

Amount and types of sugars in selected commercial and traditional kuih in Klang Valley, Malaysia

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Abstract

The aim of this study was to determine the specific content and type of sugars in selected commercial and traditional kuih in Klang Valley. The selection of the kuih was based on the validated Food Frequency Questionnaire (FFQ) for sugar. The selected commercial kuih was doughnut coated with sugar (Big Apple) while the ten traditional kuih samples consisted of kuih bingka ubi, kuih kasui, kuih keria, kuih koci, kuih lapis, kuih lopes, kuih onde-onde, kuih sagu, kuih seri muka and kuih talam. The doughnut coated with sugar (Big Apple) was purchased from Big Apple Donuts and Coffee franchise at two different locations, while the traditional kuih were randomly bought from stalls, cafeterias and restaurants around Kuala Lumpur and Rawang. The types and amount of sugar were determined using High-Performance High Chromatography (HPLC) with a refractive index (RI) detector. Results showed that doughnut coated with sugar (Big Apple) has the highest starch content (22.6 ± 0.3 g/100g) and kuih keria contained the highest available carbohydrate (41.5 ± 1.7 g/100g), comprising of 24.2 ± 2.4 g/100g total sugar and 17.3 ± 0.7 g/100g of starch. The least available carbohydrate content was found in kuih talam (20.0 ± 0.5 g/100g), which was 50% lower than the one in kuih keria. Major individual sugars detected in all kuih samples were consisted of sucrose (60.0%), glucose (16.2%), fructose (14.0%), maltose (9.5%) and lactose (0.3%). Majority of the kuih samples (90.9%) in this study can be categorized as medium sugar while only kuih keria was categorized as high sugar. Based on the two main ingredients (sugar and flour) used in the preparation of kuih, results showed that all kuih samples can be categorized as medium sugar-medium starch. In conclusion, this study served as a guideline by locals in selecting kuih of different sugar levels.

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Keywords

Sugar
Starch
Kuih
High Performance Liquid
Chromatography (HPLC)

Introduction

Malay kuih can be considered as delightful chewy desserts that are mainly made from natural ingredients like tapioca flour, sweet potato flour, bananas, palm sugar, coconut milk and glutinous rice. These kuih were mostly steamed, sometimes grilled while baking was nonexistent because in those days they did not have any oven and electricity was scarce as well. Besides sweets, there are also kuih savoury version which is often eaten or served during tea time (Azfahane *et al.* 2011).

According to the Malaysian Adults Nutrition Survey (MANS) 2003, the commonly consumed sweet snacks and desserts known as kuih, was among the top 10 daily consumed foods among all ethnicity in Malaysia. The average consumption of kuih for every person was reported to be two pieces kuih per day (Norimah *et al.* 2008). In addition to that, Nik Shanita *et al.* (2012) reported commercial and traditional kuih was one of the top 10 food items contributed to added sugar intake among Klang

Valley population where it contributed 8.1% of added sugar.

The high intake of sugar poses a serious public health threat to Malaysians, which was thought to contribute to the current high prevalence of diabetes for adults above 30 years (14.9%), overweight/obesity (43.1%) (Ministry of Health Malaysia, 2006) and dental caries (90.7%) (Oral Health Division, 2004). These health problems including cardiovascular disease and cancer are believed to be related to their diet (Sanders, 2004). Different types of carbohydrates are associated with several positive physiological effects for human body (FAO/WHO, 1998; Wahlqvist, 2002). Therefore, it is important to know the types of carbohydrate in our diet.

However, to the best of our knowledge, Malaysian Food Composition Table is lacked of data for amount and types of sugars in local traditional kuih. Besides, the amount and types of sugar that are present in traditional kuih has never been studied by Ministry of Health of Malaysia. Therefore, this study aimed to determine the amount and types of sugars in selected

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commercial and traditional kuih in Klang Valley.

Materials and Methods

Sample selection and preparation

Sugar analysis was carried out on commercial and traditional kuih in order to determine the content of the sugars. The selection of the kuih was based on the validated Food Frequency Questionnaire (FFQ) for sugar (Nik Shanita *et al.*, 2012). One type of commercial kuih and ten different types of traditional key commonly consumed by the Klang Valley population were selected as the food samples in this study. The kuih consisted of commercial kuih, namely doughnut coated with sugar (Big Apple) and traditional kuih (namely, kuih bingka ubi, kuih kasui, kuih keria, kuih koci, kuih lapis, kuih lopes, kuih onde-onde, kuih sagu, kuih seri muka and kuih talam. These kuih were prepared with different ingredients and methods (refer Table 1). Random sampling was used to select the kuih in this study. The doughnut coated with sugar (Big Apple) was purchased from Big Apple Donuts and Coffee franchise at two different locations which were Low Yat and Kuala Lumpur Convention Centre (KLCC). The sampling for doughnut coated with sugar (Big Apple) was as shown in Figure 1 (a). Duplicates of doughnut samples were analyzed. The traditional kuih were randomly bought from stalls, cafeterias and restaurants located in Klang Valley which were Kuala Lumpur and Rawang. Each type of traditional kuih was prepared in three replicates for each location in Kuala Lumpur and Rawang. The sampling for traditional kuih is as shown in Figure 1 (b). A total of six replicates for each traditional kuih were analyzed. Kuih samples from each location were thoroughly homogenized using a kitchen mixer (National, Malaysia) at speed no. 2 for 5 minutes, then kept in an air-tight container and stored in refrigerator (4°C) until further analysis.

Preparation of standard for sugars

A mixed standard comprising of fructose, glucose, sucrose, maltose and lactose were prepared in a concentration of 0.5-1.5 g/100 mL. The standard solution was passed through an ultra filter until about 2 mL was collected before injecting it into the HPLC system. All the standard solutions were stored in refrigerator at 4°C when not in use.

Sugar extraction from food samples

The sugar content was extracted using a method described by Wills *et al.* (1980). About 5 g of each wet, homogenized food sample was weighed and transferred into a 100 mL beaker, and 100 mL of

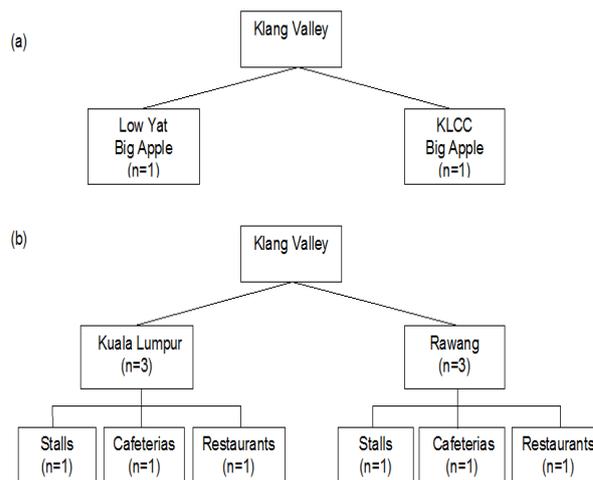


Figure 1. Sampling for doughnut coated with sugar (Big Apple) (a) and traditional kuih (b)

acidified aqueous 85% ethanol was added into it. The pH was measured and if necessary, sufficient 0.5N NaOH was added to increase the pH to 7.0 ± 0.5 . About 25 mL of boiling ethanol (85%) was added to beaker containing food sample and then placed on steam bath and covered with watch glass. The sample was stirred while waiting for the solution to boil. This was followed by removing the sample from the steam bath and filtered the samples through the preweighed filter paper (Munktell) into a 250 mL round-bottom, short-neck flask. The sample was then re-extracted with 25 mL boiling ethanol (85%) for three times. Ethanol was distilled from samples by using a rotary evaporator at 45°C and left behind an aqueous solution of approximately 3 mL. The aqueous solution was transferred to a 10 mL volumetric flask and made up to volume with distilled water. The solution was passed through the ultra filter until about 2 mL filtrate sample was collected before injecting it into the HPLC system.

Starch extraction from food samples

Peak area of individual sugars in samples and standard solution were measured.

Weight of sugar (g/100 g fresh food) was calculated

$$= \frac{\text{Sugar area} \times 10 \text{ mL} \times \text{std vol} (\mu\text{L}) \times \text{std conc} (\text{g}/100 \text{ mL})}{\text{Vol injected} (\mu\text{L}) \times \frac{\text{std area} \times 100}{\text{wet food weight} (\text{g})}}$$

The above formula deduced the weight of sugar (g/100g fresh food) as:

$$= \frac{\text{Sugar area} \times \text{std vol} (\mu\text{L}) \times \text{std conc} (\text{g}/100 \text{ mL}) \times 10}{\text{std area} \times \text{sample vol} (\mu\text{L}) \times \text{wet food weight} (\text{g})} \quad 1$$

Table 1. Description of cooked kuih

Name of kuih	Serving size (g)	Ingredients	Method of preparation/cooking
Doughnut (Big Apple) [†]	-	Plain flour, salt, butter, baking powder, sugar, milk, egg, cinnamon, nutmeg	Put flour in shallow pan, add salt, baking powder and sugar. Rub in butter with fingertips. Add the well beaten egg and milk and stir thoroughly. Toss on floured board, roll to one-fourth inch in thickness, shape, fry and drain.
Kuih bingka ubi kayu [‡]	100	Tapioca, coconut milk, sugar, salt	Tapioca grated and mixed with coconut milk, sugar and salt. Placed in mould and cooked with fire at the bottom and charcoal fire on top of the mould.
Kuih kasui [‡]	103	Rice flour, brown sugar, lime water, grated coconut, salt	Flour, sugar and lime water mixed and steamed. <i>Kuih</i> coated with grated coconut before serving.
Kuih keria [‡]	38	Wheat flour, sweet potatoes, sugar, salt	Sweet potatoes boiled and meshed. Flour added to it and made into dough. The dough made into small balls with hole in the centre and deep fried. Coated with sugar before serving.
Kuih koci [‡]	82	Glutinous rice flour, coconut milk, grated coconut, brown sugar, salt	Dough prepared from flour and coconut milk. Filling prepared from brown sugar and grated coconut and placed into dough, wrapped in cone-shape banana leaf and steamed.
Kuih lapis [‡]	87	Rice flour, coconut milk, sugar, salt	Ingredients mixed and made into two portions (red and white). Steamed layer after layer, alternating the two colors.
Kuih lopes [‡]	83	Glutinous rice, brown sugar, grated coconut, salt	Glutinous rice steamed. Made into small triangles and coated them with grated coconut and served with brown sugar syrup.
Kuih onde-onde(buah melaka) [‡]	15	Glutinous rice flour, gula melaka, grated coconut, salt	Dough prepared from glutinous rice flour. The dough shaped into small balls and placed gula melaka as the filling. Boiled, drained the water and coated with grated coconut.
Kuih sagu [‡]	92	Sago pearls, sugar, grated coconut, salt	Sago pearls boiled until clear. Sugar and coloring added and mixed over fire. Placed in moulds and cooled it before coating with grated coconut before serving.
Kuih seri muka [‡]	99	Glutinous rice, eggs, coconut milk, pandan juice, sugar, salt	Glutinous rice steamed and pressed. Other ingredients mixed and placed on the surface of the rice and steamed again.
Kuih talam (ubi kayu) [‡]	122	Tapioca, sugar, coconut milk	Tapioca grated and mixed with sugar. <i>Kuih</i> topped with coconut custard.

[†] Big Apple Donuts and Coffee (2009)

[‡] Malaysian Food Composition Table (Tee et al., 1997)

[‡] The Composition of Foods Commonly Eaten in Singapore (Ministry of Health Singapore, 2000)

Starch content:

1. Peak area of glucose and standard were measured

2. Weight of starch was calculated as polymer (g/100g food)

$$= \frac{\text{Sugar area} \times 10 \text{ mL} \times \text{Standard volume} (\mu\text{L}) \times \text{concentration} (\text{g}/100 \text{ mL})}{\text{Sample vol} (\mu\text{L}) \times \text{Std area} \times 100}$$

$$\times \frac{2 \times \text{total residue} (\text{mg})}{\text{Sample residue} (\text{mg})} \times \frac{100}{\text{wet food weight} (\text{g})} \times \frac{1}{1.1}$$

The above formula deduced the weight of starch polymer (g/100g food) as:

$$= \frac{\text{Sugar area} \times \text{std vol} (\mu\text{L}) \times \text{std conc} (\text{g}/100 \text{ mL}) \times \text{total residue} (\text{mg}) \times 1000}{\text{std area} \times \text{sample vol} (\mu\text{L}) \times \text{sample residue} (\text{mg}) \times \text{wet food weight} (\text{g}) \times 55}$$

(Wills et al. 1980)

HPLC analysis

Purified sugar extracts were analyzed using HPLC of Waters model 2707 using a XBridge Amide column (250 x 4.6 mm, 3.5 μm) coupled with Waters RI- 2414 refractive index detector maintained at 30°C. The mobile phase applied was acetonitrile/deionized water (75:25) plus 0.2% of triethylamine (TEA). The injection volume was 20 μL with flow rate of 1.0 mL/min.

Spiking and recovery tests

Kuih samples contained either fructose or glucose was spiked with the same standard sugar solution with a known concentration (20 g/100 mL). The peaks of the standards were identified by their retention times.

Statistical analysis

The results collected were analyzed using SPSS version 18.0 and expressed as means ± standard deviation (SD). One-way ANOVA and Kruskal-Wallis were used to determine any significant differences between the means of the kuih samples. Coefficient of variation was calculated for analysis of kuih samples. Spearman correlation was performed to determine the relationship between total sugar and starch content with available CHO content in analyzed kuih.

Results and Discussion

Limits of detection (LODs) measurements of sugars were 0.02 g/100g for fructose, (0.22 g/100g) for glucose, (0.08 g/100g) for sucrose, (0.17 g/100g) for maltose and (0.24 g/100g) for lactose. Therefore, sugar content could not be detected if the value is lower than the LOD for each sugar.

Table 2 showed the individual sugar compositions in kuih samples. There was no significant different ($p > 0.05$) in fructose and lactose in all kuih samples. Kuih lopes and kuih talam contained the highest fructose content compared to other kuih. The fructose

Table 2. Individual sugar compositions in kuih

<i>Kuih</i> (n=11)	Fructose (g/100g)	Glucose (g/100g)	Sucrose (g/100g)	Maltose (g/100g)	Lactose (g/100g)	Total sugar (g/100g)
Commercial <i>kuih</i>						
Doughnut coated with sugar (Big Apple)	0.3 ± 0.1 ^a	7.1 ± 1.3 ^c	<0.08 ^a	0.7 ± 1.3 ^a	<0.24 ^a	8.3 ± 2.0 ^b
Traditional <i>kuih</i>						
<i>Kuih bingka ubi</i>	1.2 ± 0.3 ^a	0.3 ± 0.1 ^a	10.4 ± 4.1 ^{a,b,c}	0.2 ± 0.2 ^a	<0.24 ^a	12.1 ± 3.7 ^{a,b}
<i>Kuih kasui</i>	2.6 ± 0.1 ^a	1.4 ± 0.2 ^{a,b}	7.0 ± 5.0 ^{a,b,c}	0.9 ± 0.2 ^a	<0.24 ^a	11.9 ± 1.8 ^{a,b}
<i>Kuih keria</i>	0.6 ± 0.1 ^a	1.3 ± 0.2 ^{a,b}	16.1 ± 1.6 ^c	6.2 ± 0.8 ^b	<0.24 ^a	24.2 ± 2.4 ^a
<i>Kuih koci</i>	1.5 ± 0.5 ^a	2.0 ± 0.5 ^b	4.0 ± 2.0 ^{a,b}	0.8 ± 0.2 ^a	<0.24 ^a	8.3 ± 3.3 ^b
<i>Kuih lapis</i>	2.4 ± 0.8 ^a	0.3 ± 0.1 ^a	11.7 ± 2.7 ^{b,c}	<0.17 ^a	<0.24 ^a	14.5 ± 0.9 ^{a,b}
<i>Kuih lopes</i>	3.0 ± 0.5 ^a	2.0 ± 0.4 ^b	2.8 ± 0.0 ^{a,b}	0.6 ± 0.1 ^a	<0.24 ^a	8.5 ± 1.6 ^b
<i>Kuih onde-onde</i>	1.6 ± 0.1 ^a	1.3 ± 0.5 ^{a,b}	3.3 ± 1.3 ^{ab}	0.7 ± 0.4 ^a	<0.24 ^a	6.9 ± 3.6 ^b
<i>Kuih sagu</i>	1.9 ± 0.0 ^a	1.4 ± 0.3 ^{a,b}	10.2 ± 2.3 ^{a,b,c}	<0.17 ^a	<0.24 ^a	13.5 ± 0.8 ^{a,b}
<i>Kuih seri muka</i>	1.3 ± 0.4 ^a	1.4 ± 0.4 ^{a,b}	4.3 ± 0.2 ^{a,b}	0.8 ± 0.1 ^a	<0.24 ^a	7.8 ± 1.3 ^b
<i>Kuih talam</i>	3.0 ± 1.0 ^a	1.5 ± 0.1 ^{a,b}	4.4 ± 0.1 ^{a,b}	0.4 ± 0.2 ^a	<0.24 ^a	9.3 ± 0.5 ^{a,b}

Mean ± standard deviation (SD)

ANOVA test, significant at p<0.001

abc different letters in same column indicate significant differences

content in kuih lopes may contributed from brown sugar that contained not less than 90% of sugar and invert sugar (glucose and fructose) (Malaysia, 2012; Tee *et al.*, 1997; White, 2009).

Doughnut coated with sugar (Big Apple) contained significantly highest (p<0.001) of glucose content (7.1±1.3 g/100g) compared to other kuih. Both kuih bingka ubi and kuih lapis contained significantly (p<0.001) lowest glucose content (0.3±0.1 g/100g) compared to doughnut coated with sugar, kuih lopes and kuih koci.

The sucrose content in kuih keria (16.1±1.6 g/100g) was significantly highest (p<0.001) when compared to doughnut coated with sugar, kuih koci, kuih lopes, kuih onde-onde, kuih seri muka and kuih talam. However, sucrose could not be detected in doughnut coated with sugar (Big Apple) although table sugar was the main ingredient in preparation of the doughnut (Big Apple Donuts and Coffee, 2009). This may due to sucrose was hydrolyzed into fructose and glucose during the preparation. Therefore, glucose content in doughnut coated sugar was significantly higher (p<0.001) compared to other kuih.

Table 2 also showed that maltose was detected in all kuih except kuih sagu. Kuih keria contained the significantly (p<0.001) highest maltose content (6.2±0.8 g/100g) compared to other kuih. One of the main ingredients in preparation of kuih keria was sweet potato (Tee *et al.* 1997). According to Walter *et al.* (1975), when cooking, the will be a major change in sugar composition which is the production of maltose from hydrolyzed starch. Much of the starch was converted into dextrins and maltose by alpha-amylase and beta-amylase. Result also indicated that fructose, glucose and sucrose were detected in

kuih keria. This finding was similar with the study by Collins and Walter (1985) that reported sweet potatoes contained the three types of sugars.

The main types of individual sugars detected in kuih samples were sucrose (60.0%), followed by glucose (16.2%), fructose (14.0%), maltose (9.5%) and lactose (0.3%). Sucrose was the main contributor of total sugar in kuih samples. It may due to sugar used as the basic ingredient for preparing all kuih in this study. According to the Food Act 1983, regulation 188 (1), sugar is the food chemically known as sucrose and includes granulated sugar, loaf sugar, castor sugar and powdered sugar (Malaysia, 2012).

Table 3 showed the comparison of total sugar, starch and available CHO content in kuih between this study and other references. Coefficient of variation (CV) was also calculated in this study. All CV value for samples in starch analysis was less than 20% and there were only a few samples in sugar analysis showed the CV value more than 20%. However, majority of the samples have accepted CV value which is less than 20%. Spiking and recovery method were in the range of 80-120% which showed acceptable value (Ederveen, 2010; EMEA, 2009; WHO, 1997). Sugars used in spiking were glucose and fructose that showed a recovery value of 99.3 ± 15.7% and 86.8±11.0% respectively.

The range of total sugar, starch and available CHO in kuih samples was 6.8-25.0 g/100g, 9.0-23.0 g/100 g and 20.0-42.0 g/100g respectively. It was further observed that the total sugar content in kuih keria (24.2±2.4 g/100g) was significantly highest (p<0.05) than the one in doughnut coated with sugar, kuih koci, kuih lopes, kuih onde-onde and kuih seri muka. In addition to that, kuih keria also contained significantly highest (p<0.05) of available CHO

Table 3. Comparison of total sugar, starch and available CHO content in kuih between this study and other references

Kuih (n=11)	This study (g/100g)					Nik Shanita (2005)			MOH Singapore (2000)		
	Total sugar ^a	CV (%)	Starch ¹	CV (%)	Available CHO ²	Total sugar	Starch	Available CHO	Total sugar	Starch	Available CHO
Commercial kuih											
Doughnut coated with sugar (Big Apple)	8.3 ± 2.0 ^a	24.1	22.6 ± 0.3 ^{abcd}	1.4	30.9 ± 2.4 ^{ab}	7.6 ± 1.7	35.1 ± 4.6	42.7 ± 6.3	13.5	31.0	44.5
Traditional kuih											
<i>Kuih bingka ubi</i>	12.1 ± 3.7 ^{ab}	30.4	16.6 ± 0.5 ^{cd}	3.0	28.7 ± 3.2 ^{ab}	-	-	-	21.4	19.8	41.2
<i>Kuih kasui</i>	11.9 ± 1.8 ^{ab}	15.2	11.6 ± 1.5 ^{de}	13.2	23.5 ± 0.3 ^d	-	-	-	8.0	16.8	24.8
<i>Kuih keria</i>	24.2 ± 2.4 ^{ab}	9.8	17.3 ± 0.7 ^d	4.0	41.5 ± 1.7 ^{ab}	-	-	-	-	-	-
<i>Kuih koci</i>	8.3 ± 3.3 ^a	39.2	16.8 ± 1.0 ^d	6.0	25.1 ± 4.3 ^{ab}	-	-	-	-	-	-
<i>Kuih lapis</i>	14.5 ± 0.9 ^{ab}	6.0	12.7 ± 0.7 ^{cd}	5.7	27.2 ± 0.1 ^{ab}	-	-	-	9.0	22.3	31.3
<i>Kuih lopes</i>	8.5 ± 1.6 ^a	18.6	14.4 ± 0.2 ^{cd}	1.6	22.9 ± 1.4 ^a	-	-	-	Tr	33.3	33.3
<i>Kuih onde-onde</i>	6.9 ± 3.6 ^a	52.9	17.0 ± 0.7 ^d	3.9	23.9 ± 4.3 ^a	-	-	-	15.1	8.4	23.6
<i>Kuih sagu</i>	13.5 ± 0.8 ^{ab}	5.6	9.1 ± 1.2 ^e	13.6	22.6 ± 0.5 ^d	-	-	-	-	-	-
<i>Kuih seri muka</i>	7.8 ± 1.3 ^a	16.6	15.7 ± 0.3 ^{cd}	2.2	23.5 ± 1.6 ^d	-	-	-	-	-	-
<i>Kuih talam</i>	9.3 ± 0.5 ^{ab}	4.9	10.7 ± 0.1 ^{de}	0.9	20.0 ± 0.5 ^d	-	-	-	18.2	14.4	32.5

Mean ± standard deviation (SD)

Tr = A trace amount of the nutrient was found, but the quantity is too small to be of dietetic significance

¹ANOVA test, significant at p<0.001

²Kruskal-Wallis test, significant at p<0.05

^{abcd} different letters in same column indicate significant differences

content (41.5±1.7 g/100g) compared to kuih talam, kuih sagu, kuih lopes, kuih kasui, kuih seri muka, kuih onde-onde and kuih koci. For starch analysis, results showed that doughnut coated with sugar contained the significantly highest (p<0.05) of starch content (22.6±0.3 g/100g) compared to the rest of the kuih.

Malaysian Food Composition Table (FCT) only provides data on total CHO but not total sugar, starch and available CHO (Tee *et al.*, 1997). According to Menezes *et al.* (2004), most food composition database show total CHO data measured by difference, which does not specify each CHO component. Hence, the results in this study were compared with data from The Composition of Foods Commonly Eaten in Singapore (Ministry of Health Singapore, 2000) and the study done by Nik Shanita (2005).

According to Nik Shanita (2005), the doughnut used in her study was the one coated with sugar which was the same type with the one used in this study. Therefore, comparison was made to determine the different contents of total sugar, starch and available CHO between these two doughnuts. Results indicated that doughnut coated with sugar in this study contained lower available CHO than the one reported by Nik Shanita (2005) and Ministry of Health Singapore (2000). However, its total sugar content was higher than the one reported by Nik Shanita (2005). It may due to different types of doughnut analyzed. Nik Shanita (2005) stated that doughnut sample in her study was bought from Dunkin Donuts while this study bought the doughnut from Big Apple Donuts and Coffee.

Table 3 showed available CHO for all traditional kuih in this study were lower than the one reported by the Ministry of Health Singapore (2000). However, total sugar in kuih kasui and kuih lapis of this study were higher than the one reported by the Ministry of Health Singapore (2000). Kuih onde-onde in this study also contained higher starch content compared to Ministry of Health Singapore (2000).

Figure 2 also showed the amount of available CHO comprising of total sugar and starch content in kuih samples. According to Nik Shanita (2005), available CHO is the sum of total sugar and starch content. Results indicated that kuih keria contained the highest available CHO content. Kuih talam contained the least available CHO content, which was 50% lower than the one in kuih keria. One of the main ingredients used in making kuih talam was coconut milk which contained 28.3% fat and 2.8% protein content (Tee *et al.* 1997). According to Hasnah *et al.* (2013), the concentration of coconut milk may cause different amount of fat and protein in kuih. Therefore, using high concentration of coconut milk in preparing kuih talam may cause higher content of fat and protein but lower content of CHO.

Figure 2 also indicated that kuih keria contained the highest total sugar content. According to Tee *et al.* (1997), kuih keria was made from wheat flour, sweet potato and sugar. Apart from the sugar used in making kuih keria, sweet potato and wheat flour also contributed to the high sugar content. Collins and Walter (1985) estimated available sugar in sweet potato was between 30-35% on a dry-weight basis. Results also showed that kuih onde-onde had

the lowest sugar content. According to Ministry of Health Singapore (2000), gula melaka was used as the filling instead of granulated sugar in kuih onde-onde. However, sucrose content in gula melaka (70%) is lower compared to granulated sugar ($\geq 99.5\%$) (Malaysia 2012). This may cause lowest content of total sugar in kuih onde-onde compared to other kuih which mostly made by granulated sugar.

For analysis of starch, findings showed that doughnut coated with sugar (Big Apple) contained the highest starch content compared to other kuih. According to Big Apple Donuts and Coffee (2009), plain flour was the main ingredient for preparing doughnut. Generally, wheat flour was composed of 70-75% of starch (Hatae *et al.* 2003). Therefore, the usage of wheat flour as the main ingredient for preparing doughnut may contribute to high percentage of total starch existed in doughnut coated with sugar (Big Apple).

Figure 2 also showed that kuih sagu had the least starch content. This may due to its method of cooking. Cooking increases the rate of starch hydrolysis by gelatinizing the starch and makes it available for enzymatic action (Bornet *et al.*, 1989; Svihus *et al.* 2005; Roder *et al.* 2009; Alsaffar 2010; Singh *et al.* 2010). However, based on the observation during sampling, most of the kuih sagu samples in this study contained the white dot at the centre of sago pearl. This showed that the sago pearl used in making kuih sagu was not fully cooked and that the starch was not completely gelatinized. Therefore, starch content was low in kuih sagu.

The classification of sugar category was based on Food Standards Agency (2007). In this study, majority of the kuih samples (90.9%) were categorized as medium sugar and only kuih keria was categorized as high sugar. Kuih keria was categorized as high sugar because of the sugar content more than 15 g per 100 g. Doughnut coated with sugar (Big Apple), kuih bingka ubi, kuih kasui, kuih koci, kuih lapis, kuih lopes, kuih onde-onde, kuih sagu, kuih seri muka and kuih talam were categorized as medium sugar because sugar content ranged between 5-15g per 100g sample.

Campaign *et al.* (2003) suggested the classification of sugar and starch category, where low sugar means food containing 6% or less sugar. The medium sugar definition ranged from just above 6% to 35-40%, while the high sugar definition clustered foods containing more than 40% sugar. Thus, when based on the two main ingredients (sugar and flour) used in preparation of kuih, results indicated that all kuih samples can be categorized as medium sugar-medium starch. The doughnut coated with sugar

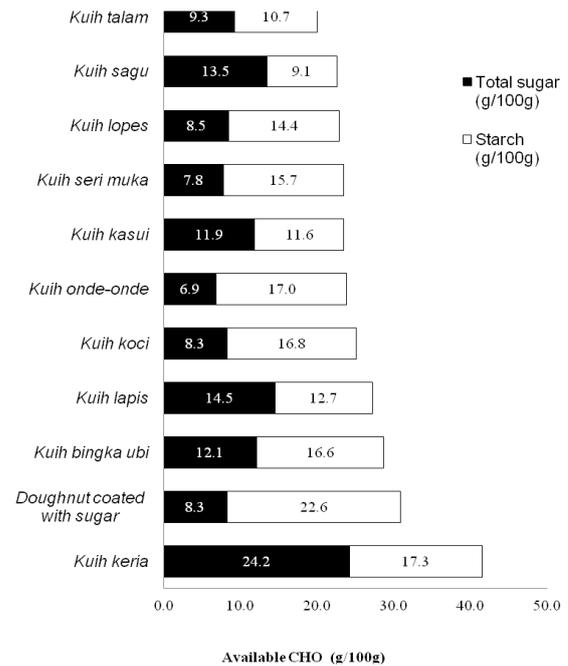


Figure 2. Amount of available CHO, comprising of total sugar and starch content in kuih

(Big Apple) in this study was categorized as medium sugar-medium which was similar to the one reported by Campaign *et al.* (2003).

Conclusion

Doughnut coated with sugar (Big Apple) has the highest starch content (22.6 ± 0.3 g/100g) compared to the other kuih. Kuih keria contained the highest available carbohydrate (41.5 ± 1.7 g/100g), comprising of 24.2 ± 2.4 g/100g total sugar and 17.3 ± 0.7 g/100g of starch. The least available carbohydrate content was found in kuih talam (20.0 ± 0.5 g/100g), which was 50% lower than the one in kuih keria. The majority of the kuih samples (90.9%) in this study was categorized as medium sugar and only the kuih Korea was categorized as a high sugar. Based on the two main ingredients (sugar and flour) used in the preparation of kuih, results indicated that all kuih samples can be categorized as medium sugar-medium starch. The results of this study can be used as a guide by locals when choosing kuih in the low to moderate sugar category.

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