ISBN : 978-602-14917-9-9

TOTAL CONSUMPTION OF HONEY WHICH PROVIDES LOW RESPONSE TO GLYCEMIC INDEX AND GLYCEMIC LOAD

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Abstract. Honey is a sweet liquid produced by bees that is sourced from nectar or liquid from high contained-carbohydrate plants (sucrose, fructose, and glucose). The high carbohydrate content makes it not allowed to be consumed by Diabetes Mellitus (DM) patients. This research aimed to obtain one of the biological values of honey which is Glycemic Index (GI). The result of this research is expected to be reference for the amount of honey that is allowed in one-time consumption especially for people with DM. The type of honey used in this research are from West Kalimantan, namely Tikung and Kelulut. Tikung honey is obtained from a nest called tikung which made from rambesu wood. This honey is widely available in Kapuas Hulu Regency. Kelulut honey is from *Trigona sp.* cultivation, and widely cultivate in Mempawah Regency. This research is conducted at the laboratory of Agricultural Product Technology (THP) of Agriculture Faculty, Tanjungpura University in collaboration with the Sungai Raya Community as medical personnel in GI measurement. The measurement was taken by in vivo method using 12 healthy respondents. The result shows that glycemic index for tikung honey is 35 (low) and kelulut is 39 (low). Recommendation for maximum honey consumption in one-time based on glycemic load values (low category) is 20g or one tablespoon (for kelulut honey) and 40g or two tablespoon (for tikung honey). This research is expected to be one of the references in honey consumption for both healthy people and DM patients.

1. INTRODUCTION

A survey conducted by World Health Organisation (WHO) shows that Indonesia is ranked fourth as the highest country with Diabetes Mellitus (DM) [1]. One of the presumptions that cause a plenty of DM patients is excessive consumption of sugar. This is supported research which shows that there is an increase in sugar consumption from 17 pounds / year (in 1915) to 124 pounds / year (1980) [2]. This is relevant to the increase in DM patients from 13.6 people / 1000 population (in 1963) to 54.5 people / 1000 population (in 2005). One of the natural product that has potential to be developed as sugar substitute is honey.

Honey has a natural characteristic that provides sweet taste. According to its nature, honey is considered safer than any synthetic sweetener that commonly used. Healthy food trend nowadays can increase honey potentials to be developed and deeply studied, especially its physicochemistry and its role on increasing blood sugar level.

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Glycemic Index is a respond of blood sugar towards food with carbohydrate content in certain time and level [3]. The definition of Glycemic index is the value that reflects blood glucose levels after consuming a food that contains carbohydrate [4]. The higher GI level means the higher blood sugar levels. Information of glycemic index is very helpful for DM patients. According to The British Diabetic Association that mentioned [5], it is suggested for diabetes mellitus patients to consume at least 50% of total rice consumption in the form of low glycemic index food. Data of food glycemic index value becomes really important. This is caused by data showed that shows 20-22 million of Indonesian population are suffering from diabetes melitus, which 300-500 thousand of the patients are from West Kalimantan [6].

West Kalimantan has abundant natural food resources. They also have various type of honey, like tikung and kelulut. Tikung honey is obtained from bees that nested inside a wood which usually located in the forest (tikung is the name of the nest). Kelulut is a honey that cultivates from Trigona bees (*Trigona sp.*). Based on the background that shows West Kalimantan as the highest rank for DM patients in Indonesia, and also has potential for honey development, thus it is needed to conduct a research on physicochemistry and biological value of various honeys from West Kalimantan. The purpose of this research is to obtain biological value of honey, which is Glycemic Index that can be an information resource for honey consumption in DM patients.

2. METHODOLOGY

This research is conducted in the laboratory of Agricultural Technology, Agriculture Faculty, Tanjungpura University in collaboration with Sungai Raya Community as medical personnel in GI measurement. This research is passed on ethical clearance test No.3698/UN22.9/DL/2018 from ethical studies division of Medical Faculty Tanjungpura University.

Material used in this research is tikung honey and kelulut honey. Tikung honey is from Kapuas Hulu Regency and kelulut honey is from Mempawah Regency. Other materials used are chemicals for chemical analysis, glucose test kit and cotton, needle, and alcohol tissue. Main tool that used in this research is supportive devices for chemical analysis and glucometer.

Chemical analysis that conducted is proximate analysis as a supporting measurement of glycemic index (GI), namely water content, ash content, protein, fat, and carbohydrate level (*by difference)*. Carbohydrate level measurement is needed as a limitation on consumption level for Glycemic Index measurements, which is 50g carbohydrate/consumption of the GI measurements.

Proximate analysis of honey samples were determined by AOAC method [7] [8]. Water content measurement were carried out by taking 2,0g of each sample then dried up to constant weight in a hot air oven at 70 °C. Ash content was determined by drying 5,0g honey samples inside crucible porcelain at 105 °C for 3 hours in a hot air oven. Dried samples were ignited in the furnace at 550-600 °C to a constant weight, then cooled and weighed. Protein content is determined using micro-kjeldhal procedure to estimate the total nitrogen content and protein content which was calculated using a conversion factor of 6.25. Crude fat content was determined after extraction using rob-ring tubes or Majonnier fat extraction device [7]. Five grams (5.0 g) honey samples were weighed with extraction device and mixed with 2.0 ml of 99% ethyl alcohol. Ten millilitres (10.0 ml) dilute HCl (made by adding 11 volumes of water into 25 volumes of concentrated HCl) were prepared and mixed. The tube then installed to the waterbath at 70-80 °C and shakes at 30-40 minutes interval.

Fat extraction device then filled with alcohol up to half of its capacity and cooled. Twenty five millilitres (25.0 ml) of ethyl ether is added, then shaken vigorously and left until the top liquid becomes clear. Next, ether extract is withdrawn through filter into 125 ml pre-weigh beaker glass, and then dried in the waterbath. The remaining liquid in the tube then get re-extraction twice, each with 1.0 ml ether. After that, pre-weigh glass is used for drying process at 100 °C. The beaker glass then cooled down inside desicator and weighed up to its constant weight. Carbohydrate content from honey sample is determined *by difference*, which calculate by subtracts 100% with water, fat, protein, and ash percentage (unit in %). Calculation for summed energy obtained is performed by adding up the

ISBN : 978-602-14917-9-9

measurement results of protein and carbohydrate then times by 4, meanwhile the calculation for fat is times by 6.
Glycemic index measurement is performed by using human as panellist (*in vivo*). There are 12 volunteers and data that is used for research is 10 [5].
The volunteers who participate in this research are volunteers who have passed the panellist selection. Selection was performed to minimise the variety that might arise between the volunteers. Requirements to be volunteers are healthy, non-diabetes, and have BMI (Body Mass Index) score in the normal range which is 18-22. Volunteers are given the samples which equals to 50 gram of total carbohydrate. Carbohydrate level is determined by total carbohydrate analysis. The standard used is 50 gram of glucose powder dissolved into 200 ml water.
The measurement of blood sugar level is performed after 9 hours of fasting. Blood sample is taken through finger capillaries within 2 hours after samples consumption, i.e. 0 minute (fasting blood sugar), 30 minutes, 60 minutes, 90 minutes, and 120 minute. Blood sugar level is measured with glucometer. This blood sugar values then plotted into a graphic with x-axes as the measurement time and y-axes as the blood sugar level. Glycemic index is calculated as comparison of curve area between the increment of blood sugar level after consuming samples and the standard (glucose) [9]. Final glycemic index score is average glycemic value from 10 participants. Glycemic index is considered low if <55 and considered high if >70. Glycemic load counts as a comparison between glycemic index and carbohydrate level per serving, the results then times by a hundred (100). Glycemic load is considered low if ≤10, considered moderate if scores between 11-19, and high if ≥ 20.
Data analysis of Glycemic Index is an average result from 10 volunteers. Data of proximate analysis obtained in the research then analysed using ANOVA and t-test differentiation test. The difference between average score (6 repetition) considered significant at $P<0.05$.

3. RESULTS AND DISCUSSION

3.1. Honey Proximate

Honey nutrition is measured based on its water, ash, protein, fat, and carbohydrate contents. Limitation in SNI (Indonesian National Standard) for honey which is 22% water content and 0.5% ash content [10]. Nutrition value of both tikung and kelulut honey are showed in table 1.

Table 1. Proximate Value of Tikung Honey and Kelulut Honey

Parameter	Tikung Honey	Kelulut Honey	SNI Score for Honey
Water Content (%)	27.44 ± 0.27^a	$29.95 + 0.24^b$	Max. 22
Ash Content (%)	0.15 ± 0.01^a	0.15 ± 0.01^a	Max. 0.5
Protein Content (%)	0.12 ± 0.01^a	$0,89 \pm 0.01^b$	-
Fat Content (%)	0.03 ± 0.01^a	0.03 ± 0.01^a	-
Carbohydrate Content (%)	72.63 ± 0.60^b	69.00 ± 0.25^a	-

Note: Different letters in the same column row show significant differences at $P<0.05$

Water content of both tikung and kelulut honey are still considered high and not in accordance for SNI standard, but the ash content are in accordance with SNI standard. Furthermore, there are differences on protein and carbohydrate contents. The difference of nutritional values contained in various honey might be caused of different types of honey and different types of flowers that consumed by the bees. Bees that produced tikung honey in the forest mostly flies to the forest plants especially to the season fruit plants. According to the interview results, bees that produce kelulut honey mostly flies to the fruit plants like mango.Some text.

3.2. Glycemic Index (GI)

Glycemic Index (GI) measurements shows that both tikung and kelulut honey scores 35 and 39 consecutively, which considered low. The alteration of glucose content and GI value of honey is showed in picture 6. The GI measurement of honey shows its accordance to research which indicates that GI scores of honey is on the range 32- 85 (low to high) [11].

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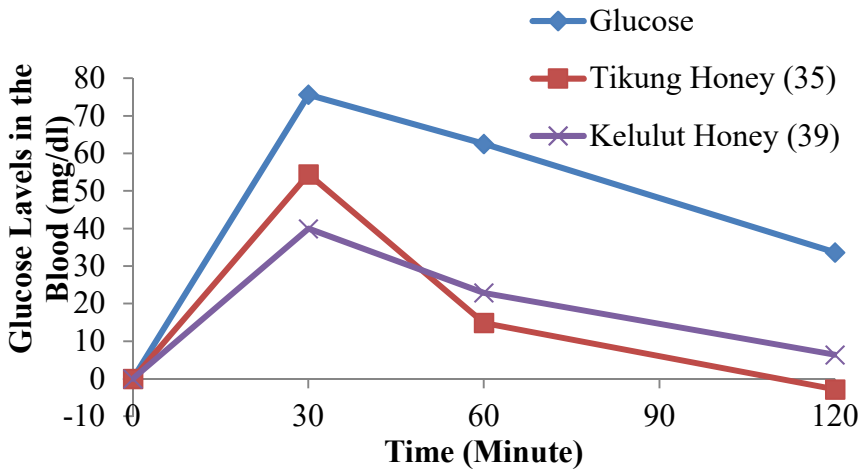
The alteration in blood glucose level shows unique results, which is honey with high glucose content (kelulut), has low GI and low blood sugar level increment. This is presumably due to the presence of components that gives the sour taste in kelulut honey. This is proved by its low pH level which is 2.57 and its total acidity score which is 29.09mg/100g. It is also supported by research that showed if components that is acidic (cinnamic acid/ phenol compound) has roles in the body including stimulating insulin secretion, increasing pancreatic beta cell function, inhibiting gluceogenesis in the liver (glucose forming), increasing blood sugar uptake, stimulating insulin releasing signals, delaying carbohydrate digestion and glucose absorption [12]. Based on these results, acidic components can delay carbohydrate absorption so that high content of sugar in kelulut honey will not affected in increasing blood sugar level compared to tikung honey which has lower score in total sugar and total glucose. Another support is showed that honey also contains phenol compound 56-500 mg/kg [11]. According to these results, it is necessary to conduct further research about phenol component that is contained in honey from west Kalimantan.



Note: The number in the description is GI score

Figure 1. Effect of Honey Consumption on Blood Glucose Level

3.3. Glycemic Load (GL)

Glycemic Load (GL) is calculated based on the highest dose of honey consumption which is 50-80g per drink [11]. The calculation result shows that at 20g level consumption level or about one table spoon (tbs), both GL score of tikung and kelulut honey are categorized low. But at 40g consumption level or two tablespoons, GL of kelulut honey is categorised moderate. Based on the results, recommendations for maximum honey consumption is 20 g or 1 tablespoon, which will give contribution about 56-59 kcal of energy. The research that is conducted using both healthy and diabetes participants showed that sweet foods consumption (honey, sucrose and sweeteners) at 50 g per day for 14 days, results in increasing glycemic response, fat metabolism (TG/triglyceride), and inflammation for both type of participants [13].

Table 2. Nutritional Value of Tikung Honey and Kelulut Honey

Parameter	20g / 1 tablespoon		40g / 2 tablespoon		60g / 3 tablespoon	
	GL	Calories (kkal)	GL	Calories (kkal)	GL	Calories (kkal)
Tikung Honey	5 (Low)	58	10 (Low)	116	15 (Intermediete)	175
Kelulut Honey	5 (Low)	56	11 (Intermediete)	112	16 (Intermediete)	168

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4. CONCLUSION AND SUGGESTION

The research shows that glycemic index of tikung honey is 35 (low), and kelulut honey is 39 (low). Recommendation that is given for maximum consumption of honey based on low glycemic load (GL) category is 20 g (1 tablespoon) for kelulut honey and up to 40 g (2 tablespoons) for tikung honey.

It is suggested to conduct further research to identify closely of phenol components and the types of acidity that may be contained in honey from west Kalimantan.

5. ACKNOWLEDGEMENTS

This acknowledgement is given to all parties involved in this research, all respondents, Dr. Diska Astarini as medical personnel from Sungai Raya Dalam Health Center, and all parties whom I could not mentioned one by one. Another acknowledgement is also given to Tanjungpura University especially for Agriculture Faculty as DIPA funders, with contract number 1167/UN22.3/PP/2018 date March 6th, 2018.

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