UNIVERSITI PUTRA MALAYSIA

AGRICULTURE • INNOVATION • LIFE

PHYSICOCHEMICAL PROFILES AND MINERALS OF STINGLESS BEE HONEY FROM MALAYSIA AND AUSTRALIA : A COMPARATIVE CHARACTERIZATION

DR. NORHASNIDA BINTI ZAWAWI

SENIOR LECTURER @ DEPARTMENT OF FOOD SCIENCE, FACULTY OF FOOD SCIENCE AND TECHNOLOGY

Email : norhasnida@upm.edu.my

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

PERSONAL BACKGROUND

- Nutritional Biochemist.
- Senior Research Fellow of Queensland Alliance of Agriculture and Food Innovation (QAAFI) – Department of Animal and Fisheries.
- Working Group Kelulut Standard Malaysia.
- Australian Native Bees Association (ANBA) Committee for Standard Development.

CONTENTS

- INTRODUCTION
- RESEARCH BACKGROUND
- SAMPLE COLLECTION
- RESEARCH FINDINGS
- CONCLUSION

INTRODUCTION

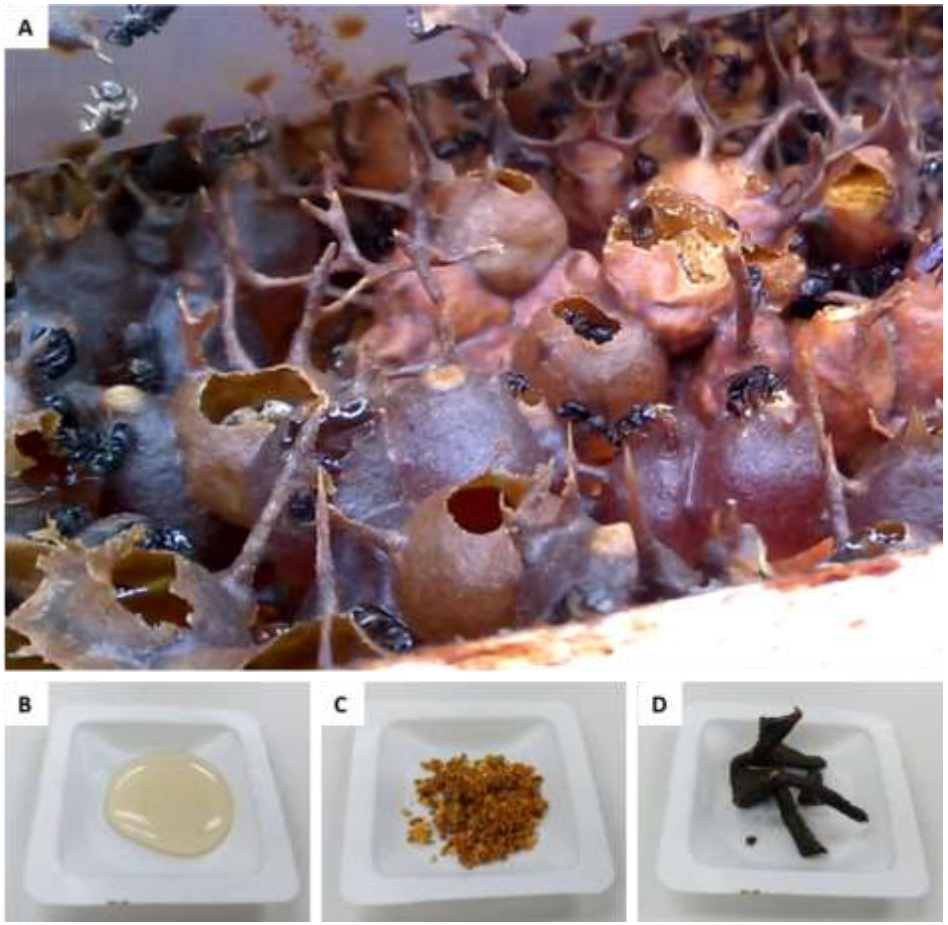
STINGLESS BEE

- Most diverse and useful of all the insect groups in the tropical regions for over 65 million years.
- Found in the tropical or subtropical regions:
  - American tropics (Neotropics)
  - Sub - Saharan African (Afrotropical region)
  - Indoaustralian (Indo - Malaya / Austroasian).
- Until now, 500 species of stingless bee have been discovered and possibly much more as yet undescribed.

Pantropical distribution (blue color) of stingless bees (Apidae, Meliponini). After Sakagami (1982)

STINGLESS BEE HONEY

- Colonies make far less honey compared to the honey bee colonies.
- Honey produced has a strong acid flavor, are less viscous and darker than the honey of honey bees.
- Widely used for its therapeutic effects with more than 200 substances such as carbohydrate, protein, amino acid, vitamins, minerals, flavonoids, organic acids, and etc.
- Different species produce different composition of honey with distinct organoleptic properties.
- The composition of honey varies depending on the bee species and on the plants on which the bee feeds.



The stingless bee products of *Heterotrigona itama*. (A) The stingless bee products in the hive; (B) Honey; (C) Bee bread, and (D) Propolis.

HONEY IN THE QURAN

> *[Quran 16.68-69] And your Lord (Allah) revealed to the bees: Build your hives in mountains, trees and in what they build. Then **eat (for females)** from every fruit and **follow (for females)** your Lord's enslaved paths, from **its bellies (بُطُونِهَا)** exits drink of different colors, in it healing for man. These are signs for those who contemplate.*

٦٨ وَأَوْحَىٰ رَبُّكَ إِلَى النَّحْلِ أَنِ اتَّخِذِي مِنَ الْجِبَالِ بُيُوتًا وَمِنَ الشَّجَرِ وَمِمَّا يَعْرِشُونَ

٦٩ ثُمَّ كُلِي مِن كُلِّ الثَّمَرَاتِ فَاسْلُكِي سُبُلَ رَبِّكِ ذُلُلًا ۚ يَخْرُجُ مِن بُطُونِهَا شَرَابٌ مُّخْتَلِفٌ أَلْوَانُهُ فِيهِ شِفَاءٌ لِّلنَّاسِ ۗ إِنَّ فِي ذَٰلِكَ لَآيَةً لِّقَوْمٍ يَتَفَكَّرُونَ

- For the word "eat": "Kuli" is for females; "Kul" is for males. The Quran used "Kuli" (females).
- For the word "follow a path": "Usluki" is for females; "Usluk" is for males. The Quran used "Usluki" (females).
- For the word "its bellies": "butuniha" is for females; "butunihim" is for males. The Quran used "butuniha" (females).

How could an illiterate man who lived 1400 years ago have known that those honey making bees are females?

Butuniha بُطُونِهَا in Arabic means multiple stomachs of a single female. Today we know that a honey bee has an extra stomach dedicated for honey.

http://www.miracles-of-quran.com/honey_bees.htm

The word “fiihi” means “in itself” which is different from the word “hua” meaning “it is”.

RESEARCH BACKGROUND

ECONOMIC POTENTIAL

- Like the bees, stingless bees collect nectar, pollen grains, and resins as the raw material of bee products.
- Three stingless bee products that are mostly collected are honey, bee bread, and propolis.
- In Malaysia, the current market price for honey, bee bread and propolis are approximately 28 USD / kg, 35 USD / kg, and 60 USD / 100 ml, respectively.
- Several biological properties have been detected in stingless bee products by a wide series of scientific studies.
- Different reviews have been dedicated to summarize therapeutic properties and uses as nutraceutical, pharmaceutical and cosmetic ingredients.

LEGISLATION

- Honey trade in many parts of the world is governed by regulations. These regulations fall into two broad categories
- They are used to ensure that a product sold as honey really is **honey**, and not an adulterated substance or false honey
- They are used to ensure that any honey is **safe** to eat, and is not contaminated with anything harmful to human health
- The purpose of regulations are to maintain standards and keep consumers safe. In different parts of the world different regulations apply.

STANDARD

- Dominant standard: The Codex Alimentarius Commission (CAC) which was established in 1963 by FAO and WHO to develop food standards, guidelines and codes of practice applicable to globally traded foods.
- The CAC for Honey is regarded as the minimum standard which should be achieved by any trader entering the international market.
- Regions and countries also develop their own standards - based on the CAC Standard.
- Many nations have developed their own National Honey Standards.
- However, no international standard for stingless bee honey have been developed yet.

MALAYSIA STANDARD FOR KELULUT (STINGLESS BEE) HONEY 2017

Standards for Raw Honey			
Parameters	European Union (2001)	Codex Standards (1981)	Standards Malaysia (2017) for kelulut honey
Moisture (%)	Max 20.0	Max 20.0	Not more than 35
Brix	N/A		N/A
pH	N/A		2.5 - 3.8
Free Acidity (meq/kg)	Max 50.0	Max 50.0	N/A
Ash (%)	N/A		Not more than 1
Colour (mmPfund)	N/A		N/A
Colour description	N/A		N/A
Electric conductivity (uS/cm)	Max 0.8	Max 0.8	N/A
Diastase activity (Schade)	Min 8.0	Min 8.0	N/A
Reducing sugars (%)	Min 60.0	Min 60.0	Not more than 85
Sucrose (%)	Max 5.0	Max 5.0	Not more than 7.5
Plant phenolics	N/A		Present

SAMPLE COLLECTION

36 bottles of fresh honey samples from 4 different species of stingless bee were collected from Malaysia and Queensland.

The species from Malaysia are: *Heterotrigona itama* and *Geneotrigona thoracica.* They are collected between January to April 2018.

The species from Queensland are: *Tetragonula carbonaria* and *Tetragonula hockingsi*. They are collected between April to June 2018.

Sampling in Malaysia

Sampling in Queensland

MALAYSIA STINGLESS BEES

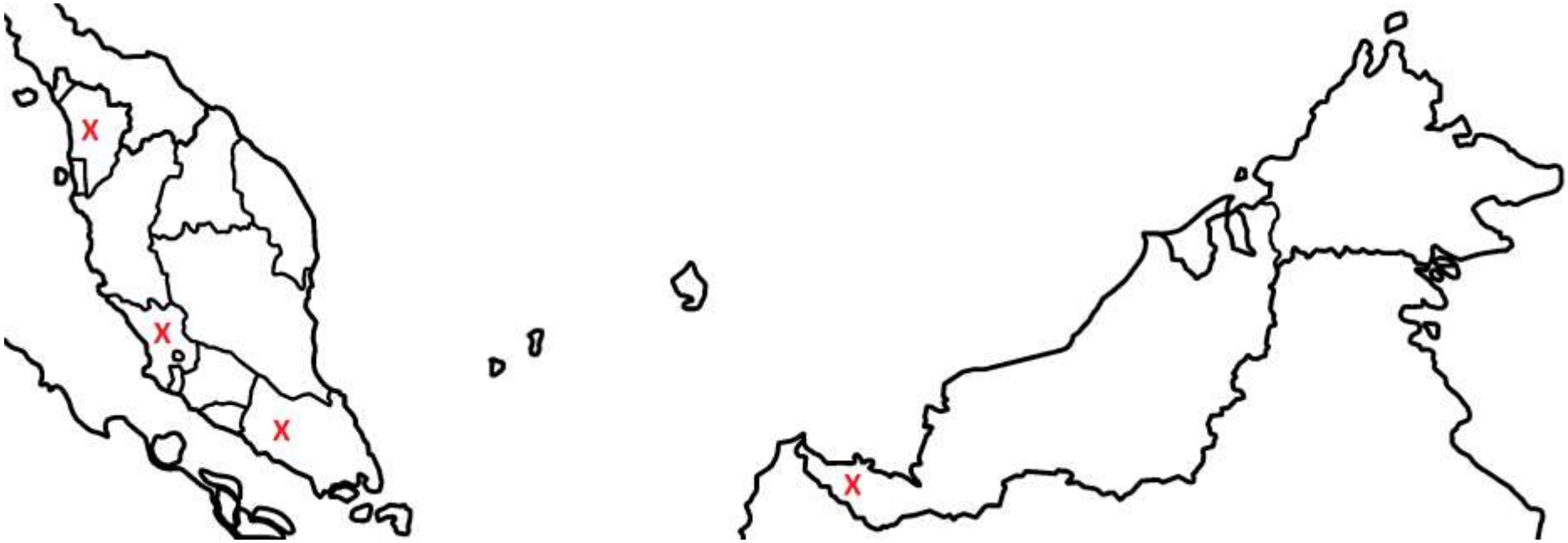
Comparison of 5 common bees. Above from left: *Apis cerana*, *Heterotrigona itama*, *Tetrigona apicalis*, *Tetragonula laeviceps*. © 2014 S. X. Chui. Below: *Geniotrigona thoracica.* © 2011-2016 Hadel Go

AUSTRALIA STINGLESS BEES

Tetragonula carbonaria

Tetragonula hockingsi

LOCATION IN MALAYSIA



LOCATION IN QUEENSLAND

*Bargara, Central Queensland

RESEARCH FINDINGS

PHYSICOCHEMICAL PROPERTIES

Physicochemical Properties

Variable	*T. carbonaria*	*T. hockingsi*	*H. itama*	*G. thoracica*
Colour, Pfund (mm)	436.4 (±131.5)	365.7 (±116.2)	230.4 (±111.6)	148.5 (±58.8)
Total Soluble Solid (°Brix)	72.92 (±0.88)	73.24 (±1.17)	70.16 (±1.49)	70.03 (±2.14)
Moisture (%)	25.48 (±0.85)	25.15 (±1.155)	28.16 (±1.45)	28.3 (±2.08)
Electrical conductivity (mS/cm)	0.61 (±0.11)	0.7 (±0.05)	0.29 (±0.05)	0.32 (±0.06)
Ash (g/100g)	0.27 (±0.064)	0.32 (±0.03)	0.09 (±0.027)	0.10 (±0.033)
pH	3.6 (±0.06)	3.6 (±0.13)	3.2 (±0.15)	3.1 (±0.04)
Free acidity	167.8 (±32.8)	125.4 (±40.9)	211.5 (±93)	235.6 (±95.8)
Total Phenolic (µg/g)	162.01 (±21.17)	143.6 (±38.8)	64.8 (±35.4)	47.59 (±9.98)
Antioxidant activities				
DPPH (µm TE/g DW)	93.6 (±78.1)	70.81 (±27.84)	57.32 (±17.84)	53.5 (±10.11)
Ferrous Ion Chelation (%)	46.98 (±15.61)	50.02 (±11.44)	34.67 (±11.46)	22.89 (±5.99)
Reducing Sugars				
Fructose (g/100g)	19.13 (±4.09)	19.16 (±3.58)	15.97 (±6.05)	5.37 (±1.4)
Glucose (g/100g)	12.457 (±1.78)	12.301 (±2.28)	13.86 (±5.71)	18.5 (±24.9)

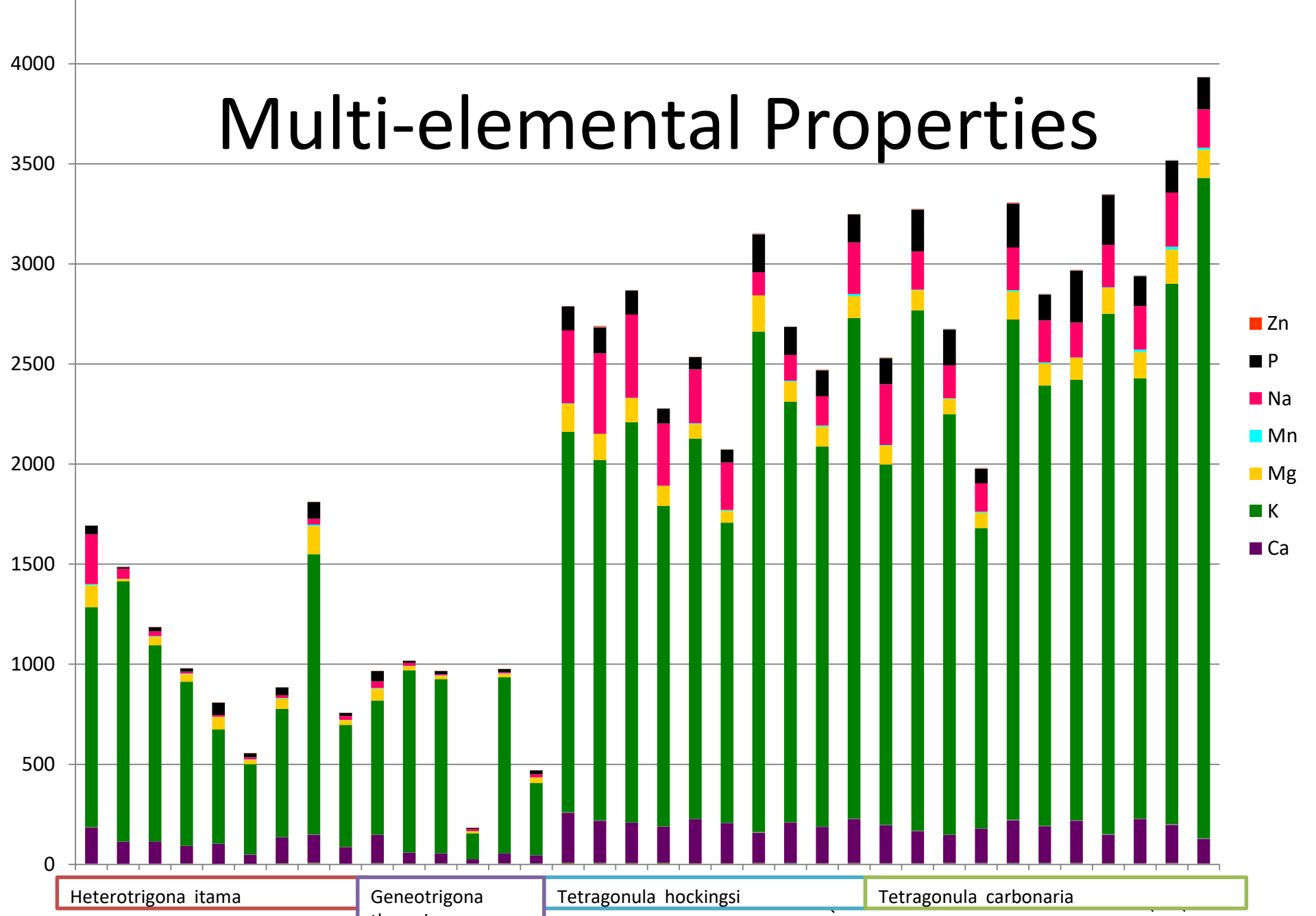
Compliance to CODEX Standard

Variable	*T. carbonaria*	*T. hockingsi*	*H. itama*	*G. thoracica*
Colour, Pfund (mm)	436.4 (±131.5)	365.7 (±116.2)	230.4 (±111.6)	148.5 (±58.8)
Total Soluble Solid (°Brix)	72.92 (±0.88)	73.24 (±1.17)	70.16 (±1.49)	70.03 (±2.14)
Moisture (%)	25.48 (±0.85)	25.15 (±1.155)	28.16 (±1.45)	28.3 (±2.08)
Electrical conductivity (mS/cm)	0.61 (±0.11)	0.7 (±0.05)	0.29 (±0.05)	0.32 (±0.06)
Ash (g/100g)	0.27 (±0.064)	0.32 (±0.03)	0.09 (±0.027)	0.10 (±0.033)
pH	3.6 (±0.06)	3.6 (±0.13)	3.2 (±0.15)	3.1 (±0.04)
Free acidity	167.8 (±32.8)	125.4 (±40.9)	211.5 (±93)	235.6 (±95.8)
Total Phenolic (µg/g)	162.01 (±21.17)	143.6 (±38.8)	64.8 (±35.4)	47.59 (±9.98)
Antioxidant activities				
DPPH (µm TE/g DW)	93.6 (±78.1)	70.81 (±27.84)	57.32 (±17.84)	53.5 (±10.11)
Ferrous Ion Chelation (%)	46.98 (±15.61)	50.02 (±11.44)	34.67 (±11.46)	22.89 (±5.99)
Reducing Sugars				
Fructose (g/100g)	19.13 (±4.09)	19.16 (±3.58)	15.97 (±6.05)	5.37 (±1.4)
Glucose (g/100g)	12.457 (±1.78)	12.301 (±2.28)	13.86 (±5.71)	18.5 (±24.9)

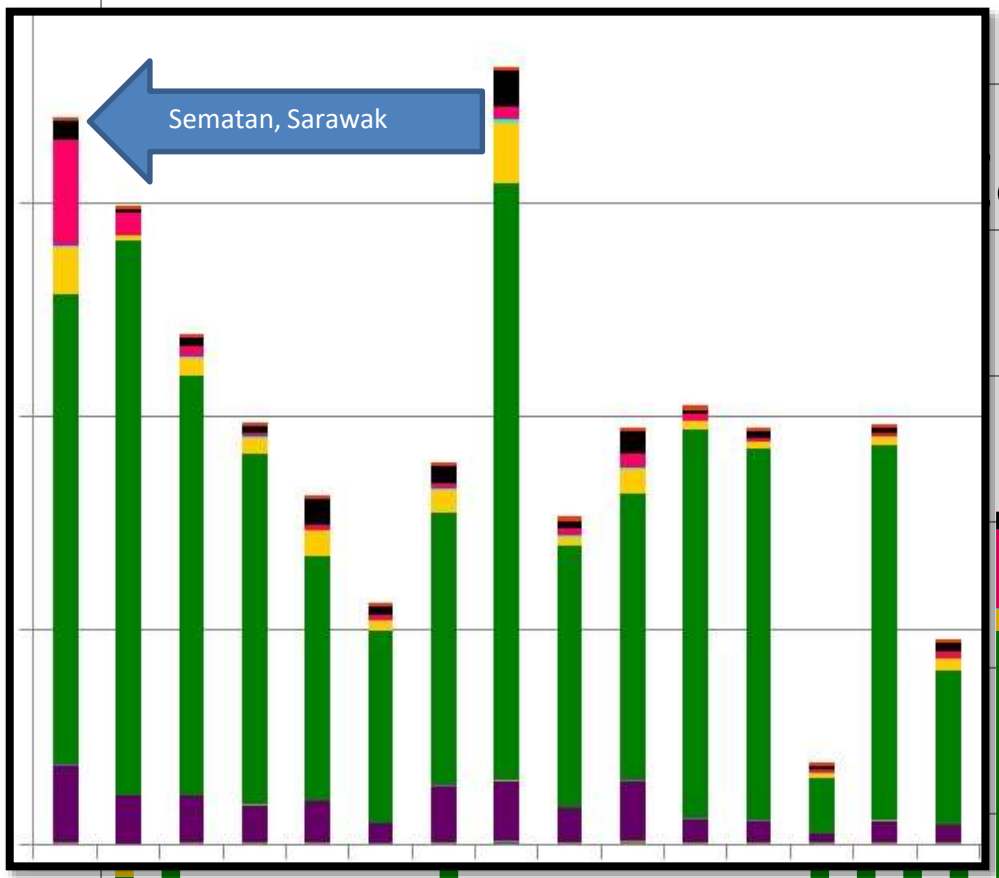
Compliance to Standard Malaysia (Raw Honey)

Variable	*T. carbonaria*	*T. hockingsi*	*H. itama*	*G. thoracica*
Colour, Pfund (mm)	436.4 (±131.5)	365.7 (±116.2)	230.4 (±111.6)	148.5 (±58.8)
Total Soluble Solid (°Brix)	72.92 (±0.88)	73.24 (±1.17)	70.16 (±1.49)	70.03 (±2.14)
Moisture (%)	25.48 (±0.85)	25.15 (±1.155)	28.16 (±1.45)	28.3 (±2.08)
Electrical conductivity (mS/cm)	0.61 (±0.11)	0.7 (±0.05)	0.29 (±0.05)	0.32 (±0.06)
Ash (g/100g)	0.27 (±0.064)	0.32 (±0.03)	0.09 (±0.027)	0.10 (±0.033)
pH	3.6 (±0.06)	3.6 (±0.13)	3.2 (±0.15)	3.1 (±0.04)
Free acidity	167.8 (±32.8)	125.4 (±40.9)	211.5 (±93)	235.6 (±95.8)
Total Phenolic (µg/g)	162.01 (±21.17)	143.6 (±38.8)	64.8 (±35.4)	47.59 (±9.98)
Antioxidant activities				
DPPH (µm TE/g DW)	93.6 (±78.1)	70.81 (±27.84)	57.32 (±17.84)	53.5 (±10.11)
Ferrous Ion Chelation (%)	46.98 (±15.61)	50.02 (±11.44)	34.67 (±11.46)	22.89 (±5.99)
Reducing Sugars				
Fructose (g/100g)	19.13 (±4.09)	19.16 (±3.58)	15.97 (±6.05)	5.37 (±1.4)
Glucose (g/100g)	12.457 (±1.78)	12.301 (±2.28)	13.86 (±5.71)	18.5 (±24.9)

Multi-elemental Properties



al Properties



1000

500

0

Zn
V
Sr
Sn
Se
Sb
Pb
P
Ni
Na
Mo
Mn
Mg
K
Hg
Fe
Cu
Cr
Co
Cd
Ca
Ba
B

Heterotrigona itama

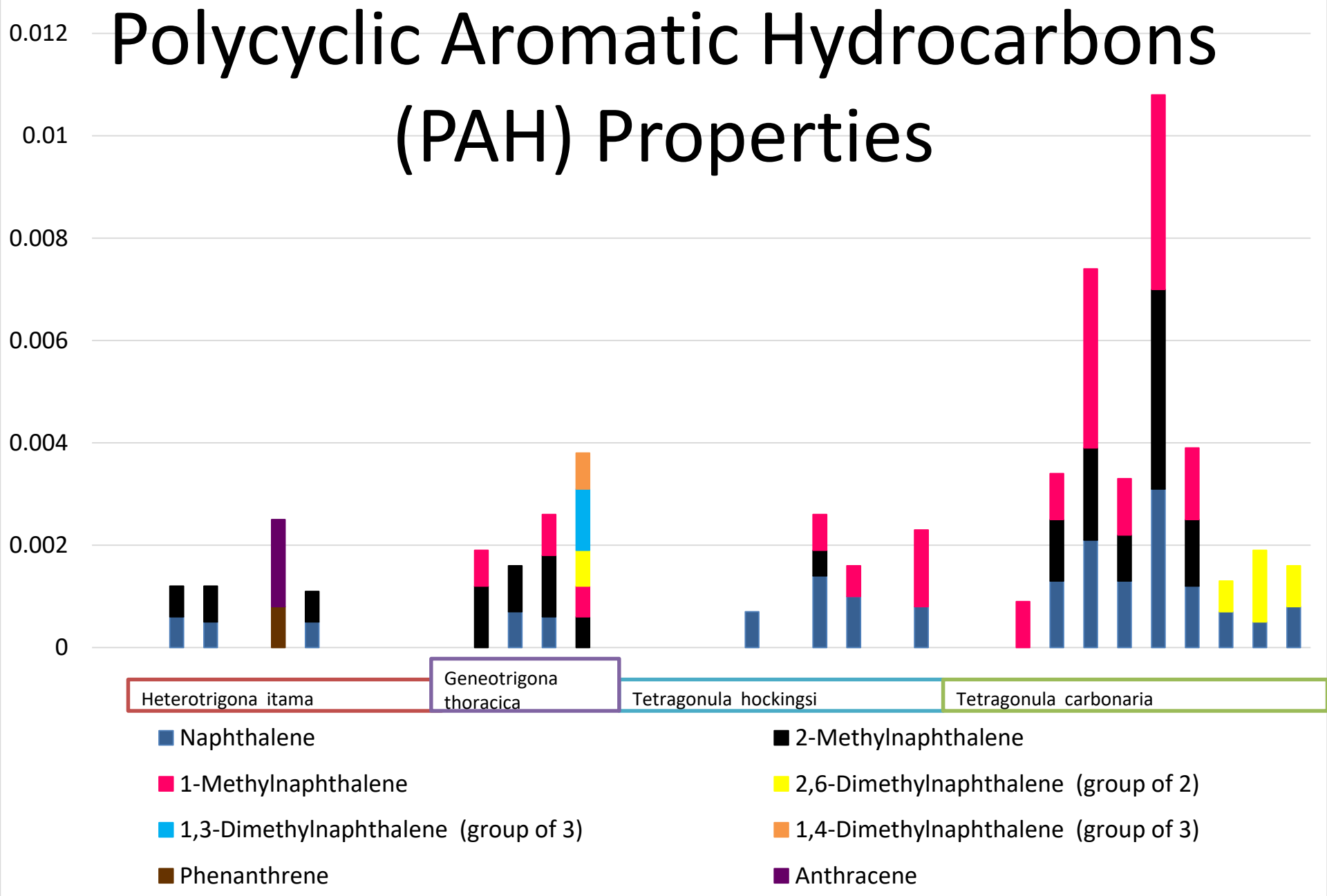
Geneotrigona thoracica

Tetragonula hockingsi

Tetragonula carbonaria

TOXICANTS AND CONTAMINANTS

Polycyclic Aromatic Hydrocarbons (PAH) Properties



Brief summary of toxicants and contaminants

- Non alarming levels of arsenic, cadmium, mercury and lead was found in all samples.
- Non alarming levels of pesticides and herbicides as well.
- Pyrrolizidine alkaloids were detected in Malaysian honey samples.

CONCLUSION

Unique Properties of Stingless Bee Honeys

- Different across species.
- Different across both countries.
- Presence of toxicants might also be different.
- Different than honey produced by European honeybees – new standard for commercialization is required.

Thank You for Bee-ing So Sweet!