

## A COMPARATIVE REVIEW: EFFECT OF THERMAL AND NON-THERMAL TREATMENT TOWARDS THE PHYSICOCHEMICAL CHARACTERISTICS OF STINGLESS BEE HONEY

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**Abstract:** Stingless bee or *Kelulut* honey is known to have a higher water content compared to other types of honey that may reach up to 28%. Malaysian Standard has stated that a good quality of *Kelulut* honey shall have a water content of not more than 17%. Hence, many approaches, including thermal and non-thermal treatment, have been done to reduce its moisture content. This is because high water content may lead to quality degradation of *Kelulut* honey. This review aims to compare the effect of both thermal and non-thermal treatment towards the physicochemical characteristics such as moisture content, viscosity, colour, total phenolic content, 5-hydroxymethylfurfural (HMF), diastase activity, and antioxidant activity (DPPH) of stingless bee honey. Numbers of studies reported that both treatments were able to reduce the moisture to a level recommended by the Malaysian Standard. The results also showed that other physicochemical characteristics of stingless bee honey were altered after both treatments, highlighting the changes of honey to become more viscous and darker colour, and increasing in phenolic content. On the other hand, the changes in diastase number and HMF are slightly different. As for thermal treatment, diastase number decreased and HMF increased with the temperature and contrariwise for the non-thermal treatment. To sum up, by implementing the right temperature and processing time, thermal treatment results in a better quality of dehydrated *Kelulut* honey.

**Keywords:** Stingless bee honey, thermal treatment, non-thermal treatment, physicochemical characteristics

### 1. Introduction

Honey can be defined as a sweet substance that is naturally produced by the honeybees either from the nectar of plants, from the secretion of living parts of plants, or the excretions of plant-sucking insects on the living parts of the plants. Two main species of bees uniquely produce honey, which are honey bees (*Apis* sp.) and stingless bees (*Meliponini* sp.). There are various species of stingless bees worldwide. The most commonly known species of stingless bee in Malaysia is *Heterotrigona itama*. Honey consists of a complex mixture of simple sugar and other constituents which includes enzymes, amino acids, organic acids, carotenoids, vitamins, minerals and aromatic substances (Da Silva et al., 2016). However, compared to other types of honey, *Kelulut* honey is considered a rare product as it has high moisture and acidity content and low sugar content (Braghini et al., 2019). This contributes to a storage problem faced by the meliponiculture which is rapid alcoholic fermentation that led to quality degradation of honey. Several treatments were conducted towards the *Kelulut* honey to reduce its moisture while preserving its quality. This treatment can be done



in several approaches, such as dehydration, thermosonication, and open and cabinet drying. There is also new research on implementing low temperature drying towards these heat-sensitive materials to ensure that the quality, nutrients, and other qualities will be preserved. Different treatment results in different effects, hence selecting the right treatments is important to preserve the quality of stingless bee honey.

## 2. Discussion

The quality of *Kelulut* honey can be determined through its physicochemical characteristics. The physicochemical characteristics of honey, in general, depends on four main factors including honeybee associated factors, geographical origin and environmental condition, floral origin, and factors associated with the honey itself. This paper is focused on one of the honey associated factors which are processing consisting of both thermal and non-thermal processing. Application of both thermal and non-thermal treatments towards the honey can alter its physicochemical characteristics such as the moisture content, viscosity, colour, TPC, HMF, diastase activity and antioxidant activity.

For moisture content, both treatments could reduce the moisture to a level recommended by the Malaysian standard. The factors that affect the removal of moisture in *kelulut* honey are the treatment period and either temperature or the power used (Yap et al., 2019). Hence, prolong thermal treatment led to drastic moisture reduction that may reach to as low as 0%. Reducing the moisture content be it thermally or non-thermally causing its viscosity to increase. The increment of viscosity value is not only related to the water content, but also colloidal matters and protein present in honey. Commonly, when honey is treated at a high temperature, denaturation of proteins tends to occur causing the increase of water uptake at the expense of free unbound water present in the honey matrix. Thus, decreasing the free unbound water and lead to an increase in the viscosity of honey. Therefore, it can be concluded that there is a positive relationship between moisture reduction and viscosity of honey.

The colour of *Kelulut* honey is commonly being determined in several ways including the determination of colour intensity by using mAU and by measuring the colour parameters. Thermally treated honey reported the increment of its colour intensity together with the temperature. This might occur because of the degradation of the volatile substance, caramelization of sugar present in the honey, and the production of brown melanoidins as a result of the Maillard reaction. Razali et al. (2019) in their study is determining the colour changes of *Kelulut* honey through the browning index (BI) and both kinds of honey undergone high-pressure processing and thermal treatment resulting in a lower browning index in comparison to the untreated honey. The study indicates that processing can reduced the browning in *Kelulut* honey. TPC in *Kelulut* bee honey can be affected by several factors, including the impact of industrial heat treatment. Previous studies show the effect of thermal and non-thermal treatment on the phenolic compound of *Kelulut* honey where the TPC of honey undergone both treatments are higher compared to the fresh honey. The increment was related to the thermal extraction of phenolic compounds during the dehydration process. Complimentary to the total phenolic content, honey's antioxidant properties are also related to the colour intensity. This is because phenolic content contributes as one of the sources of antioxidants in *Kelulut* bee honey. This can be seen through the results obtained as the observed antioxidant properties and TPC increased together with the colour. Thus, it can be summarized that the darker colour of honey indicates honey with a more significant antioxidant property. In contrast, a study reported that honey samples undergo both dehumidification and microwave



treatment which can be considered as non-thermal, results in lower antioxidant capacity compared to the untreated stingless bee honey samples

HMF plays a crucial role in the industry that acts as a quality parameter for the freshness of the honey, indicating any possible exposure to either overheating or a prolonged storage time. Several studies reported that the increment of HMF in thermally treated honey. This is caused by the sugar present in *Kelulut* honey undergone dehydration under an acidic circumstance during thermal treatments. The effect of non-thermal treatment on the HMF content can be seen in the research conducted by Schvezov et al. (2020), pasteurized stingless bee honey results in a higher HMF value compared to dehumidified honey while no changes reported for refrigerated honey. The diastase activity can be described as the enzyme activity of 1g of honey that able to hydrolyse 0.01g of starch at 40 °C within 1 hour (Da Silva et al., 2016). Typically, this value will be reduced by the presence of heat and due to processing and storage time. However, Razali et al. (2019) recorded no significant difference among all samples and this might be associated with the possible recovery of diastase activity after the thermal treatment. The possible recovery of diastase activity could be related to the alteration in the structure of enzymes, therefore affecting their enzymatic activity. Other than that, the insufficient number of activated molecules that were exceeding the energy barrier of the transition state, causing less denaturation to occur, also contributing to these results.

### 3. Conclusion

Thermal treatments were reported to results in changes such as lowering the moisture content, increasing the viscosity, notable changes in terms of colour, increase in TPC and HMF value, increase in antioxidant activity and decrease in diastase activity. As for the non-thermal treatment, the results are contradictory from one research to another due to the diastase recovery. Although thermal treatments are reported to cause drastic moisture reduction, it can be seen that both treatments (thermal and non-thermal) have the ability to reduce the moisture and water content in stingless bee honey. The results gathered shows that non-thermal treatments work better in preserving the quality of stingless bees honey.

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