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Adulteration Identification of Stingless Bee Honey Using Dielectric Spectroscopy Technique

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INTRODUCTION


Just because it's sweet and sticky doesn't mean it's 'honey'

NEWS

Thursday, 10 Apr 2014
12:00 PM MYT

Source: https://www.thestar.com.my/lifestyle/food/news/2014/04/10

BH ONLINE

BERITA SUKAN DUNIA HIBURAN BISNES RENCANA WANITA HUJUNG MINGGU BHPLUS

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Madu tiruan jejas peniaga

455 dibaca

KOTA BHARU: Kewujudan madu tiruan dalam pasaran tempatan diakui menjejaskan lebih 50 peratus pendapatan peniaga madu asli apabila produk mereka turut diragui orang ramai.

Perkara itu diakui anak kepada pemilik Pak Nik Madu Enterprise, Nik Abdul Jabbar Nik Abdul Malek, 23, apabila ramai pelanggan mula mempersoalkan keaslian madunya sejak tahun lalu sehingga ada antara mereka sudah berhenti membelinya.

Nik Abdul Jabbar yang kini membantu perniagaan ayahnya, Nik Abdul Malek Nik Mahmood, 50, yang dibuka sejak 1995, berkata madu asli dan tiruan mempunyai banyak perbezaan jika seseorang itu sudah terbiasa merasai manisan yang asli.

Bagaimanapun, katanya, disebabkan ramai yang meragui produk madu tualang, perniagaannya mula merosot lebih 50 peratus sejak tahun lalu.

"Bagi pakar madu seperti ayah saya, mereka tahu ciri madu asli walaupun ada cubaan menipu dengan mencampurkan dengan gula melaka.

1.Stingless bees produce only about 1–5 kg of honey per year depending on the species compared to *Apis mellifera* bees, with an average of 20 kg of honey per hive

2.(Chuttong et al. (2016b)

Due to limited source and high demand of honey, the retail price of stingless bee honey is higher than common honey bees. Average stingless bee honey retail price is between RM250-RM300/kg (57 – 70 USD/kg).

Nevertheless, with abundance of stingless bee honey product in the market, the purity of these honey is somehow questioned

PROBLEM STATEMENT

According to the Malaysian Standard on *Kelulut* (Stingless bee) honey

MS 2683:2017, *kelulut* honey shall free from foreign matter and not contain any food additives.

The modes of honey adulteration rapidly change and the current official method cannot detect honey adulteration

Hand-held refractometer is usually used to check sugar content in honey. But it just provides total soluble solid content.

Moreover, sucrose–adulterated honey cannot be identified easily by visually examining or tasting.

Dielectric Spectroscopy

Dielectric spectroscopy is a powerful tool to study the structure and dynamics of matter.

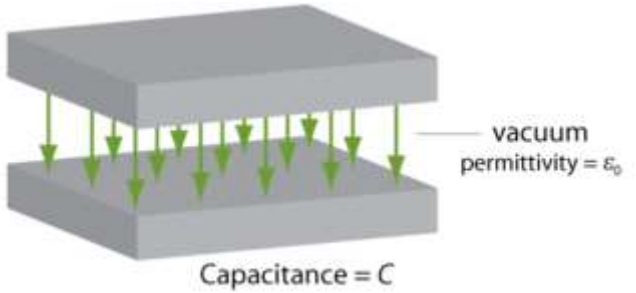
Each material has its own dielectric properties when electrical field applied. –dipole moment, polarization.

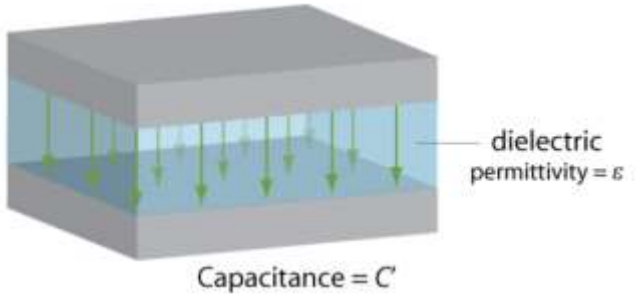
Dielectric permittivity ,ε = ε′ -jε″

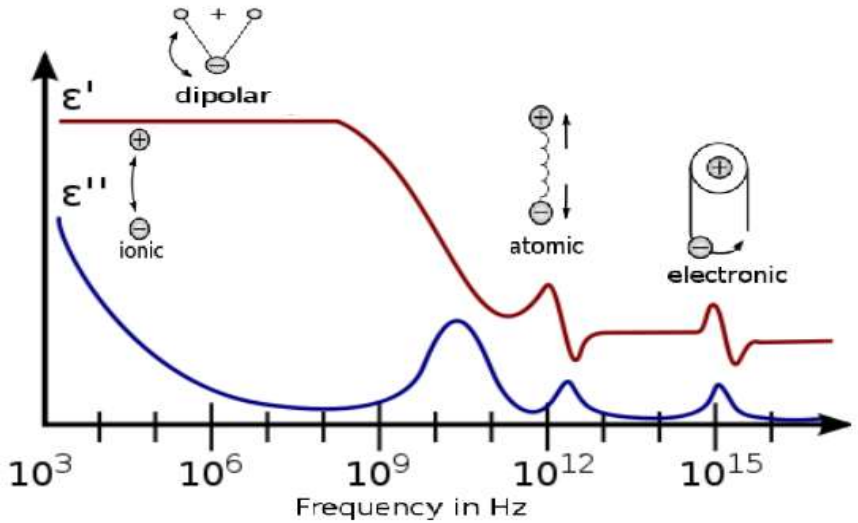
Dielectric constant (ε') -the real part , associated with the capability of energy storage in the material, and

Loss factor (ε ") - the imaginary part, associated with energy dissipation in the material in the form of heat

Dielectric constant of pure water = 80







Source: https://www.doitpoms.ac.uk/tlplib/dielectrics2/dielectric_constant.php

Material and Method

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Sample Preparation

No	Treatment	Amount of pure honey	Amount of sucrose/water
1.	Pure honey	50 ml	-
2.	Adulterated with 15% water	42.5 ml	7.5 ml water
3.	Adulterated with 30% water	35 ml	15 ml water
4.	Adulterated with 15% sucrose	42.5 ml	7.5 ml sucrose
5.	Adulterated with 30% sucrose	35 ml	15 ml sucrose

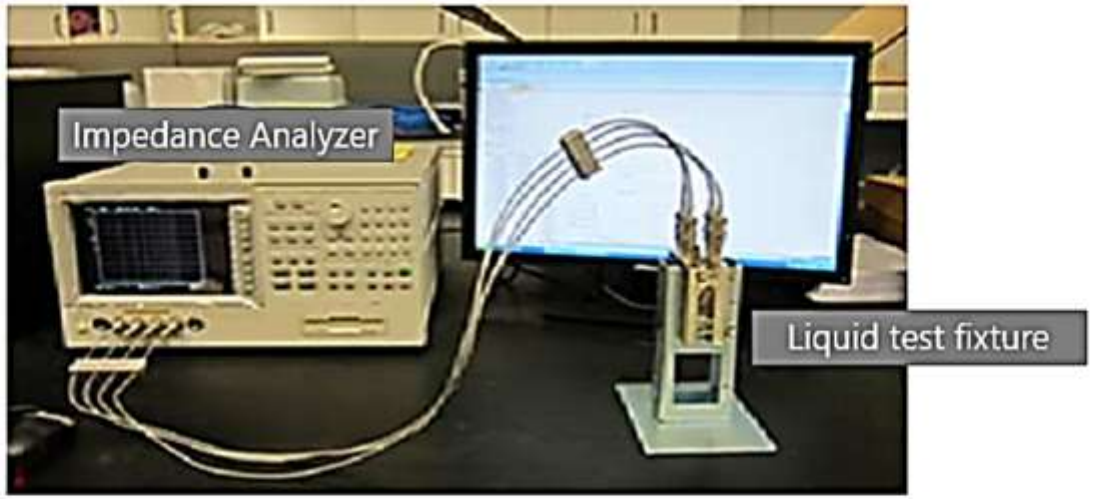
Pure stingless bee honey from *Heterotrigona Itama sp.* was obtained at Ladang 10, Universiti Putra Malaysia (UPM).

Adulterated groups mixture was left in water bath at 45° C for about 3 hours to ensure that the sucrose and water added to the honey mixed well and to dissolve the presence of bubbles and crystal in the solution

Dielectric properties measurement

DIELECTRIC SPECTROSCOPY

Liquid test fixture Agilent 16452A, Agilent Technologies, connected to
a Precision Impedance Analyzer Agilent 4294A, Agilent Technologies, Hyogo, Japan



Frequency range
40 kHz to 40 MHz

5ml stingless bee honey
sample per measurement

Measure capacitance (Cp) and resistance (Rp), display value of Ɛ' (dielectric constant) and Ɛ "(loss factor)

Honey sample is inserted carefully thru the opening of the test fixture

Sucrose content, moisture content and viscosity measurement

Sucrose & Moisture Content Measurement

Instrument:
Digital Refractometer (D-22297, KRUeSS Optronic, Germany

Viscosity Measurement

Instrument:
Sine-wave Vibro Viscometer (A&D SV-10, Tokyo,)

Sucrose content and moisture content measurement

- Two drops of sample was poured on the prism.
- The refractive index and temperature were displayed simultaneously on the LCD.
- The water content is calculated from the refractive index measure, by applying the equation of Wedmore (1955).

$$W_{wed} = \frac{-0.2681 - \log\ (R.I - 1)}{0.002\ 243}$$

where

W_{wed} is the water content in g per 100 g honey; and *R.I* is the refractive index

Viscosity measurement

- It measures viscosity by detecting the driving electric current necessary to resonate the two sensor plates at constant frequency of 30Hz and amplitude of less than 1mm.
- A sample of 40 ml was poured into the cup until the surface reaches between the level gauges.

Results and discussion

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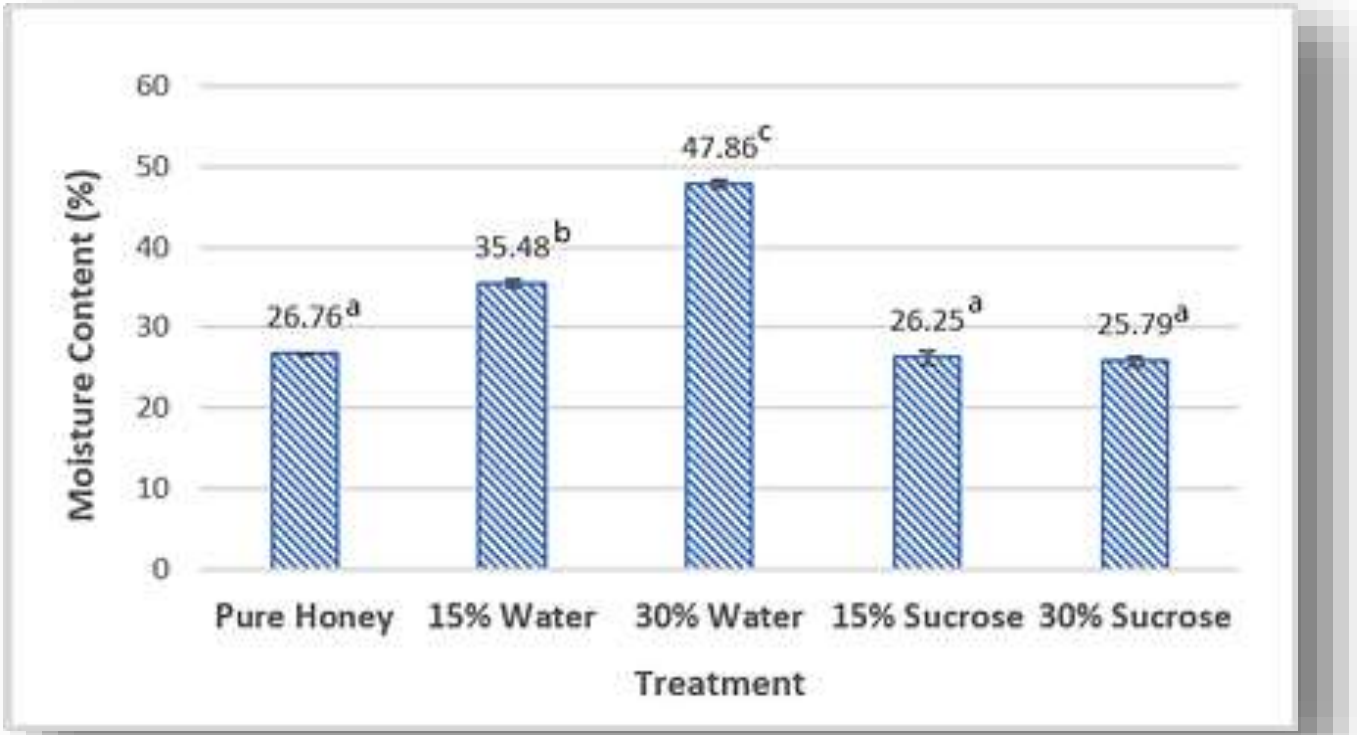
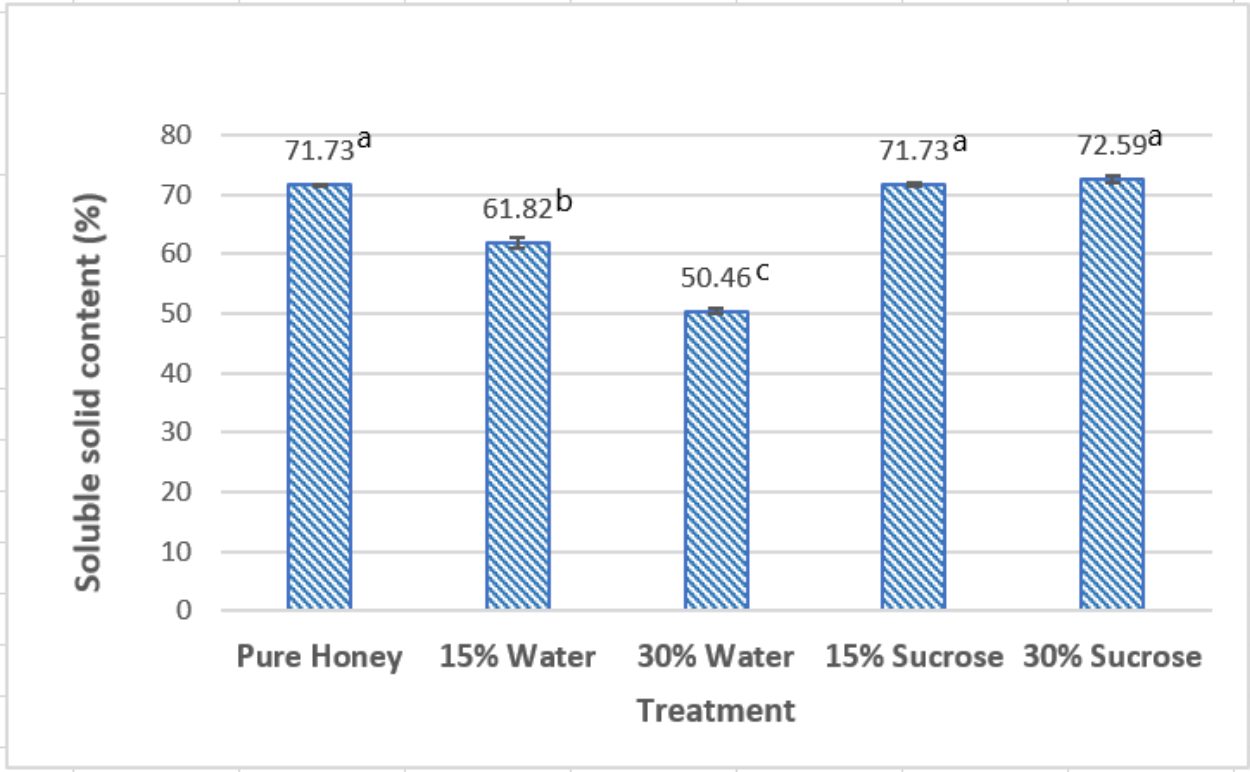
Moisture content of pure and adulterated stingless bee honey

- Honey adulterated with 30% of water has the highest moisture content follow with 15% water and pure honey.
- Honey adulterated with sucrose has slightly the same moisture content value with pure honey with no significant difference.
- This shows that moisture content increase with increasing water in honey.
- By referring to the Malaysian Standard, moisture content of raw honey shouldn't exceed 35% . But based on the result, if we adulterated the pure sample with sucrose, the moisture content is still below the level.



Soluble solid content (SSC) of pure and adulterated stingless bee honey

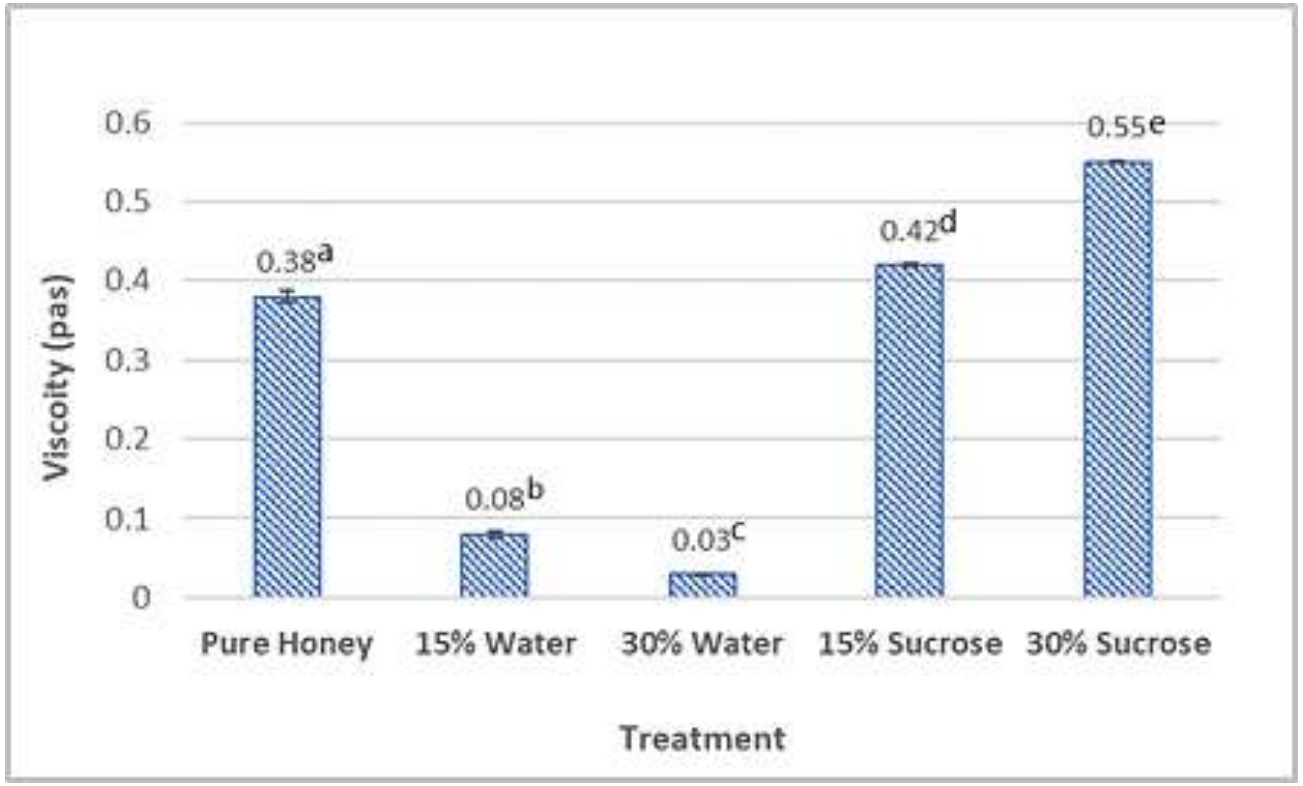
- Honey adulterated with 30% of water has the lowest SSC value while honey adulterated with sucrose and pure honey have slightly the same SSC value with no significant difference
- This shows that SSC value decreases with increasing water in honey
- This also shows that SSC analysis couldn't differentiate between pure honey and honey adulterated with 15% and 30% sucrose



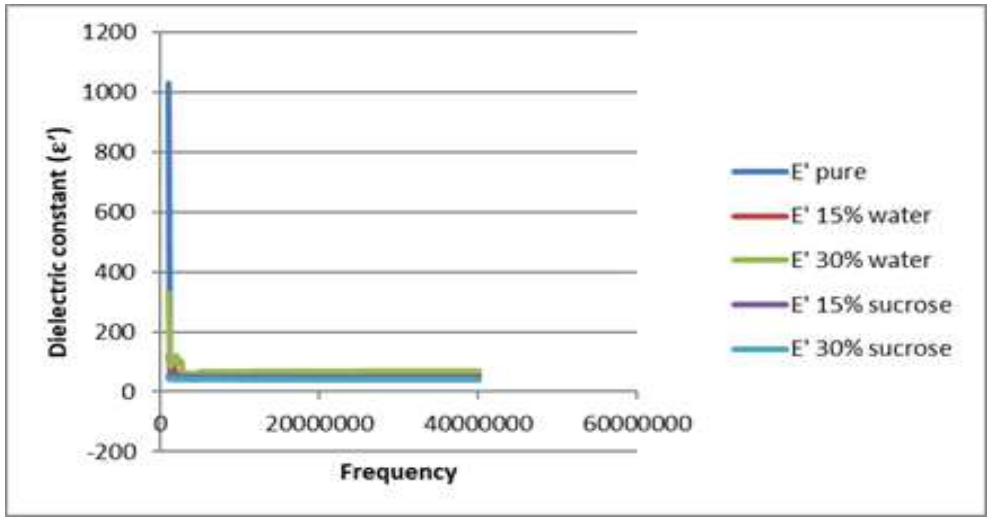
Viscosity of pure and adulterated stingless bee honey

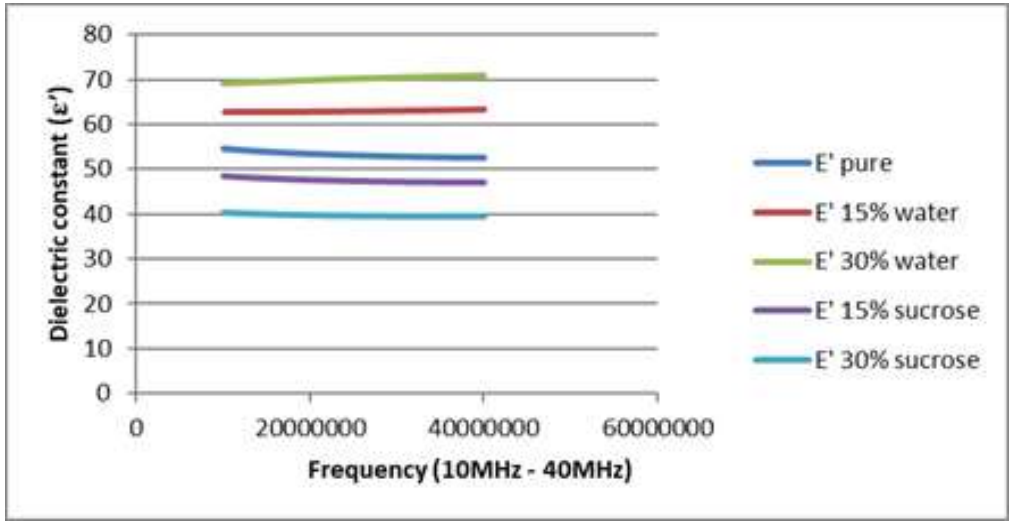
- Sucrose adulterated honey has higher viscosity compared to pure honey, while honey adulterated with water has lower value of viscosity

- This shows viscosity of pure and adulterated honey is significantly different with each treatment.



Variation of dielectric constant (ε') against frequency range of 40 kHz to 40 MHz

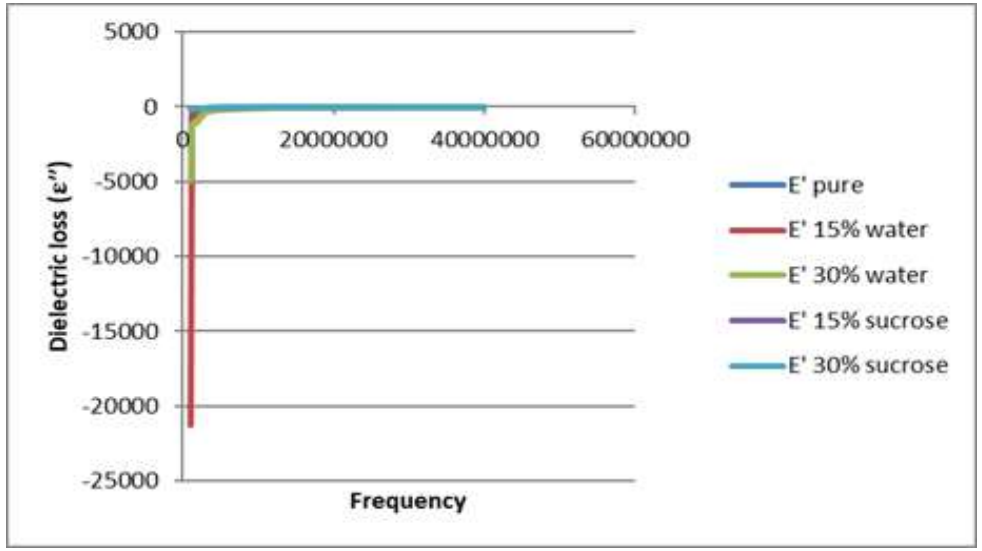


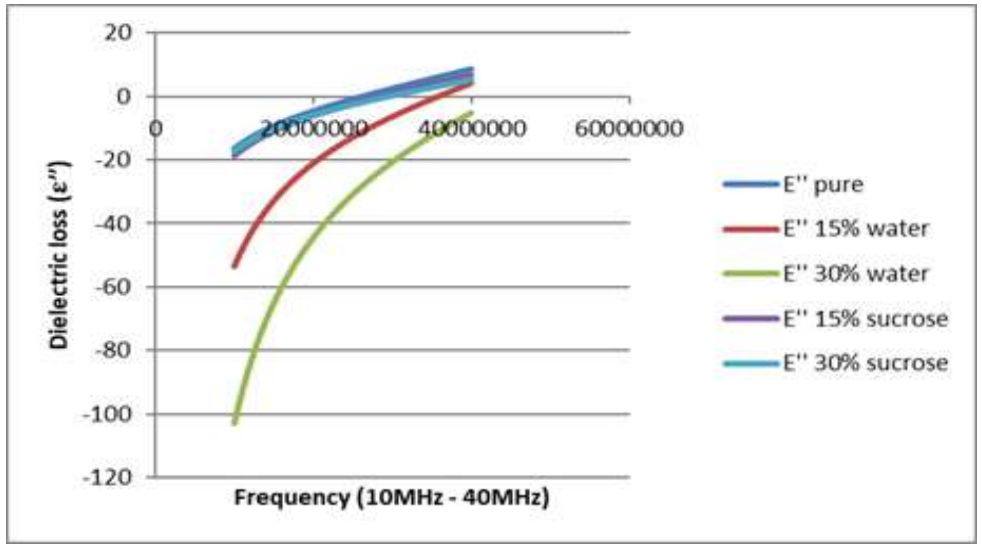


- Dielectric constant of pure and adulterated honey at frequency range 40 kHz to 40 MHz.

- **Frequency range between 10 MHz to 40 MHz.** Honey adulterated with 30% water shows highest dielectric constant (70) compared to other treatment, and honey adulterated with 30% sucrose shows lowest dielectric constant (40). The graph also shows that pure (ε'=53) and adulterated honey can be differentiate using dielectric constant value.

Variation of dielectric loss (ε'') against frequency range of 40 kHz to 40 MHz





- Dielectric loss of pure and adulterated honey at frequency range 40 kHz to 40 MHz

- **Frequency range between 10 MHz to 40 MHz.** Honey adulterated with 30% water shows lowest dielectric loss, and honey adulterated with 30% sucrose shows highest dielectric loss.

Relationship between dielectric constant (ε') and dielectric loss (ε'') with moisture content, SSC and viscosity.

Regression equation for each parameter based on **dielectric constant at 40 MHz** as functioning equation

Parameter	Regression equation	R^2
Viscosity	y = -0.018 ε' + 1.260	0.960
Moisture Content	y = 0.688 ε'-5.126	0.832
SSC	y = -0.699 ε'+ 103.85	0.844

Regression equation for each parameter based on **dielectric loss at 10Mhz** as functioning equation

Parameter	Regression equation	R^2
Viscosity	y = 0.0053x + 0.516	0.777
Moisture Content	y = -0.2527x + 21.878	0.998
SSC	y = 0.2544x + 76.288	0.996

CONCLUSION

- Dielectric properties of stingless bee honey shows promising result to be used as adulteration indicator and to develop a rapid, handheld sensor based on dielectric properties.

FUTURE WORKS

1. **Data fusion analysis**

   Integrating dielectric spectroscopy and optical spectroscopy to develop better model in detecting adulteration in SB honey
2. **Data Bank (Big Data)**

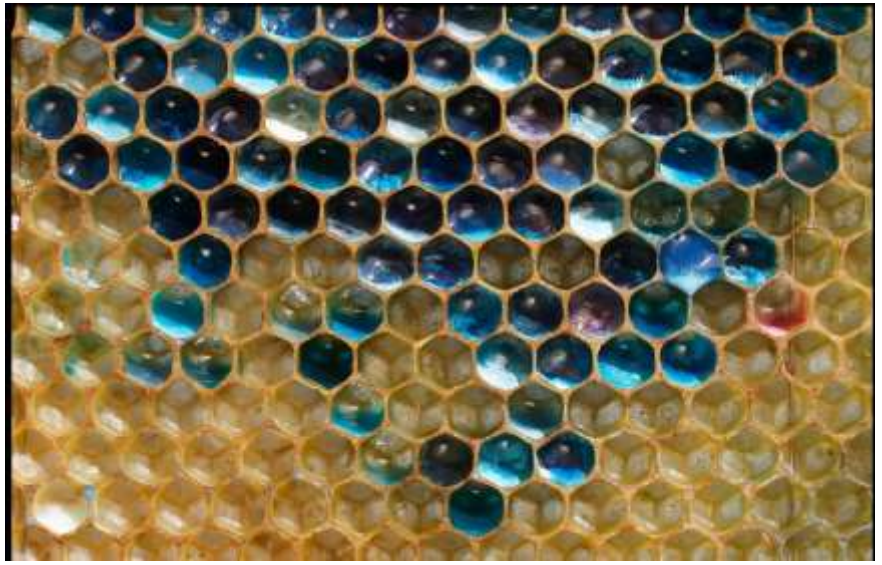
   Stingless bee honey sample collection from producers all around Malaysia
3. Analyzing **various method of adulteration**

Pictures: Colored Honey Made by Candy-Eating French Bees

Mysterious blue and green honey comes from honeybees feeding off remnants of M&M candy shells.

COLORFUL HONEY

Beekeepers in northeastern France found themselves in a sticky situation after bees from their hives began producing honey in shades of blue and green (pictured).



Source: https://news.nationalgeographic.com/news/2012/10/pictures/121011-blue-honey-honeybees-animals-science/

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