Nutritional Composition and Glycaemic Index of Milk Chocolate using Different Sweeteners

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ABSTRACT

Palm sugar is a type of sugar that has been claimed to be a healthier alternative sweetener to sucrose because it contains minerals, vitamins, and antioxidant and exhibits low glycaemic index. Malaysian Tualang honey has been reported to provide significant nutritional and medicinal benefits. The substitution of the sugarcane used in the milk chocolate with these natural sweeteners is known to lowering the GI value of milk chocolate. In this study, the glycaemic index of the respondents after consuming the test chocolates (control, PS, H) and the proximate analysis of the chocolate were evaluated. One group of female students named Group A (n=10) were asked to consumed the control, PS and H chocolates after an overnight fasting. Blood glucose level were evaluated at 0, 30, 60, 90 and 120 min. The result showed that the consuming the control, PS and H chocolates cause a slower rise in the respondent’s blood glucose level indicating low GI food. The proximate analysis revealed that both chocolates sweetened with palm sugar and honey had significantly higher moisture content but no significant different observed for fat and protein content compared to control. Chocolate sweetened with palm sugar also had significantly higher ash and crude fibre content compared to control.

Keywords: Milk chocolate, Palm sugar, Tualang honey, Glycaemic index, Nutritional composition

INTRODUCTION

Chocolate is typically sweet and usually consumed in pleasant situation. However, chocolate has high sugar content, which can be the major cause of dental carries and lead to diverse health issues like diabetes mellitus and hypertension. Concerning this fact, market should provide chocolate with low sugar or low glycemic index value in order to add variety of healthy product. Low GI foods has an important role in the dietary management of diabetes, weight reduction, peak sport performance and the reduction of risks associated with heart disease and hypertension.

Glycemic index is a type of measurement on the blood glucose raising potential of the carbohydrate content of a food compared to reference food. GI values can be categorized into three categories which is low (GI of 55 or less), moderate (GI of 56-69) and high (GI of 70 or higher). Low GI foods are more slowly digested, absorbed and metabolise and cause a lower and slower rise in blood glucose and insulin levels. Milk chocolate has low GI value. Palm sugar has been claimed to be a healthier alternative sweetener to sucrose because it contains minerals, vitamins, and antioxidant and also exhibits low glycemic index (35-40). According to Srikaeo & Thongta, (2015), although sucrose is the major sugar component in palm sugar similar to sugarcane, but the starch digestion rate and GI values were found to be lower than those of sugarcane. According to Abdullah et al., (2015), palm sugar or brown sugar has a low glycemic index value that is lower by 35 while white sugar has
glycaemic index value of 58. Palm sugars also undergo minimal processed and their natural forms are complex and contain other ingredients rather than sugar (Srikaeo & Thongta, 2015). Trinidad et al., (2010) and Vayalil, (2012) reported that palm sugars contain significant amount of dietary fibre, especially inulin. It could play an important role in lowering the GI values of sugars compared to refined sugarcane that contain almost 100% of sucrose.

Tualang honey is known to has a significant nutritional and medicinal benefits including antimicrobial, anti-inflammatory, antioxidant, antimitogenic, antitumor, and antidiabetic properties and also wound-healing attributes (Ahmed & Othman, 2013) and also exhibit intermediate glycemic index. Honey is usually eaten as an energy food and it has simple sugars which absorbed directly into the bloodstream without digestion (Abeshu & Geleta, 2016). During digestion, the main sugars of honey which is fructose and glucose are quickly transported into the blood and can be utilized for energy requirements by the human body (Abeshu & Geleta, 2016). The glucose in honey is absorbed by the body quickly and gives an immediate energy boost, while the fructose is absorbed more slowly providing sustained energy. It is also known that honey has been found to keep levels of blood sugar fairly constant compared to other types of sugar. Therefore, honey is particularly recommended for children and sportsmen because it can help to improve on the efficiency of the energy system of the elderly and invalid (Alvarez-Suarez et al., 2010).

The increasing rate of diabetes and obesity worldwide has increased the low GI foods consumption making sugar-free products are highly in demand. Thus, this study aims to determine the Glycaemic index and proximate analysis of milk chocolate substituted with palm sugar and honey as sweeteners.

**MATERIAL AND METHODS**

**Materials**
The raw materials for milk chocolate (cocoa butter, cocoa powder, whole milk powder and icing sugar) were purchased from Sweet Vanilla bakery shop in Jerteh, Terengganu. Other materials including Tualang honey was purchased from a supplier in Besut and palm sugar was purchased from a market in Besut.

**Chocolate Preparation**
The formulation used for milk chocolate sweetened with sugar cane (control), milk chocolate sweetened with palm sugar (PS) and milk chocolate sweetened with Tualang honey (H) were based on the Table 1. The chocolate was prepared by adding all the ingredients into the mixing bowl. The ingredients were mixed for 12 to 15 min at 45°C in order to obtain a homogenize formulation, then, the chocolate was refined to produce a smooth texture of chocolate and later was conched for at least 5 h at temperature of 50°C to reduce the moisture content and also to develop viscosity, final texture and flavor of the chocolate. Next, the liquid chocolate underwent tempering process. The chocolate was heated to 50°C for 20 min to melt all the fat. After completing the melting step, it was cooled to 32°C for 3 min and at the same time seed was added to initiate crystal formation. The chocolate was then further cooled to 27°C. Finally it was heated to 31°C to melt the unstable crystal. After that, the chocolate was poured into a molder and cooled at temperature of 15-18°C for 1 h before demoulding. Lastly, the chocolate was stored at room temperature for further analysis.

**Selection of Subjects**
In this study, Group A (n=10) was asked to consume 35 g of control, PS and H chocolates to determine their Glycemic value. Subjects were selected based on Nutrition and Health Questionnaire.

**Glycemic Index Test**
The Glycemic Index (GI) of the students was measured using a glucometer (On-Call Plus brand) that was assessed by collecting finger-prick blood samples. This study was conducted as described by Ali et al., (2013) with slight modifications. A rounded drop of blood was taken from one group consists of 10 subjects who were asked to drink glucose (17 g of glucose in 100 ml of water equivalent to 17 g of available carbohydrates in 35 g of chocolate bar) and eat 35 g of control, PS and H chocolates. Immediately before (0 min) and after 30, 60, 90 and 120 min of the consumption, their 2 hours postprandial blood sugar (2HPP) was assessed by taking their finger-prick blood (mmol/L). They need to fast overnight for 12 h before consuming the chocolate samples.
Table 1 Formulation of milk chocolate

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Amount (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>Sugar</td>
<td>47</td>
</tr>
<tr>
<td>Palm sugar</td>
<td>-</td>
</tr>
<tr>
<td>Tualang honey</td>
<td>-</td>
</tr>
<tr>
<td>Cocoa butter</td>
<td>25</td>
</tr>
<tr>
<td>Whole milk powder</td>
<td>21</td>
</tr>
<tr>
<td>Cocoa powder</td>
<td>7</td>
</tr>
</tbody>
</table>

Proximate Analysis
The proximate composition of each chocolate sample was determined using the standard methods of analysis of Association of Official Analytical Chemists, AOAC 1995. Oven drying method was used to determine the moisture content of the samples. The ash content was determined using a muffle furnace at 550°C overnight. The protein was determined by Kjeldahl method with conversion factor of 6.38. Soxhlet extraction method using petroleum ether was used to extract the fat content. The crude fibre was determined by extraction of the defatted sample with sulphuric acid and sodium hydroxide by using Gerhardt Fibretherm Automated Fibre Analysis. The carbohydrate content was obtained by difference. The analyses were done in triplicates and the average value was reported.

Statistical Analysis
Glycemic index’s test was presented in the total average blood glucose level (mg/dL). Proximate analysis was expressed in term of mean ± standard deviation. One way analysis of variance (ANOVA) was performed in this test to determine the level of significance which the confidence level was set at p<0.05 and the data was compared using Turkey’s test at =0.05. The data analysis was conducted by using SPSS.

RESULTS AND DISCUSSION

Glycemic Index Determination
From the results of average blood glucose level (mg/dL) of the respondents displayed in Figure 1 and Figure 2, it shows that glucose solution has the highest peak at 30 min of its consumption with the average blood glucose level of 137.88 mg/dL. Both PS and H chocolates had slightly higher of respondent’s average blood glucose level (99.72 mg/dL) after its consumption compared to control (97.74 mg/dL). At 60 min, majority of the respondent’s blood glucose level started to decrease and their blood glucose level further decreased between 90 to 120 min. This is because the body uses the sugar to generate energy.

Carbohydrate are the main constituent of food that can raise blood sugar level. Carbohydrate from liquid such as juice and soft drinks are usually digested more rapidly. Carbohydrate from solid foods such as pasta and fruits take a bit more time to breakdown. This explains the high average blood glucose level of glucose solution as it is in liquid form.

Glucose is simple sugar that is easily broken down by the body and transport into the cell for energy. Consumption of glucose solution results in a drastic rise in respondents blood glucose level because it is easily absorb into the bloodstream and cause a dramatically rise in their blood sugar level after 30 min of consumption. Jenkins et al., (2002) reported that the blood sugar level can start increasing after 15 min after meal and food with high GI will rise highly due to the type of carbohydrate found in food.

In this study, the GI value for the three chocolates (control, PS and H) were 21, 12 and 11 respectively. The low GI value caused a slow rise in the blood glucose level of the respondents as shown in the Figure 1 and
2. This is because low GI foods have a modest effect on blood glucose levels and it may take a little bit longer to see a rise (Jenkins, et al., 2002).

Furthermore, there were many factors affecting GI of food and some of it were the type of food, extend of food processing, fat, protein, and acidity. Different types of a particular food can have different GI value. The method of processing of a single food can greatly change its GI such as grinding, rolling or pressing a kernel or other starch food as it disrupts the outer germ layer and granules and increases GI (Xavier, 2002). The presence of fat, protein or acid retards the emptying of the stomach. In this study, the fat content of the chocolate samples (control, palm sugar and honey) was quite high and this was one of the reasons the chocolates give low rises of blood glucose level to the respondents. However, it is not advisable to add much more fat in food due to health reasons. Guevarra & Panlasigul (2000) reported that organic acids presence in food such as malic, citric and tartaric acid lower the glycemic index of food.

![Figure 1](image1.png)

**Figure 1** Average blood glucose level (mg/dl) after PS chocolate consumption

![Figure 2](image2.png)

**Figure 2** Average blood glucose level (mg/dl) after H chocolate consumption

**Proximate Analysis of Milk Chocolate**

Proximate analysis was done to determine the nutritional composition of a food sample. The proximate composition of milk chocolate with different sweeteners is presented in Table 2. The result shows that the
substitution of palm sugar and honey for sugarcane in milk chocolate caused a significant difference (p<0.05) in moisture content. The H chocolate recorded the highest mean value (9.12 ± 0.01%) while control chocolate has the lowest mean value (1.90 ± 0.32%). The moisture content of ingredients used in chocolate making is known to influence the final moisture content of chocolate and subsequently affecting its sensorial properties. The moisture content of tualang honey was (17.53 ± 0.12%) as reported by Moniruzzaman et al., (2013). The moisture content of sucrose was 0.3% and palm sugar was in the range between 1.0 to 2.4% (Saputro et al., 2016). This explains the high moisture content of H chocolate compared to control and PS chocolate. According to Saputro et al. (2016), the moisture content of palm sap-based sugar varies depending on the processing technique because different temperatures and times employed during sugar production as well as drying method applied result in different final moisture contents of palm sap-based sugars.

Ash content is an indication of the level of minerals in the samples. Based on the results obtained, there was significant different (p<0.05) in ash content when the palm sugar and honey were used in the chocolate formulation. PS chocolate showed a significant increase in ash with the mean value of 1.64 ± 0.04% while H chocolate showed lower ash content with the mean value of 1.34 ± 0.00% compared to control chocolate. Chua & Adnan, (2014) reported that the ash content of Tualang honey was (0.19± 0.02%) while for sugarcane was (1.01± 0.09) (Leang & Saw, 2011). Low ash content of Tualang honey contributes to the low ash content of H chocolate. Imanda (2007) reported that Arenga pinnata solid sugar contains 2.8% ash and ash content in palm syrup was 1.78% (Luis et al., 2012). This explains the reason of the high ash content of PS chocolate compared to H chocolate and control. According to Roos & Victor (2015), palm sugar have additional components such as protein, minerals, calcium, phosphor, iron and copper, and also have a low glycemic index (GI of 30-35) when compared to regular refined sugars (GI of 60).

For the crude fibre content, there was significant different (p<0.05) between control chocolate and chocolate sweetened with palm sugar. PS chocolate has the highest mean value (11.61± 3.37) compared to control chocolate that has the lowest mean value (3.63± 0.45). Fiber and most of the other nutrients in the plant are removed during refining process and supposedly the fiber content present in sugar is zero. According to Choong et al., (2016), the crude fibre content for refined sugarcane and aren sugar was 0.01% and 0.02% respectively. The little crude fibre content in these two sugars might be due to the fibre residue left during cane extraction and palm sap collection that was not filtered through properly in the manufacturing process which led to the existing of crude fibre (Duyff, 2011). This may be the reason of the presence of crude fibre in control, PS and HC chocolates. However, both PC and HC chocolates showed no significant difference (p<0.05) in fat, and protein content compared to control chocolate.

| Table 2 Proximate analysis of milk chocolate with different sweeteners |
|-----------------------------|-----------------------------|-----------------------------|
| Composition (%)             | Control 1.90± 0.32          | PS 3.54± 0.09               |
|                             | Ash 1.45b± 0.01             | 1.64± 0.04                  |
|                             | Fat 43.69± 0.28             | 40.97± 1.01                 |
|                             | Protein 6.02± 0.81          | 5.43± 0.50                  |
|                             | Crude fibre 3.63± 0.45      | 11.61b± 3.37                |

*a-c = significant difference (p<0.05) between samples

CONCLUSION

The addition of palm sugar and tualang honey into chocolate was an effective way in producing a healthy snack meal. This study shows that the replacement of the sugar with these two natural sweeteners have more favourable effect on glucose metabolism. Consumption of this product caused a steady rise in blood sugar and insulin levels. Both chocolate sweetened with palm sugar and Tualang honey have low glycemic index value. Besides that, both chocolates have high moisture and crude fibre content and have some minerals due to ash content. Thus, both chocolates exhibit good benefits to human health and has a big potential to be commercialized as a functional food.
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REFERENCES


