A COMPARATIVE REVIEW: PHYSICOCHEMICAL AND ANTIOXIDANT PROPERTIES OF STINGLESS BEE (*Heterotrigona itama*) HONEY AND TUALANG (*Apis dorsata*) HONEY

Nurul Afiqah Mohammad Nadzree[1] and Mohd Hilmi Hassan[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: hilmi@uitm.edu.my*

Abstract: Stingless bee honey and tualang honey are the most two common multi-floral honey available in Malaysia which is produced by *Heterotrigona itama* and *Apis dorsata* respectively. Currently, there is limited data on the comparative physicochemical and antioxidant properties of Malaysian honey. This review aims to evaluate and increase knowledge about the physicochemical composition and antioxidant activity of Malaysian honey produced by these two different species of bees. Parameters such as moisture content, pH, hydroxymethylfurfural (HMF), diastase activity, colour intensity, ash content, total phenolic content (TPC), FRAP and DPPH assays were analysed. Findings revealed that tualang honey showed higher pH, HMF reading and diastase number. Meanwhile kelulut honey is higher in moisture, ash content, total phenolic content and greater colour intensity. Besides, the antioxidant capacity was analysed to be higher in kelulut honey as it possessed lower DPPH values and greater FRAP values than tualang honey. Overall, both types of honey violate the Codex Alimentarius standard for honey in terms of moisture and diastase activity. The international standard for honey is unfavourable to the honey produced by these two types of bees. Apart from the different types of bees, the physicochemical properties of honey are diverse due to geographical origin, botanical source and seasonal factors. Further research is required to discover and understand the potential development of these honey into various food products.

Keywords: Stingless bee honey, kelulut honey, tualang honey, physicochemical properties, antioxidant activity

1. Introduction

Malaysia has a wide variety of blooms throughout the year and is considered to be the main reason for the various kinds of bees. Tualang honey and stingless bee honey are believed to be the two most common honey found in this country (Ranneh et al., 2018). Generally, honey is mainly produced by *Apis mellifera* which is mostly found in Europe and Africa, and they are being widely distributed all over the world. The other *Apis* subspecies such as *Apis dorsata*, *Apis cerana* and *Apis florea*, on the other hand, are discovered in tropical regions like Southern and Southeastern Asia. Unlike the *Apis* spp, stingless bees from the *Meliponini* tribe consist of more than one genus type, such as *Trigona*, *Melipona* and *Scaptotrigona* (Kek et al., 2014). Stingless bee honey is called kelulut honey by Malaysians.

Kelulut and tualang honey are multifloral honey produced by *Trigona spp* and *A. dorsata* respectively, which both are mostly found in tropical rainforests. Compared with *A. mellifera*

honey, the production and consumption of tualang and kelulut honey are still scanty because they have not reached the industrial level, lack quality standards and limited information regarding the honey. Honey can be divided into monofloral and multifloral. Monofloral honey is made from only one type of plant nectar or one predominant nectar. On the other hand, multifloral honey has a variety of plant sources, but none of them is predominant. It can be seen as a mixture of several monofloral honeys, which have important contributions from nectar from different plants (Kharsa, 2017). The *A. mellifera* honey falls into the monofloral group while tualang and stingless bee honey are multifloral honey.

2. Discussion

2.1. Physicochemical properties of honey

2.1.1. Moisture content

The range of moisture content in kelulut honey is 21.32 - 31.67% meanwhile the tualang honey is ranging from 16.39 - 26.51%. Since kelulut honey contains lower moisture content as compared to tualang honey, it was expected to have a longer shelf-life. The reason is honey with a high-water content further leads to a higher fermentation capacity, which makes it more difficult to preserve and store (Nordin et al., 2018), hence becoming a challenge for trading and distribution practices.

2.1.2. pH

The data shows that the pH values obtained for the stingless bee honey varied between 2.92 and 3.81. Meanwhile tualang honey had higher pH values compared to the kelulut honey with a range of 3.14 – 4.13. The acidity of honey is highly related to the moisture of honey. This is because the high water content in honey contributes to high water activity which makes it vulnerable to yeast fermentation. Hence, kelulut honey which consists of about 30% moisture is susceptible to yeast growth and multiplication.

2.1.3. Hydroxymethylfurfural (HMF)

Tualang honey recorded higher HMF reading (0.75 – 8.08 mg/kg) when compared to kelulut honey (0.05 – 2.27 mg/kg). These honey samples could be considered fresh as their HMF values were much lower than the limit for honey freshness (80 mg/kg). The higher HMF concentration of honey may be due to the different types of sugar content as well as its ratio of fructose and glucose (Wu et al., 2020). These results indicated that kelulut honey is more resistant to the formation of HMF.

2.1.4. Diastase activity

Observing the results for diastase activity, the honey of *H. itama* had lower values (1.62 – 3.41 DN) and the *A. dorsata* honey had larger values (2.00 – 5.48 DN). Although all honey samples were fresh, pure and unheated, their diastase activity is below the minimum 8 DN required by the Codex Alimentarius. In the Malaysian standard for kelulut honey, there is no standard set for the enzyme. Thus, both types of honey possess another parameter that does not comply with the quality standard of honey.

2.1.5. Colour intensity

The range of colour intensity of kelulut honey was 280.00 – 990.30 mAU whereas tualang honey was 475.50 – 869.00 mAU. The results indicate the kelulut honey has a broad range of colour intensity than tualang honey. The present review also showed that these two kinds of honey contain a lot of phenolic compounds.

2.1.6. Ash content

The ash content of Malaysian *H. itama* honey has greater variability which ranges from 0.08 to 0.67 g/100g. Tualang honey on the other hand was documented to have a range of 0.16 to 0.34 g/100g of ash content. All the stingless bee honey examined have ash contents within the suggested by Malaysian standard (max 1.0 g/100g). The ash content is not included in the standard of honey by Codex Alimentarius.

2.1.7. Total phenolic content (TPC)

Kelulut honey demonstrated a range of 26.45 – 791.50 mg GAE/100 g for TPC whereas the variation of TPC in tualang honey is between 16.32 to 589.20 mg GAE/100 g. Despite being analysed with the same method and collected from the same region, there is a significant difference in total phenolic contents for both kinds of honey. This is expected because the honey's characteristics and composition are severely influenced by many factors including the source of nectar, harvest time, storage, harvesting techniques and conditions

2.2. Antioxidant properties of honey

Honey is considered a rich source of antioxidant activity due to the presence of phenolic acids and flavonoids. This antioxidant potential can be measured by DPPH free radical scavenging activity (DPPH) and Ferric Reducing Antioxidant Power (FRAP). The IC_{50} values of the honey from *H. itama* ranged from 32.58 to 47.40 g/L while honey made by *A. dorsata* varied from 34.93 to 72.75 g/L. These results suggest that kelulut honey has a higher antioxidant activity compared to tualang honey. As for FRAP assay, the data from the literature show that the reducing ability of kelulut and tualang honey has a broad range, which indirectly depends on the type of flower and geographic origin because they are factors that affect the antioxidant content.

3. Conclusion

To sum up, tualang honey showed higher pH, HMF value and diastase activity meanwhile kelulut honey is higher in moisture, ash content, TPC, antioxidant capacity and greater colour intensity. Both kinds of honey violated the Codex Alimentarius standard for honey in terms of moisture (max 20%) and diastase activity (min 8 DN) while meeting the HMF parameter (max 80 mg/kg). Additionally, further studies are required to give insight into the potential development of both honeys either in food, cosmetics or nutraceuticals.

References

Kek, S. P., Chin, N. L., Yusof, Y. A., Tan, S. W., & Chua, L. S. (2014). Total phenolic contents and colour intensity of Malaysian honeys from the Apis spp. and Trigona spp. bees. *Agriculture and Agricultural Science Procedia, 2*, 150–155.

Kharsa, B. E. (2017). Physicochemical and antioxidant properties of Malaysian trigona and tualang bee honey. (Master's Thesis). International Islamic University Malaysia.

Ranneh, Y., Ali, F., Zarei, M., Akim, A. M., Hamid, H. A., & Khazaai, H. (2018). Malaysian stingless bee and Tualang honeys: A comparative characterization of total antioxidant capacity and phenolic profile using liquid chromatography-mass spectrometry. *LWT, 89*, 1–9.