A COMPARATIVE REVIEW: PHYSICOCHEMICAL PROPERTIES AND ANTIOXIDANT ACTIVITIES OF STINGLESS BEES (*Heterotrigona itama* & *Geniotrigona thoracica*) AND HONEY BEE (*Apis mellifera*) HONEY

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Abstract: Numerous studies regarding the physicochemical and antioxidant properties of stingless bee honey have been carried out and commonly compared with the honey bee, *Apis mellifera* honey. The various compositions in each species may affect the purity and originality of the honey thus comparing the honey properties are essential. The properties are capable of determining the quality of honey. This review evaluates and compares the physicochemical and antioxidant properties of honey samples produced by three different bee species namely *Heterotrigona itama*, *Geniotrigona thoracica* and *Apis mellifera*. The bee species were classified into two major groups, stingless bee, *H. itama* and *G. thoracica* and honey bee, *A. mellifera.* Both physicochemical and antioxidant properties of honey were different according to their bee species. The physicochemical analysis includes moisture content, ash content, colour characteristic, pH, free acidity, total soluble solids (TSS), and several antioxidant analysis including total phenolic content (TPC), total flavonoid content (TFC), free radical scavenging activity (DPPH) and ferric reducing antioxidant power (FRAP). The results from the different authors showed that stingless bee honey possessed significantly higher moisture content, ash content, colour characteristic, free acidity, TPC, TFC, DPPH and FRAP compared to the honey bee, *A. mellifera* honey which exhibited higher pH and total soluble solids (TSS). Among the stingless bee honey samples, *H. itama* honey exhibited higher ash content, colour characteristic, free acidity, TPC and FRAP while *G. thoracica* honey possessed higher moisture content, pH, total soluble solids (TSS), TFC and DPPH. Bee species fundamentally affect the physicochemical properties and antioxidant activities of honey samples.

Keywords: Physicochemical characteristics, antioxidant properties, *Heterotrigona itama*, *Geniotrigona thoracica*, *Apis mellifera*

1. Introduction

Honey is a natural supersaturated solution that is thick, sweet, and has golden coloured liquid produced by bees extracted from the secretions of plants. Bees are insects with wings that are closely related to wasps and ants. Approximately 20 000 different bee species have been discovered all over the world (Patel et al., 2021). Honey can be obtained from two types of beekeeping, stingless bees and honey bees. Stingless bee is commonly found in the tropical and subtropical regions around the globe, mainly in Australia, Africa, Southeast Asia, and South America (Kek et al., 2018; Shamsudin et al., 2019; Wong et al., 2019). Stingless bees are lacking functional stingers. Throughout the Malaysia region, *Heterotrigona itama (H.itama)* and *Geniotrigona thoracica (G. thoracica)* are reported most commercially producing honey. Honey

bees consist of 11 total species in the single genus *Apis*. Among those species, *A. mellifera (A. mellifera)* is the most widely spread species around the world. *A. mellifera* is historically produced and distributed throughout Africa, Asia, Middle East and Europe (Kek et al., 2014). The honey bee is a cultured bee that has functional stingers.

2. Discussion

Properties of honey are essential to be evaluated to determine the quality of honey. The properties are the physicochemical and antioxidant properties. Six (6) physicochemical properties have been reviewed based on several research papers. For moisture content, the amount of water present in honey determines its stability. The results show that *H. itama* and *G. thoracica* possessed higher moisture content compared to the honey bee, *A. mellifera* honey. Between the stingless bee honey, *G. thoracica* honey recorded higher moisture content compared to *H. itama* honey. According to Wong et al. (2019), stingless bee colonies are widely found in the tropical and subtropical regions of the world where the areas have the benefit of receiving abundant rainfall. This causes the stingless bee colonies to be exposed to high humidity hence exhibit higher moisture content. Besides that, determining ash content is crucial for evaluating the mineral content in food. Stingless bees have been reported to exhibit a higher amount of minerals in their honey compared to honey bee honey. Among stingless bee honey, *H. itama* honey exhibited a higher ash value than *G. thoracica* honey. The variations of mineral contents in honey are mainly dependent on the amount of pollen contained in honey. The higher the amount of pollen collected, the higher the mineral content in honey. Furthermore, colour is one of the most important features which can affect consumer's preferences. *H. itama* honey was reported to contain the highest colour intensity compared to other commercial honey in Malaysia (Kek et al., 2014; Maringgal et al., 2019). The available data stated that *G. thoracica* honey recorded a lower colour characteristic value than the *H. itama* honey sample. Honey bee, *A. mellifera* honey, recorded a lower value compared to stingless bee honey. Numerous studies have discovered that the honey colour variation correlates to the floral origin/native plant sources, geographical and botanical origin, minerals, light exposure, contaminating pigments, storage time and the temperature being applied to the honey samples.

pH is a measurable parameter used to measure the acidity and alkalinity of liquid or semi-solid compounds. Based on my review, *H. itama* honey is reported to have the lowest pH value and is followed by *G. thoracica* honey. Honey bee, *A. mellifera* honey recorded the highest pH value. Fuad et al. (2017) has discovered that temperature can be one of the factors that significantly influence the pH value. Low temperature causes the reaction rate of enzymes to drop thus reduces their pH value. Researchers reported that the pH value of *H. itama* honey is lower, thus the capability of honey to forbid the growth of microorganisms will be higher (Kek et al., 2018; Shamsudin et al., 2019). In addition, the free acidity contained in honey shows the presence of organic acids. Based on the reviews, stingless bee honey contains higher free acidity compared to honey bee honey. Honey from *H. itama* species recorded higher free acidity than honey from *G. thoracica* species. The difference in the total free acidity is mainly due to the fermentation process of sugars that convert to organic acids. A study has identified that the free acidity value will become greater when the moisture content in honey is higher. Total soluble solids (TSS) is a parameter to indicate the sweetness of food products. Based on my review, the lowest value of TSS is detected in *G. thoracica* honey, the stingless bee honey. The highest value of TSS is detected in the *A. mellifera* honey, the honey bee honey. Between stingless bee honey, *H. itama*

honey exhibited higher TSS compared to *G. thoracica* honey. TSS shows the relationship between water and sugar content. Stingless bee honey recorded a lower amount of soluble solids due to the high amount of water they contained.

For antioxidant properties, there are four (4) parameters have been reviewed. For the total phenolic content (TPC) parameter, honey with the highest total phenolic content comes from the species of *H. itama,* followed by *G. thoracica* and then *A. mellifera*. Stingless bee honey has been found to exhibit higher TPC compared to honey bee honey. The significant different composition of phenolic contents in honey is affected by the nectar source chosen by the bee species. Factors that contribute the phenolic contents to present in honey are the harvest season, weather, nectar source, botanical resources, floral origins, propolis, mode of storage, harvest technology and processing conditions (Kek et al., 2014; Maringgal et al., 2019; Shamsudin et al., 2019; Wong et al., 2019). Furthermore, flavonoid is a bioactive compound that functions as a superior antioxidant. Honey that recorded the highest total flavonoid content (TFC) is *G. thoracica* honey, followed by *H. itama* and *A. mellifera* honey. Honey bee, *A. mellifera* honey contains lower TFC compared to stingless bee honey. Studies have discovered that the variations of TFC in honey are greatly affected by the botanical origins, bee species, floral species and specific foraging activities. Furthermore, the free radical scavenging activity (DPPH) is used to measure compounds that act as free radical scavengers or hydrogen donors. It can also determine the antioxidant activity of foods. Based on the reviews, honey from *G. thoracica* species recorded a lower DPPH value compared to *H. itama* while *A. mellifera* honey possessed the highest DPPH value among the other two honey. According to several researchers, the variations of DPPH in honey can be due to the differences of phenolic contents and their types. Different geographical locations of nectar sources, floral sources, harvesting time, and seasonal can also be the factors that influence the DPPH in honey. Lastly, ferric reducing power assay (FRAP) is widely known to measure the total antioxidant activity in foods. Based on the results collected, the lowest FRAP value has been observed in the honey bee, *A. mellifera* honey, while the highest FRAP value has been detected in the stingless bee, *H. itama* honey. A high FRAP value indicates high reducing power and strong antioxidant activity. Factors that cause the variations of FRAP could be the different types and concentrations of phenolic and flavonoid compounds in honey.

3. Conclusion

In conclusion, this review demonstrated that the properties of stingless bees and regular bee honey are significantly different. Findings also indicated that the properties of honey are greatly dependent on the bee species. As for a recommendation, an extensive study with a significant number of bee species must be carried out to obtain more perceptions regarding the effect of bee species on the properties of honey.

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