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Glycaemic index and glycaemic load of commonly consumed Thai fruits

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Abstract

The present work was aimed to determine the glycaemic index (GI) and glycaemic load (GL) of commonly consumed Thai fruits for the potential risk of chronic diseases. Healthy subjects consumed 25 g available carbohydrate (fruits and glucose) in random order. Eighteen fruits were classified as low GI (26.5 - 54.8%) including jujube, unripe mango, banana (Kluai-Namwa, Kluai-Khai, and Kluai-Leb-Mu-Nang varieties), guava, tamarind, jackfruit, durian (Monthong and Chanee varieties), tangerine, longan, starfruit, pomelo (Thong Dee variety), sapodilla, white dragon fruit, sala, and rambutan. Fruits with medium GI (55.4 - 69.6%) includes pomelo (Kao Nampheung variety), banana (Kluai Hom variety), red dragon fruit, watermelon, coconut, mangosteen, longkong, ripe mango, papaya, rose apple, and lychee. Pineapple has a high GI value. Most of the studied fruits were classified as low GL except for tamarind, red dragon fruit, mangosteen, lychee, and pineapple which were classified as medium GL. Various kinds of Thai fruits provided different GI and GL values. Therefore, low GI fruit with low GL regimen can be considered as alternative food sources to be used for diet manipulation in diabetic patients as well as in healthy population.

Introduction

Diabetes mellitus is a growing public health concern worldwide. The prevalence of diabetes in the world has increased nearly from 350 million in 2008 to almost 382 million in 2013, and this number is expected to rise to 592 million by 2035 (Guariguata *et al.,* 2014). The goal of type 2 diabetes management is to optimise glycaemic control in patients, and prevent medical complications due to hyperglycaemia (McGuire *et al.,* 2016). The indicator of carbohydrates' ability to raise blood glucose level and serum insulin response can be represented in parts by the glycaemic index (GI) and glycaemic load (GL) (Jenkins *et al.,* 1981; Wolever, 2013). Clinical studies have shown that low GI and GL foods can improve glycaemic control, potential weight loss, and lead to positive cardiovascular health outcomes (Maki *et al.,* 2007; Hartman *et al.,* 2010; Murakami *et al.,* 2011; Rossi *et al.,* 2013; Nounmusig *et al.,* 2018).

Fruits are highly recommended dietary sources known for nutritive values and health-promoting effects. Additionally, fruits are one of the major sources of carbohydrates that directly raise postprandial blood glucose and insulin response. The range of GI in fruits is usually low to medium (GI = 30 - 60%; Atkinson *et al.,* 2008). Robert *et al.* (2008) showed that in Malaysia, the GI of pineapple was 82 ± 4%, which was significantly greater than that of papaya (58 ± 6%), watermelon (55 ± 3%), and durian (49 ± 5%) ($p < 0.05$). People who have underlying diabetes mellitus can consume fruits according to their health status.

In Thailand, there are plenty of fruits grown all year round. However, many studies on fruits are focused on the nutrient composition and antioxidant properties (Charoensiri and Kongkachuichai, 2009; Charoensiri *et al.,* 2009). Therefore, the objective of the present work was to determine the GI and GL of 30 fruits commonly consumed in Thailand as an alternative food sources to be applied for dietary manipulations.

Materials and methods

Subjects

A total of 120 healthy subjects aged 20 - 45 years old with the mean age of 30.7 ± 5.7 years old were involved. Inclusion criteria were healthy male and female adults who had a body mass index (BMI) ranging from 18.5 - 22.9 kg/m^2, had normal fasting blood sugar (FBS) ≤ 5.6 mmol/L, and HbA1c ≤ 5.9%; while exclusion criteria were subjects who drank alcohol, smoking, and taking medications.

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Twelve subjects were randomly allocated into one group for testing three different types of fruit and glucose solution (reference food containing 25 g available carbohydrate; ISO, 2010). The Human Ethics Committee of Mahidol University Institutional Review Board (MU-IRB 2012/118.1712) approved the present work. All subjects had given their informed consent before the test began.

Test fruits

Thirty types of Thai fruits were chosen, namely banana (Kluai Hom, Kluai Leb Mu Nang, Kluai Namwa, and Kluai Khai; *Musa sapientum* L.), coconut (*Cocos nucifera* L.), white dragon fruit (*Hylocereus undatus*), red dragon fruit (*Hylocereus polyrhizus*), durian (Chanee and Monthong; *Durio zibethinus* L.), guava (*Psidium guajava* L.), jackfruit (*Artocarpus heterophyllus* Lam.), jujube (*Zizyphus mauritiana* Lamk.), longan (*Euporia longana* Lamk.), longkong (*Lansium domesticum* Corr.), lychee (*Litchi chinensis* Somn.), unripe and ripe mango (*Mangifera indica* L.), mangosteen (*Garcinia mangostana* L.), papaya (*Carica papaya* L.), pineapple (*Ananas comosus* L.), pomelo (Kao Nampheung and Thong Dee; *Citrus maxima* Merr.), rambutan (*Nephelium lappaceum* L.), rose apple (*Eugenia jambos* L.), starfruit (*Averrhoa carambola* L.), sala (*Salacca edulis* Reinw.), sapodilla (*Lansium domesticum* Corr.), tamarind (*Tamarindus indica* L.), tangerine (*Citrus reticulata* Blanco), and watermelon (*Citrullus lanatus*).

The fresh fruits were obtained from three representative markets in the Nakhon Pathom province, Thailand. All fruits were analysed for total carbohydrate and dietary fibre using the AOAC method (AOAC, 2005). The ripening stages of fruits were similar between chemical analysis and GI study. The amount of available carbohydrate (availCHO) was derived from the difference between the total carbohydrate and dietary fibre values.

Experimental design

The day before the study, each subject consumed a standard meal in the evening composed of cooked white rice and stirred fried chicken with basil leaves. They were informed to refrain from vigorous exercise, alcohol drinking, smoking, and to undergo an overnight fast for 10 - 12 h. In the morning, before the consumption of each test fruit, fasting blood glucose was taken from the antecubital vein of the subject at -10 and 0 min as the baseline values. Then, the subject was asked to finish his/her fruit portion within 15 min. Blood samples were taken at 15, 30, 45, 60, 90, and 120 min after eating the fruit. Subjects remained sedentary during each session. A blood sample was analysed by the glucose oxidase method using an automatic analyser.

Calculation of the glycaemic index and glycaemic load

The incremental area under the plasma glucose curve (IAUC) for each food was calculated using GraphPad Prism 5.0. (GraphPad Software Inc., San Diego, CA, USA). The GI value of the fruit was calculated as the ratio of the 2-h IAUC of fruit divided by the 2-h IAUC of the standard glucose, and multiplied by 100. The maximum increase in plasma glucose (MIPG) was calculated using the following equation: postprandial blood glucose subtracted by fasting blood glucose (Olausson *et al.,* 2014). Meanwhile, the GL of a specific serving of each fruit = GI × availCHO in serving size (g) / 100 (Atkinson *et al.,* 2008).

Statistical analysis

Results were expressed as mean ± SD and mean ± SEM. For GI study, those with intraindividual variability (%CV) greater than 30% for reference glucose were considered as outliers. GI values that were greater than ± 2SD of the group mean GI were also considered as outliers, and were excluded from the analysis.

Results and discussion

Baseline characteristics of the subjects

The baseline characteristics of the subjects are presented in Table 1. One hundred and twenty healthy subjects were randomly allocated into ten groups. The mean age was 30.7 ± 5.7 years, and the

Table 1. Baseline characteristics of study subjects.

Subject characteristic	Value (*n* = 120)
Age (year)	30.7 ± 5.7
BMI (kg/m^2)	21.3 ± 2.0
Fasting blood glucose (mmol/L)	4.5 ± 0.3
HbA1C (%)	4.9 ± 0.3
Total cholesterol (mmol/L)	5.1 ± 0.6
Triglyceride (mmol/L)	0.9 ± 0.3
LDL-cholesterol (mmol/L)	3.1 ± 0.5
HDL-cholesterol (mmol/L)	1.6 ± 0.2

Data are mean ± SD. BMI = body mass index; LDL = low density lipoprotein cholesterol; and HDL = high density lipoprotein cholesterol.

mean BMI value was 21.3 ± 2.0 kg/m^2. The FBS (4.5 ± 0.3 mmol/L), HbA1c (4.9 ± 0.3%), and lipid profiles (total cholesterol, triglyceride, LDL-, and HDL-cholesterol were 5.1 ± 0.6, 0.9 ± 0.3, 3.1 ± 0.5, and 1.6 ± 0.2 mmol/L, respectively) were within the normal range (Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001).

Composition of the tested fruits

The nutrient composition of the test fruits (g/100 g) and the amount of fruit for GI study are described in Table 2. Carbohydrate was the main nutrient that varied according to the types of fruit. The lowest total carbohydrate content was found in coconut (6.70 g), while tamarind (72.77 g) had the highest total carbohydrate content. Watermelon (0.63 g) has the lowest dietary fibre level, while the highest dietary fibre was found in tamarind (7.64 g). AvailCHO in 100 g of fruits showed that coconut has the lowest availCHO (4.90 g); in consequence, the portion containing 25 g availCHO used to determine the GI was the highest (510.20 g).

Glycaemic index and maximum increase in plasma glucose of tested fruits

Fruits are one of the major food groups recommended to be consumed daily for water, vitamins, mineral, antioxidant, and dietary fibre. They are also one of the major sources of carbohydrates that directly raise the postprandial plasma glucose and serum insulin response. Based on the criteria for a percentage of GI values (Atkinson *et al.,* 2008), most of Thai fruits were classified as low GI (mean ± SEM; ≤ 55%) including jujube (26.5 ± 3.8%), unripe mango (28.1 ± 4.8%), banana (Kluai Namwa, 30.5 ± 2.7%), guava (34.3 ± 4.8%), tamarind (36.3 ± 5.4%), jackfruit (36.5 ± 3.1%), durian (Chanee, 42.9 ± 8.1%), tangerine (44.1 ± 7.8%), longan (44.5 ± 5.6%), starfruit (44.5 ± 7.0%), pomelo (Thong Dee, 44.7 ± 4.1%), sapodilla (47.5 ± 4.1%), banana (Kluai Khai, 47.6 ± 8.1%), durian (Monthong, 47.6 ± 3.6%), white dragon fruit (51.9 ± 4.7%), sala (52.8 ± 6.6%), banana (Kluai Leb Mu Nang, 54.0 ± 8.1%), and rambutan (54.8 ± 8.1%).

Medium GI fruits (mean ± SEM; 55 - 70%) were pomelo (Kao Nampheung, 55.4 ± 8.7%), banana (Kluai Hom, 57.0 ± 7.2%), red dragon fruit (57.2 ± 6.4%), watermelon (58.4 ± 8.0%), coconut (59.0 ± 8.2%), mangosteen (58.5 ± 8.9%), longkong (61.0 ± 11.5%), ripe mango (63.5 ± 7.1%), papaya (64.5 ± 6.5%), rose apple (66.6 ± 7.9%), and lychee (69.6 ± 7.6%).

Pineapple (72.1 ± 10.9%) had high GI (mean ± SEM; > 70%). It contained total sugar, sucrose, and dietary fibre in the served amount which were close to those in longan, ripe mango, rambutan, and tangerine, which were medium GI fruits. It contained a higher amount of glucose which may respond to the highest GI value (Atkinson *et al.,* 2008). The finding corresponded well with the study in Malaysia, showing a GI value of 82% for pineapple, thus classifying it as high GI (Robert *et al.,* 2008). However, the low GI of pineapple (45%) was reported in type 2 diabetes patients, which was based on 50 g of total carbohydrate in the fruit (Somnuk, 2004). Moreover, the GI value for pineapple (mean ± SEM; 72.1 ± 10.9%) was higher than the value of 59.0 ± 8.0% given in the International GI Tables (Atkinson *et al.,* 2008). The discrepancy of the GI values of the same type of fruits might be due to differences in cultivated areas and growth conditions, or the difference in the intact sugar content of individual fruits.

Many factors affect plasma glucose responses which are used to determine the GI value; dietary fibre content, fruit texture, type of sugars and starches, and the maturity level of the fruit. These factors may affect the rate of digestion and absorption of component sugars, which are closely related to plasma glucose responses (Vosloo, 2005). Moreover, the presence of polyphenols may affect the GI of the fruit (Oboh *et al.,* 2015). Thus, pomelo of Thong Dee variety (44.7 ± 4.1%) and white dragon fruit (51.9 ± 4.7%) had a comparatively lower GI than pomelo of Kao Nampheung variety (55.4 ± 8.7%) and red dragon fruit (57.2 ± 6.4%) (Rebecca *et al.,* 2010; Pichaiyong-vongdee *et al.,* 2014).

Glycaemic load of tested fruits

GL is an index developed from the GI value of food, and the amount of available carbohydrate intake is the determinant factor. As shown in Table 3, most Thai fruits were classified as low GL (mean ± SEM; ≤ 10) except for tamarind (10.7 ± 1.6), red dragon fruit (10.6 ± 1.2), mangosteen (11.5 ± 1.8), lychee (13.1 ± 1.4), and pineapple (10.8 ± 1.6) which were classified as medium GL (mean ± SEM; > 10 - 20). Interestingly, some of the studied fruits such as tamarind had low GI. However, its serving size contained a high density of available carbohydrates, thus placing it in the medium GL group. For jujube, banana (Kluai Namwa, Kluai Khai, Kluai Leb Mu Nang), guava, jackfruit, durian (Chanee), starfruit, pomelo (Thong Dee), and papaya, two servings exhibited low GL. Therefore, it could be implied that the data of GI and GL are important, and can be used together for the management of diabetic patients as well as healthy population.

Table 2. The nutrient composition of test fruits (g/100 g) and amount of fruit for GI study.

No.	Common name	Scientific name	Total CHO (g/100 g)	Dietary fibre (g/100 g)	AvailCHO (g/100 g)	Amount of fruit* (g)
1	Banana (Kluai Khai)	*Musa sapientum* L.	27.58	2.00	25.58	97.73
2	Banana (Kluai Leb Mu Nang)	*Musa sapientum* L.	28.46	2.19	26.27	95.17
3	Banana (Klui Namwa)	*Musa sapientum* L.	30.41	2.71	27.70	90.25
4	Banana (Kluai Hom)	*Musa sapientum* L.	23.64	1.82	21.82	114.57
5	Coconut	*Cocos nucifera* L.	6.70	1.80	4.90	510.20
6	White dragon fruit	*Hylocereus undatus*	13.26	1.70	11.56	216.26
7	Red dragon fruit	*Hylocereus polyrhizus*	13.03	2.47	10.56	236.74
8	Durian (Chanee)	*Durio zibethinus* L.	23.96	3.58	20.38	122.67
9	Durian (Monthong)	*Durio zibethinus* L.	28.84	3.39	25.45	98.23
10	Guava	*Psidium guajava* L.	11.13	3.73	7.40	337.84
11	Jackfruit	*Artocarpus heterophyllus* Lam.	22.34	1.66	20.68	120.89
12	Jujube	*Zizyphus mauritiana* Lamk.	10.83	1.54	9.29	269.11
13	Longan	*Euporia longana* Lamk.	18.55	0.72	17.83	140.21
14	Longkong	*Lansium domesticum* Corr.	16.19	1.14	15.05	166.11
15	Lychee	*Litchi chinensis* Somn.	17.80	1.00	16.80	148.81
16	Unripe mango	*Mangifera indica* L.	18.28	1.87	16.41	152.35
17	Ripe mango	*Mangifera indica* L.	15.16	1.02	14.14	176.80
18	Mangosteen	*Garcinia mangostana* L.	18.42	2.00	16.42	152.25
19	Papaya	*Carica papaya* L.	9.09	1.51	7.58	329.82
20	Pineapple	*Ananas comosus* (L.) Merr.	11.16	0.78	10.38	240.85
21	Pomelo (Kao Nampheung)	*Citrus grandis* (L.) Osbeck.	9.66	1.50	8.16	306.37
22	Pomelo (Thong Dee)	*Citrus grandis* (L.) Osbeck.	10.27	1.78	8.49	294.46
23	Rambutan	*Nephelium lappaceum* L.	18.96	1.65	17.31	144.43
24	Rose apple	*Eugenia jambos* L.	9.58	1.39	8.19	305.25
25	Starfruit	*Averrhoa carambola* L.	8.84	2.41	6.43	388.80
26	Sala	*Salacca edulis* Reinw.	17.23	1.80	15.43	162.02
27	Sapodilla	*Lansium domesticum* Corr.	22.62	7.33	15.29	163.51
28	Tamarind	*Tamarindus indica* L.	72.77	7.64	65.13	38.38
29	Tangerine	*Citrus reticulata* Blanco.	11.96	1.29	10.67	234.30
30	Watermelon	*Citrullus lanatus*	8.70	0.63	8.07	309.79

Total CHO = total carbohydrate; AvailCHO = available carbohydrate. *Amount of fruit that provides 25 g AvailCHO.

Table 3. Glycemic index and glycaemic load of test fruits.

No.	Fruit	*n*	MIPG (mmol/L)	GI (%)	Amount of serving size* (g)	GL
Low GI fruit						
1	Jujube	12	1.1 ± 0.1	26.5 ± 3.8	2 large (120)	3.0 ± 0.4
2	Unripe mango	12	1.0 ± 0.2	28.1 ± 4.8	½ medium (130)	6.0 ± 1.0
3	Banana (Kluai Namwa)	11	1.3 ± 0.2	30.5 ± 2.7	1 medium (52)	4.4 ± 0.4
4	Guava	11	1.6 ± 0.2	34.3 ± 4.8	½ medium (120)	3.2 ± 0.4
5	Tamarind	11	1.2 ± 0.2	36.3 ± 5.4	4 large (45)	10.7 ± 1.6
6	Jackfruit	11	1.4 ± 0.1	36.5 ± 3.1	2 medium (80)	4.5 ± 0.4
7	Durian (Chanee)	12	1.1 ± 0.1	42.9 ± 8.1	1 piece, medium (30)	2.6 ± 0.5
8	Tangerine	12	1.8 ± 0.2	44.1 ± 7.8	2 medium (139)	6.4 ± 1.1
9	Longan	11	2.3 ± 0.2	44.5 ± 5.6	8 large (75)	5.9 ± 0.8
10	Starfruit	12	1.7 ± 0.2	44.5 ± 7.0	1 large (121)	3.5 ± 0.5
11	Pomelo (Thong Dee)	11	1.9 ± 0.2	44.7 ± 4.1	2 pieces, large (120)	4.6 ± 0.4
12	Sapodilla	11	1.6 ± 0.1	47.5 ± 4.1	2 large (122)	8.9 ± 0.8
13	Banana (Kluai Khai)	11	1.8 ± 0.2	47.6 ± 8.1	1 medium (40)	4.9 ± 0.8
14	Durian (Monthong)	11	1.5 ± 0.2	47.6 ± 3.6	1 piece, medium (50)	6.1 ± 0.5
15	White dragon fruit	12	1.7 ± 0.1	51.9 ± 4.7	½ medium (160)	8.8 ± 0.8
16	Sala	12	1.8 ± 0.2	52.8 ± 6.6	4 medium (80)	6.5 ± 0.8
17	Banana (Kluai Leb Mu Nang)	12	1.8 ± 0.2	54.0 ± 8.1	1 large (33)	4.7 ± 0.7
18	Rambutan	11	2.3 ± 0.2	54.8 ± 8.1	4 large (76)	7.2 ± 1.1
Medium GI fruit						
19	Pomelo (Kao Nampheung)	12	2.3 ± 0.2	55.4 ± 8.7	1 piece, large (130)	5.9 ± 0.9
20	Banana (Kluai Hom)	11	1.5 ± 0.2	57.0 ± 7.2	½ medium (56)	7.0 ± 0.9
21	Red dragon fruit	11	2.2 ± 0.2	57.2 ± 6.4	½ medium (160)	10.6 ± 1.2
22	Watermelon	11	2.1 ± 0.3	58.4 ± 8.0	8 pieces (134)	6.3 ± 0.9
23	Coconut	12	2.3 ± 0.3	59.0 ± 8.2	1 medium (320)	9.6 ± 1.3
24	Mangosteen	12	1.8 ± 0.3	58.5 ± 8.9	4 large (120)	11.5 ± 1.8
25	Longkong	12	1.6 ± 0.2	61.0 ± 11.5	8 large (80)	7.3 ± 1.4
26	Ripe mango	12	1.8 ± 0.2	63.5 ± 7.1	½ medium (65)	5.8 ± 0.7
27	Papaya	12	2.1 ± 0.2	64.5 ± 6.5	8 pieces (80)	3.9 ± 0.4
28	Rose apple	11	2.5 ± 0.3	66.6 ± 7.9	2 large (128)	7.0 ± 0.8
29	Lychee	11	2.7 ± 0.2	69.6 ± 7.6	4 large (112)	13.1 ± 1.4
High GI fruit						
30	Pineapple	11	2.5 ± 0.3	72.1 ± 10.9	8 pieces (145)	10.8 ± 1.6

Data are mean ± SEM. *According to the Thai FBDG (2009). MIPG = Maximum Increase in Plasma Glucose; GI = Glycaemic Index; GL = Glycaemic Load. GI is calculated as the ratio of incremental area under the blood glucose curve for 2 h after fruit is eaten and the corresponding area after glucose is eaten, multiplied by 100%.

Conclusions

Most of the Thai fruits assessed in the present work had low GI and low GL values. With these characteristics, it is an opportunity to promote these fruits among the Thai people, particularly those who are diabetic. Diet modification using the appropriate portion size of low GI fruit as a part of meals will help improve glycaemic control of people at risk.

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References

Association of Official Analytical Chemists (AOAC). 2005. Official methods of analysis of AOAC International. 18th ed. USA: AOAC.

Atkinson, F. S., Foster-Powell, K. and Brand-Miller, J. C. 2008. International tables of glycemic index and glycemic load values. Diabetes Care 31: 2281-2283.

Charoensiri, R. and Kongkachuichai, R. 2009. Sucrose profiles, and insoluble and soluble dietary fiber content in selected of Thai fruits. International Journal of Food Sciences and Nutrition 1: 126-139.

Charoensiri, R., Kongkachuichai, R., Siriwan, S. and Sungpung, P. 2009. Vitamin E beta-carotene and lycopene content in selected of fresh Thai fruit. Food Chemistry 113: 202-207.

Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. 2001. Executive summary of the third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III.). Journal of the American Medical Association 285: 2486-2497.

Guariguata, L., Whiting, D. R., Hambleton, I., Beagley, J., Linnenkamp, U. and Shaw, J. E. 2014. Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Research and Clinical Practice 103: 137-149.

Hartman, T. J., Albert, P. S., Zhang, Z., Bagshaw, D., Kris-Etherton, P. M., Ulbrecht, J., ... and Lanza, E. 2010. Consumption of a legume-enriched, low-glycemic index diet is associated with biomarkers of insulin resistance and inflammation among men at risk for colorectal cancer. Journal of Nutrition 140: 60-67.

International Organization for Standardization (ISO). 2010. ISO 26642:2010 food products — determination of the glycaemic index (GI) and recommendation for food classification. Geneva: ISO.

Jenkins, D. J. A., Wolever, T. M. S., Taylor, R. H., Barker, H., Fielden, H., Baldwin, J. M., ... and Goff, D. V. 1981. Glycemic index of foods: a physiological basis for carbohydrate exchange. American Journal of Clinical Nutrition 34: 362-366.

Maki, K. C., Rains, T. M., Kaden, V. N., Raneri, K. R. and Davidson, M. H. 2007. Effects of a reduced-glycemic-load diet on body weight, body composition, and cardiovascular disease risk markers in overweight and obese adults. American Journal of Clinical Nutrition 85: 724-734.

McGuire, H., Longson, D., Adler, A., Farmer, A. and Lewin, I. 2016. Management of type 2 diabetes in adults: summary of updated NICE guidance. British Medical Journal 353: 1575-1577.

Murakami, K., Miyake, Y., Sasaki, S., Tanaka, K. and Arakawa, M. 2011. Dietary glycemic index and glycemic load in relation to risk of overweight in Japanese children and adolescents: the Ryukyus Child Health Study. International Journal of Obesity 35: 925-936.

Nounmusig, J., Kongkachuichai, R., Sirichakwal, P. P., Yamborisut, U., Charoensiri, R. and Vanavichit, A. 2018. The effect of low and high glycemic index based rice varieties in test meals on postprandial blood glucose, insulin and incretin hormones response in prediabetic subjects. International Food Research Journal 25(2): 835-841.

Oboh, G., Ademosun, A. O., Akinleye, M., Omojokun, O. S., Boligon, A. A. and Athayde, M. L. 2015. Starch composition, glycemic indices, phenolic constituents, and antioxidative and antidiabetic properties of some common tropical fruits. Journal of Ethnic Foods 2: 64-73.

Olausson, E. A., Grundin, H., Isaksson, M., Brock, C., Drewes, A. M., Attvall, S. and Simrén, M. 2014. Postprandial plasma glucose response and gastrointestinal symptom severity in patients with diabetic gastroparesis. Journal of Diabetes Science and Technology 8(4): 881-888.

Pichaiyongvongdee, S., Rattanapun, B. and Haruenkit, R. 2014. Total polyphenol content and antioxidant properties in different tissues of seven pomelo (*Citrus grandis* (L.) Osbeck) cultivars. Kasetsart Journal - Natural Science 48: 989-996.

Rebecca, O. P. S., Boyce, A. N. and Chandran, S. 2010. Pigment identification and antioxidant properties of red dragon fruit (*Hylocereus polyrhizus*). African Journal of Biotechnology 9(10): 1450-1454.

Robert, S. D., Ismail, A. A., Winn, T. and Wolever, T. M. 2008. Glycemic index of common Malaysian fruits. Asia Pacific Journal of Clinical Nutrition 17(1): 35-39.

Rossi, M., Turati, F., Lagiou, P., Trichopoulos, D., Augustin, L. S., La Vecchia, C. and Trichopoulou, A. 2013. Mediterranean diet and glycaemic load in relation to incidence of type 2 diabetes: results from the Greek cohort of the population-based European Prospective Investigation into Cancer and Nutrition (EPIC). Diabetologia 56(11): 2405-2413.

Somnuk, S. 2004. Glycemic indexes of durian, mango, longan, pineapple, guava and dragon fruit and acute responses of plasma glucose, serum lipids and blood viscosity after ingestion different amounts of fruits in hyperlipidemic type 2 DM patients. Thailand: Mahidol University, MSc thesis.

Vosloo, M. C. 2005. Some factors affecting the digestion of glycaemic carbohydrates and the blood glucose response. Family and Consumer Sciences Research Journal 33: 1-9.

Wolever, T. M. S. 2013. Is glycaemic index (GI) a valid measure of carbohydrate quality? European Journal of Clinical Nutrition 67(5): 522-531.