



Total Phenolic, Total Flavonoid And Antioxidant Activity Of Honey Of Klanceng From Klaten, Magelang And Boyolali, Central Java

Nurul Hidayati¹, Sri Widodo Agung Suedy², Kasiyati³

¹Postgraduate Student, Departement of Biology, Faculty of Science and Mathematics, Diponegoro University

Jl. Prof. H. Soedarto, SH, Tembalang, Semarang 50275, Central Java, Indonesia

hidayatinuruul@gmail.com¹ agung.suedy@gmail.com²

Article details:

Received: dateth month, year



Abstract

Klanceng honey is a type of honey with potential as an antioxidant agent, aiding in the reduction of oxidative reactions and free radicals in the body. Phenolics and flavonoids play a crucial role as antioxidants in honey, and their content is influenced by the plants that serve as a source of nectar and pollen for bees. The characteristics of polyphenolic compounds in plants are closely tied to the topography of their

cultivation location, indirectly affecting the phenolic content, flavonoids, and antioxidant activity in honey.

This study aims to determine the total phenolic, total flavonoid, and antioxidant activity in honey samples from Penggung Village (Boyolali Regency), Kebonrejo Village (Magelang Regency), Ceper Village, and Ngemplak Village (Klaten Regency). The purposive sampling method was used, and the data was analyzed using Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) with a 95% confidence level. The results indicate that the nest location influences the total phenolic value and antioxidant activity but does not significantly affect the total flavonoid value. The total phenolic values range from 73.14 to 138.16 GAE mg/100g, while the total flavonoid values range from 0.50 to 0.60 mg/g QE. Antioxidant activity values range from 84.02 to 142.83 ppm. The honey sample with the highest total phenolic, flavonoid, and antioxidant activity is from Penggung Village in Boyolali Regency.

Keywords: Antioxidant activity. Stingless honey, Total phenolic, Total flavonoid

To cite this article :

(Nurul Hidayati, Sri Widodo Agung Suedy, 2023) Nurul Hidayati, Sri Widodo Agung Suedy, K. (2023). Total Phenolic, Total Flavonoid And Antioxidant Activity Of Honey Of Klanceng From Klaten, Magelang And Boyolali, Central Java. *International Journal of Health, Education and Social (IJHES)*, 6(7), 53–65.



INTRODUCTION

Honey is produced by honeybees from flower nectar (plant floral) and secretions from plant parts other than flowers (plant extra floral). Bees add secretory enzymes during the production process (Balasubramanyam, 2021; Khan *et al.*, 2018). The composition of honey consists of at least 181 components, with carbohydrates being the dominant component (80-85%), followed by water (15-17%). Honey also contains minor components such as protein, ash, enzymes, organic acids, amino acids, phenolic acids, vitamins, and minerals (Hasam *et al.*, 2020; Lim *et al.*, 2019; Tafere, 2021). Indonesia is home to several species of honeybees, including stinging bees (*Apis mellifera*, *A. andreniformis*, *A. dorsata*, *A. cerana*, *A. koschenikovi*, *A. nigrocincta*) and stingless bees (Genus: *Austroplebeia*, *Geniotrigona*, *Heterotrigona*, *Homotrigona*, *Leidotrigona*, *Lisotrigona*, *Papuatrigona*, *Pariotrigona*, *Tetragonula*, *Wallacetrigona*) (Engel *et al.*, 2018; Gratzner *et al.*, 2019; Kahono *et al.*, 2018).

The stingless bee, known as klanceng, lanceng, kelulut, and galo-galo, is smaller in size compared to *Apis* spp. bees and does not possess a sting (Evahelda *et al.*, 2021). Honey produced by stingless bees differs in characteristics from honey produced by *Apis* spp. bees. It tends to be thinner, has a more sour taste, and undergoes a longer crystallization process (Julika *et al.*, 2020; Pimentel *et al.*, 2021). The sour taste of klanceng honey indicates a high antioxidant content (Evahelda *et al.*, 2021), exhibiting activity 3-4 times higher than the antioxidant activity of honey produced by stinging bees (Shamsudin *et al.*, 2019a). The abundance of antioxidants in klanceng honey provides numerous therapeutic benefits, such as acting as an anti-inflammatory, anticancer, antimicrobial, anti-proliferative, skin aging-delaying, and anti-diabetic agent. (Pimentel *et al.*, 2021; Yaacob *et al.*, 2017).

Components that play a vital role as antioxidant agents in honey are phenolic compounds and flavonoids (Avila *et al.*, 2018; Rao *et al.*, 2016; Shamsudin *et al.*, 2019b). Phenolic compounds and flavonoids function by reducing free radicals and binding their electrons through the hydroxyl group, thereby decreasing their activity (Tuksitha *et al.*, 2018). Phenolic compounds are synthesized through the shikimate pathway and the phenylpropanoid pathway,



while flavonoid compounds are synthesized through the acetate and shikimate pathways (de la Rosa *et al.*, 2019; Nabavi *et al.*, 2018; Samanta *et al.*, 2011). The content of phenolic and flavonoid compounds in honey is influenced by the types of plants on which the bees feed. Phenolic compounds are associated with the source of nectar collected by bees, while flavonoid compounds are related to the sources of pollen collected by bees (Majid *et al.*, 2020; Maringgal *et al.*, 2019; Shamsudin *et al.*, 2019a). The location of beehives will impact the content of phenolic compounds and flavonoids due to variations in the diversity of plants that serve as food sources for bees. (Majid *et al.*, 2020; Selvaraju *et al.*, 2019). This study aims to determine the total phenolic content, total flavonoids, and antioxidant activity in klanceng honey based on geographical variations in nest locations.

METHODS

Sampling.

Klanceng honey was collected using purposive sampling from four different locations of Klanceng honey farms. These locations include Ceper Village, Ceper Sub-district, Klaten District (7°67'35.42"S 110.10353 BT) with an altitude of approximately 118.4 masl; Ngemplak Village, Karangnongko Sub-district (7°38'33.2"S 110°31'29.0" East Longitude) with an altitude of approximately 383 masl; Kebonrejo Village, Candimulyo Sub-district, Magelang District (70.30'01.5"S 110.10353 BT) with an altitude of approximately 448.2 masl; and Penggung Village, Boyolali Sub-district, Boyolali District (70.50'77.53 South Latitude 110.569495 East Longitude) with an altitude of approximately 567.4 masl. A total of 300 ml of honey was collected from each location and stored in airtight glass bottles in the refrigerator at a temperature of 4°C. The honey samples were analyzed and tested at the Laboratory of Structural Biology and Plant Physiology, Department of Biology, Universitas Diponegoro.



Tools and materials

The tools utilized in this study included an analytical balance, test tubes, and a UV-Vis spectrophotometer. The materials employed consisted of methanol, DPPH (2,2-diphenyl-1-picrylhydrazyl), Folin-Ciocalteu reagent, sodium carbonate solution, sodium nitrate solution, aluminum chloride solution, sodium hydroxide solution, and distilled water.

Total Phenolic Test (TPC)

The TPC (Total Phenolic Content) test utilized the Folin-Ciocalteu method with gallic acid as a positive control (Badrulhisham *et al.*, 2020). A standard curve for Gallic acid was constructed using a series of concentrations: 0, 3.9, 7.8, 15.6, 31.3, 62.5, 125, 250, and 500 ppm. TPC analysis involved dissolving 0.1 g of honey sample in 1 ml of methanol. Then, 0.5 ml of the sample solution was transferred to a test tube, followed by the addition of 2.5 ml of 10% Folin-Ciocalteu reagent and 2 ml of 7.5% sodium carbonate solution. The mixture was incubated for 60 minutes at 40°C. The absorbance value of the sample solution was measured using UV-Vis spectrophotometry at a wavelength of 765 nm. The total phenolic value was calculated as Gallic acid equivalents (GAE) per 100 g of sample (% w/w).

Total Flavonoid Test (TFC)

The TFC (Total Flavonoid Content) test employed the AlCl_3 colorimetric method with quercetin as a positive control (Agus *et al.*, 2019). A series of quercetin concentrations were prepared: 0, 1,563, 3,125, 6,250, 12,500, 25,000, and 50,000 ppm. For TFC analysis, 0.20 g of honey sample was dissolved in 4 ml of distilled water. The honey solution was then mixed with 0.3 ml of 5% sodium nitrate solution. After 5 minutes, 0.6 ml of 10% aluminum chloride solution was added, followed by a 5-minute incubation period. Next, 2 ml of 1M sodium hydroxide solution was added. The resulting mixture was brought to a final volume of 10 ml by adding 2.4 ml of distilled water and shaken to ensure homogeneity. Subsequently, the absorbance value of the sample solution was measured using UV-Vis spectrophotometry at a wavelength of 510 nm.



The total flavonoid value was calculated as milligrams of quercetin equivalents (QE) per gram of honey.

Antioxidant Activity Test

The DPPH (1,1-diphenyl-2-picrylhydrazyl radical) test was conducted with ascorbic acid as a positive control (Agus *et al.*, 2019). Honey sample solutions were prepared with a series of concentrations: 0, 1,563, 3,125, 6,250, 12,500, 25,000, and 50,000 ppm in a methanol solvent. The antioxidant activity analysis involved taking 100 μ l from each concentration series and placing it in a test tube. Subsequently, 900 μ l of 0.1mM DPPH solution was added to the sample solution, followed by 1 minute of homogenization using a vortex. The sample solution was then incubated in the dark at room temperature for 30 minutes. The absorbance value of the sample solution was measured using UV-Vis spectrophotometry at a wavelength of 517 nm (Agus *et al.*, 2019; Septiana *et al.*, 2019). The antioxidant activity curve of the sample was generated by plotting the percentage inhibition value on the Y-axis against the concentration series on the X-axis. The Inhibition Concentration (IC₅₀) value, which represents 50% inhibition, was determined by fitting it into the linear regression equation obtained from the curve (Banerjee *et al.*, 2004).

Data analysis

The data analysis utilized Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test (DMRT) with a 95% confidence interval. Pearson correlation was employed for the correlation analysis.

RESULTS AND DISCUSSION

The test results demonstrated that the location of the hives significantly influenced the total phenolic value ($p < 0.05$) and antioxidant activity ($p < 0.05$) of Klanceng honey. However, no significant effect of nest locations on the total flavonoid value was observed.

Table 1. Measuring result of TPC, TFC, and Antioxidant activity of klanceng honey from four village (Ceper, Ngemplak, Kebonrejo, Penggung).



Honey Sample	TPC (GAE mg/100g)	TFC (mg/g QE)	Aktivitas Antioksidan (IC ₅₀) (ppm)
Ceper Village (DC)	73.14 ^b ± 36.43	0.54 ± 0.05	114.95 ^b ± 19.59
Ngemplak Village (DN)	80.39 ^b ± 15.47	0.50 ± 0.06	136.21 ^{ab} ± 14.15
Kebonrejo Village (DK)	92.96 ^b ± 18.90	0.56 ± 0.06	142.83 ^a ± 15.14
Penggung Village (DP)	138.16 ^a ± 33.58	0.60 ± 0.05	84.02 ^c ± 21.95

Note: Numbers denoted by different letters on the same histogram (bar) indicate a significant difference based on Duncan's post hoc test at a 95% confidence interval.

Total Phenolic (TPC)

The analysis revealed that the TPC values in the four locations ranged from 73.14 to 138.16 GAE mg/100 g of honey. These values are higher compared to the measurements of *Tetragonula leviceps* honey from East Thailand, which ranged from 10 to 50 mg GAE/100g (Khongkwanmueang *et al.*, 2020); Klanceng honey from Santa Catarina, Brazil, with a range of 10.3 to 98.0 mg GAE/100g (Biluca *et al.*, 2016); Klanceng honey from Malaysia, with a range of 3.04 to 9.37 mg GAE/100g (Maringgal *et al.*, 2019) and among the measured values for klanceng honey from Malaysia, which ranged from 40.11 to 179.04 mg GAE/100g (Badrulhisham *et al.*, 2020). The variation in TPC values may be influenced by factors such as bee species, geographical origin, and the plants on which the bees foraged. (Agus *et al.*, 2019; Biluca *et al.*, 2020; Haron *et al.*, 2022; Selvaraju *et al.*, 2019).

Klanceng honey from Penggung Village (DP) exhibited the highest TPC value among the four types of honey, measuring 138.16 GAE mg/100g. This indicates that DP honey possesses a greater polyphenol content and higher antioxidant potential (Suleiman *et al.*, 2020). The TPC values of the other three types of honey, namely DC, DN, and DK, did not show significant differences. The elevated TPC value of DP honey was found to correlate with the altitude of the hive location, as the DP beehive was situated at the highest elevation compared to the other three locations. According to Suleiman *et al.*, (2020), honey sourced from highland nest locations tends to have higher phenolic content compared to lowland honey. This correlation can be attributed to the presence of plant phytochemicals, which serve as a food source for bees. The synthesis of phytochemicals in plants can be influenced by various environmental factors, such



as temperature, soil conditions, atmospheric pressure, and radiation intensity specific to each planting location. Plants in highland areas tend to produce a greater amount of secondary metabolites in response to abiotic and biotic stressors in their environment (Avila *et al.*, 2019; Becerril-Sanchez *et al.*, 2021).

Total Flavonoids (TFC)

Flavonoid compounds are essential in determining the aroma characteristics of honey (Ramlan *et al.*, 2021; Tuksitha *et al.*, 2018). These compounds are present in honey and are derived from nectar, pollen, and plant exudates collected by bees (Maringgal *et al.*, 2019). The most commonly found flavonoid compounds in honey include flavones, flavanones, and flavonols (Zawawi *et al.*, 2021).

The analysis revealed that the total flavonoid content (TFC) of honey from the four locations ranged from 0.50 to 0.60 mg/g QE. These TFC values fall within the range of values reported by Agus *et al.*, (2019) and Tuksitha *et al.*, (2018), which ranged from 0.21 to 0.90 mg/g QE and from 0.36 to 1.94 mg/g QE, respectively. In comparison, the TFC value in this study was higher than the measurement conducted by Maringgal *et al.*, (2019), which ranged from 0.03 to 0.14 mg/g QE. The content of flavonoids in honey is closely associated with the plants that serve as a food source for bees and the foraging behavior of bees (Shamsudin *et al.*, 2019a; Tuksitha *et al.*, 2018; Ya'akob *et al.*, 2019). Different plant species possess varying phytochemical compositions, which can influence the chemical profile of honey, including its flavonoid content. (Agus *et al.*, 2019).

Klaceng honey from DP exhibited the highest TFC value of 0.60 mg/g QE, while klaceng honey from DN had the lowest value of 0.50 mg/g QE. However, the TFC values among the four klaceng honeys did not show a significant difference ($p > 0.05$). This similarity in TFC values may be attributed to the presence of similar types of flavonoids, as indicated by pollen analysis, which revealed a dominance of *Cocos nucifera* pollen in all four honey samples. Plant pollen,



being a source of nutrition for bees, directly influences the flavonoid content in honey, as pollen itself contains flavonoids (Maringgal *et al.*, 2019).

Antioxidant (IC₅₀) Activity

Antioxidant activity was assessed based on the IC₅₀ value, where a smaller IC₅₀ value indicates higher antioxidant activity (Al-Farsi *et al.*, 2018; Majid *et al.*, 2020; Shamsudin *et al.*, 2019a; Zakaria *et al.*, 2020). The analysis revealed that the antioxidant activity values of the four klanceng honey samples ranged from 84.02 to 142.83 ppm. These values were higher compared to Majid *et al.*, (2020), which reported a range of 26.67-74.63 mg/mL, Avila *et al.*, (2019) study with a range of 9.71-39.10 $\mu\text{mol TE/kg}$, and Shamsudin *et al.*, (2019a) study with a range of 14.29-90.63 mg/mL. The variations in antioxidant activity values could be attributed to differences in the plants that served as a food source for the bees and the location of the hives, which are associated with environmental factors such as temperature, soil composition, and post-harvest conditions that can influence the composition of nectar and honey production (Majid *et al.*, 2020).

Klanceng honey from Penggung Village (DP) exhibited the highest inhibition ability, with a value of 84.02 ppm, while Klanceng honey from Kebonrejo Village (DK) had the lowest value at 142.83 ppm. The antioxidant activity of Klanceng honey from DP showed a statistically significant difference compared to the other three types of honey ($p < 0.05$). The variation in antioxidant activity among the four types of honey could be attributed to differences in their phenolic content and the types of phenolic compounds present in the honey.

Phenolic and flavonoid compounds play a crucial role in the antioxidant activity of honey (Agus *et al.*, 2019). In addition to these compounds, other components present in honey, such as ascorbic acid, organic acids, amino acids, glucose oxidase, and Maillard reaction products, also contribute to its antioxidant activity (Shamsudin *et al.*, 2019a; Tuksitha *et al.*, 2018).



Correlation

The results of the Pearson correlation analysis showed a positive correlation between the TPC and TFC values of the four kinds of honey. However, they exhibited a negative correlation with the value of antioxidant activity, which was statistically significant at a significance level of 0.05.

Table 2. Correlation of TPC, TFC, and antioxidant activity of klanceng honey from four village (Ceper, Ngemplak, Kebonrejo, Penggung).

Parameter	r	R ²	Signification
TPC vs TFC	+	0,506	0,023
TPC vs IC ₅₀	-	0,275	0,241
TFC vs IC ₅₀	-	0,300	0,198

The correlation between TFC and TPC values was quite strong, with a correlation coefficient of $r = 0.506$. This indicates that as the TFC value increases, the TPC value also tends to increase. This strong correlation can be attributed to the fact that flavonoid compounds belong to the group of polyphenols (Asem *et al.*, 2019).

The correlation between antioxidant activity and TPC and TFC values was relatively low, with correlation coefficients of $r = -0.275$ and $r = -0.300$. This negative correlation aligns with the findings of Al-Farsi *et al.*, (2018) who reported a negative correlation between antioxidant activity and TPC and TFC values with correlation coefficients of $r = -0.771$ and $r = -0.616$, respectively. Similarly, Boussaid *et al.*, (2018) observed a negative correlation between antioxidants and TPC and TFC values with correlation coefficients of $r = -0.945$ and $r = -0.866$, respectively. The negative correlation between antioxidant activity and TPC/TFC values can be attributed to the IC₅₀ calculation, where lower IC₅₀ values indicate higher antioxidant ability (Al-Farsi *et al.*, 2018). Higher TPC and TFC values indicate a greater capacity of honey to scavenge free radicals, as phenolic and flavonoid compounds play a vital role in honey's antioxidant activity (Ya'akob *et al.*, 2019). However, in this study, the low correlation values suggest that components other than phenolic compounds, such as ascorbic acid, protein, organic



acids, amino acids, Maillard reaction products, and catalase, may also contribute to the antioxidant activity of honey (Kędzińska-Matysek *et al.*, 2021; Shamsudin *et al.*, 2019a; Tuksitha *et al.*, 2018).

CONCLUSION

The analysis of antioxidant components in the four types of klanceng honey revealed that geographic differences could impact the total phenolic value and antioxidant activity of the honey, while having no effect on the total flavonoid content. There was a positive correlation between the total phenolic content (TPC) and total flavonoid content (TFC) of klanceng honey, whereas a negative correlation was observed between TPC and TFC values and antioxidant activity. Among the varieties of klanceng honey, the one from Penggung Village exhibited the most favorable antioxidant components.

ACKNOWLEDGMENTS

This research was supported by the Faculty of Science and Mathematics, Diponegoro University, through the Letter of Assignment for the Implementation of Research on Funding Sources other than APBN for 2021. The authors would like to express their gratitude to the beekeepers who kindly assisted in collecting the honey samples.



REFERENCES

- Agus, A., Agussalim, Nurliyani, Umami, N., Budisatria, I.G.S. (2019). Evaluation of antioxidant activity, phenolic, flavonoid and vitamin C content of several honeys produced by the Indonesian stingless bee: *Tetragonula laeviceps*. *Livestock Research for Rural Development*, 31.
- Al-Farsi, M., Al-Amri, A., Al-Hadhrami, A., Al-Belushi, S. (2018). Color, flavonoids, phenolics and antioxidants of Omani honey. *Heliyon*, 4.
- Asem, N., Gapar, N.A.A., Hapit, N.H.A., Omar, E.A. (2019). Correlation between total phenolic and flavonoid contents with antioxidant activity of Malaysian stingless bee propolis extract. *Journal of Apicultural Research*, 59, 437-442.
- Avila, S., Beux, M.R., Ribani, R.H., Zambiazi, R.C. (2018). Stingless bee honey: quality parameters, bioactive compounds, health-promotion properties and modification detection strategies. *Trends in Food Science & Technology*, 81, 37–50.
- Avila, S., Hornung, P.S., Teixeira, G.L., Malunga, L.N., Apea-Bah, F.B., Beux, M.R., Beta, T., Ribani, R.H. (2019). Bioactive compounds and biological properties of Brazilian stingless bee honey have a strong relationship with the pollen floral origin. *Food Research International*, 123, 1–10.
- Badrulhisham, N.S.R., Hamid, S.N.P.A., Ismail, M.A.H., Yong, Y.K., Zakuan, N.M., Harith, H.H., Saidi, H.I., Nurdin, A. (2020). Harvested locations influence the total phenolic content, antioxidant levels, cytotoxic, and anti-inflammatory activities of stingless bee honey. *Journal of Asia-Pacific Entomology*, 23, 950–956.
- Balasubramanyam, M. (2021). Factors Influencing The Transformation of Nectar to Honey in *Apis cerana indica*. *International Journal of Biological Innovations*, 3, 271–277.
- Banerjee, A., Dasgupta, N., De, B. (2004). In vitro study of antioxidant activity of *Syzygium cumini* fruit. *Food Chemistry*, 90, 727–733.
- Becerril-Sanchez, A.L., Quintero-Salazar, B., Dubian-Garcia, O., Escalona-Buendia, H.B. (2021). Phenolic Compounds in Honey and Their Relationship with Antioxidant Activity, Botanical Origin, and Color. *Antioxidants*, 10, 1700.
- Biluca, F.C., Braghini, F., Gonzaga, Luciano V., Costa, A.C.O., Fett, R. (2016). Physicochemical profiles, minerals and bioactive compounds of stingless bee honey (Meliponinae). *Journal of Food Composition and Analysis*, 50, 61–69.
- Boussaid, A., Chouaibi, M., Reziq, L., Hellal, R., Donsi, F., Ferrari, G., Hamdi, S. (2018). Physicochemical and bioactive properties of six honey samples from various floral origins from Tunisia. *Arabian Journal of Chemistry*, 11, 265–274.
- de la Rosa, L.A., Moreno-Escamilla, J.O., Rodrigo-García, J., Alvarez-Parrilla, E. (2019). *Phenolic Compounds*, in: *Postharvest Physiology and Biochemistry of Fruits and Vegetables*. United Kingdom : Woodhead Publishing. pp. 253–272.
- Engel, M.S., Kahono, S., Pegg, D. (2018). A key to the genera and subgenera of stingless bees in Indonesia (Hymenoptera: Apidae). *Treubia*, 45, 65–84.



- Evahelda, Setiawan, I., Aini, S.N., Afriani, Z.L. (2021). Chemical characteristics of kelulut honey (*Trigona sp.*) in Bangka Tengah District, Indonesia. *IOP Conference Series : Earth and Environmental Science*, 694.
- Gratzer, K., Susilo, F., Purnomo, D., Fiedler, S., Brodschneider, R. (2019). Challenges for Beekeeping in Indonesia with Autochthonous and Introduced Bees. *Bee World*, 96, 40–44.
- Hasam, S., Qarizada, D., Azizi, M. (2020). A Review: Honey and Its Nutritional Composition. *Asian Journal of Research in Biochemistry*, 7, 34–43.
- Julika, W.N., Ajit, A., Ismail, N., Aqilah, N., Naila, A., Sulaiman, A.Z. (2020). Sugar profile and enzymatic analysis of stingless bee honey collected from local market in Malaysia. *IOP Conference Series: Material Science and Engineering*, 736.
- Kahono, S., Chantawannakul, P., Engel, M.S. (2018). Social Bees and the Current Status of Beekeeping in Indonesia. Singapura : Springer.
- Kędzierska-Matysek, M., Stryjecka, M., Teter, A., Skalecki, P., Domaradzki, P., Florek, M. (2021). Relationships between the Content of Phenolic Compounds and the Antioxidant Activity of Polish Honey Varieties as a Tool for Botanical Discrimination. *Molecules*, 26, 1810.
- Khan, S.U., Anjum, S.I., Rahman, K., Ansari, M.J., Khan, W.U., Kamal, S., Khattak, B., Muhammad, A., Khan, H.U. (2018). Honey: Single food stuff comprises many drugs. *Saudi Journal of Biology Science*, 25, 320–325.
- Khongkwanmueang, A., Nuy, A., Straub, L., Maitip, J. (2020). Physicochemical Profiles, Antioxidant and Antibacterial Capacity of Honey from Stingless Bee *Tetragonula laeviceps* Species Complex. *E3S Web of Conference*, 141, 1-6.
- Lim, D.C.C., Abu Bakar, M.F., Majid, M. (2019). Nutritional composition of stingless bee honey from different botanical origins. *IOP Conference Series : Earth and Environmental Science*, 269.
- Majid, M., Ellulu, M.S., Bakar, M.F.A. (2020). Melissopalynological Study, Phenolic Compounds, and Antioxidant Properties of *Heterotrigona itama* Honey from Johor, Malaysia. *Scientifica*, 2020, 1-9.
- Maringgal, B., Hashim, N., Tawakkal, I.S.M.A., Mohamed, M.T.M., Shukor, N.I.A. (2019). Phytochemical Compositions and Antioxidant Activities of Malaysian Stingless Bee Honey. *Pertanika Journal of Science and Technology*, 27, 15–28.
- Nabavi, S.M., Šamec, D., Tomczyk, M., Milella, L., Russo, D., Habtemariam, S., Suntar, I., Rastrelli, L., Daglia, M., Xiao, J., Giampieri, F., Battino, M., Sobarzo-Sanchez, E., Nabavi, S.F., Yousefi, B., Jeandet, P., Xu, S., Shirooie, S. (2018). Flavonoid biosynthetic pathways in plants: Versatile targets for metabolic engineering. *Biotechnology Advances*, 38.
- Pimentel, T.C., Roseet, M., de Sousa, J.M.B., de Oliveira, L. lara, Mafaldo, I.M., Manuela, M., Pintado, E., de Souza, E.L., Magnani, M. (2021). Stingless bee honey: An overview of health benefits and main market challenges. *Journal of Food Biochemistry*, 46, 1-21.



- Ramlan, N.A.F.M., Zin, A.S.M., Safari, N.F., Chan, K.W. (2021). Application of Heating on the Antioxidant and Antibacterial Properties of Malaysian and Australian Stingless Bee Honey. *Antibiotics*, 10, 1365.
- Rao, P.V., Krishnan, K.T., Salleh, N., Gan, S.H. (2016). Biological and therapeutic effects of honey produced by honey bees and stingless bees: a comparative review. *Revista Brasileira de Farmacognosia*, 26, 657–664.
- Samanta, A., Das, G., Das, S.K. (2011). Roles Of Flavonoids In Plants. *International Journal of Pharmacy Science Technology*, 6, 12–35.
- Selvaraju, K., Vikram, P., Soon, J.M., Krishnan, K.T., Mohammed, A. (2019). Melissopalynological, physicochemical and antioxidant properties of honey from West Coast of Malaysia. *Journal of Food Science and Technology*, 56, 2508–2521.
- Septiana, A.T., Handayani, I., Winarsi, H. (2019). Aktivitas Antioksidan dan Sifat Fisikokimia Madu Temulawak (*Curcuma zanthorrhiza Roxb*) yang Ditambah Ekstrak Jahe (*Zingiber officinale Rosc*). *Jurnal Aplikasi Teknologi Pangan*, 8, 155–160.
- Shamsudin, S., Selamat, J., Sanny, M., Razak, S.-B.A., Jambari, N.N., Mian, Z., Khatib, A. (2019). Influence of origins and bee species on physicochemical, antioxidant properties and botanical discrimination of stingless bee honey. *International Journal of Food Properties*, 22, 239–264.
- Suleiman, M.H.A., Alaerjani, W.M.A., Mohammed, M.E.A. (2020). Influence of altitudinal variation on the total phenolic and flavonoid content of Acacia and Ziziphus honey. *International Journal of Food Properties*, 23, 2077–2086.
- Tafere, D.A. (2021). Chemical composition and uses of Honey: A Review. *Journal of Food Science and Nutrition Reserach*, 4, 194–201.
- Tuksitha, L., Chen, Y.-L.S., Wong, K.-Y., Peng, C.-C. (2018). Antioxidant and antibacterial capacity of stingless bee honey from Borneo (Sarawak). *Journal of Asia-Pasific Entomology*, 21, 563–570.
- Yaacob, M., Rajab, N., Shahar, S., Sharif, R. (2017). Stingless bee honey and its potential value: a systematic review. *Food Research International*, 2, 124–133.
- Ya'akob, H., Norhisham, N.F., Mohammed, M., Sadek, N., Edriani, S. (2019). Evaluation of Physicochemical Properties of *Trigona sp.* Stingless Bee Honey from Various Districts of Johor. *Jurnal Kejuruteraan SI*, 2, 59–67.
- Zakaria, N.N., Jaafar, N. M., Desa, N. M. Mohamad, A.Z. (2020). Antioxidant, Antibacterial and Anti-Diabetic Activities of Stingless Bee Honey from Selected Areas in Peninsular Malaysia. *IOP Conference Series : Earth and Environmental Science*, 596.
- Zawawi, N., Chong, P.J., Tom, N.N.M., Anuar, N.S.S., Mohammad, S.M., Ismail, N., Jusoh, A.Z. (2021). Establishing Relationship between Vitamins, Total Phenolic and Total Flavonoid Content and Antioxidant Activities in Various Honey Types. *Molecules*, 26, 4399.