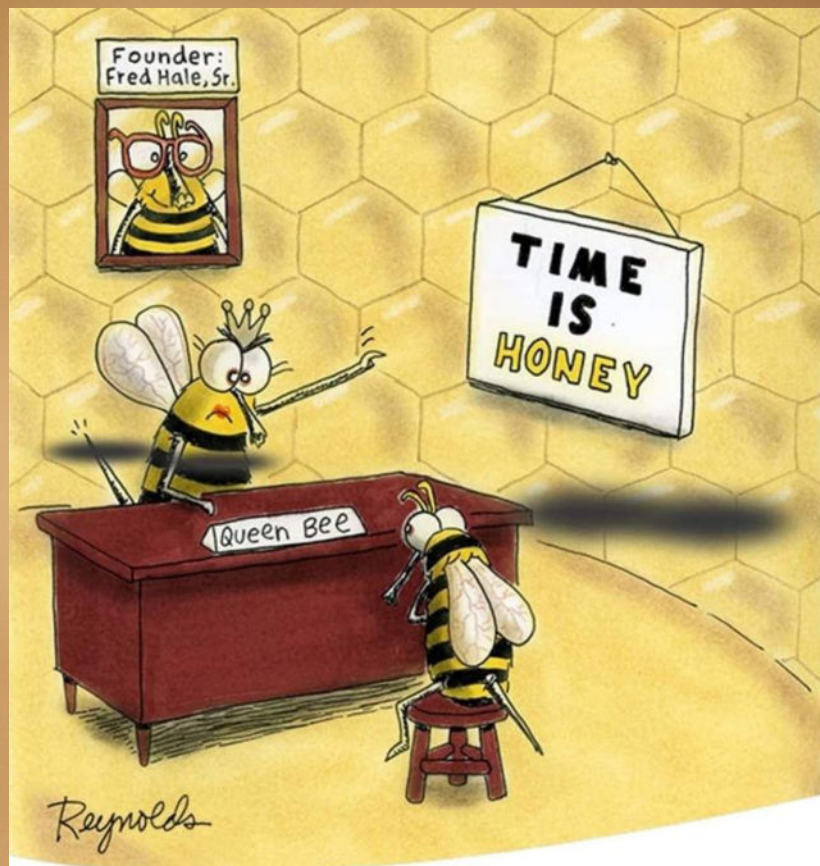


CONCLUSIONS



1. Chilean honeys have a defined isotopic ratio within a characteristic range of data that can be differentiated when considering their botanical origin.

2. Phenolic compounds, Antioxidant Activity and some Physicochemical parameters provide relevant information for constructing specific profiles of Chilean honeys, which facilitates the definition of appropriate criteria for authenticity certification.



THANK YOU!!!

