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DETERMINATION AND ESTIMATION OF THE GLYCEMIC INDEX OF SELECTED MALAYSIAN FOODS

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By

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Chair: Associate Prof Dr Barakatun Nisak Mohd Yusof, PhD
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Glycemic Index (GI) is used to rank carbohydrate foods based on their ability to raise postprandial blood glucose level after eating. Research on GI testing for Malaysian foods are still at its infancy and its applicability in mixed meals are debatable. Therefore, this experimental study was conducted to determine and estimate the GI of commonly consumed foods in Malaysia including mixed meals. A total of 33 healthy subjects (15 men and 18 women, mean BMI 22 ± 2.25 kgm^{-2}, mean age 23 ± 2 years) were recruited via advertisement throughout Universiti Putra Malaysia. Subjects were divided into three groups namely Rice (Fragrant Rice, Red Rice, and Parboiled Rice), Noodles (Noodles) and *Kuih (Keropok Lekor, Cucur Bilis, Cekodok,* Wet Spring Roll and Fried Spring Roll*)* Groups. Besides, mixed meals (Fried Fragrant Rice, Fried Red Rice, Fried Parboiled Rice, Fried Noodles, and Noodles Soup and Spaghetti Soup) were assigned to the subjects from Rice and Noodles Group respectively. Subjects were randomly assigned to the food tested and the three times reference food (glucose solution). Capillary blood glucose was measured before eating and over two hours postprandial. The incremental areas under the blood glucose curve (iAUC) were calculated and GI value of tested foods were measured. All the procedures were adhered to the Australian Standard 2007©. The estimation of GI in mixed meals were calculated using predicted or adjusted techniques. If the GI is a valid measure in estimating the GI in mixed meals, it should provide significant association between measured GI and predicted techniques or measured GI and adjusted techniques. The iAUC of the test foods ranging from 72.15±8.96 to 161.09±15.14 mmol.min/L with Wet Spring Roll yielding the highest, while Fried Parboiled Rice showed the lowest blood glucose response. There was no significant difference were found between the iAUC of each test food and the reference food (202±7.75mmol.min/L) ($p<0.05$) except for Noodles Group which showed significantly lower than the reference food. Adding fat and protein in mixed meals was further reduced the iAUC by 18 to 36%. There was a significant difference between GI of the tested foods and reference food. Wet Spring Roll has the highest GI value and this were significantly difference to Red Rice, Parboiled Rice, Noodles, *Keropok Lekor, Cucur Bilis* and *Cekodok Pisang* ($p<0.05$). The GI (glucose =100) of the food in descending order were as

followed; Wet Spring Roll (GI = 78), Fragrant Rice (GI=65), Fried Spring Roll (GI=63), Red Rice (GI=62), *Cucur Bilis* (GI=58), Parboiled Rice (GI=57), *Keropok Lekor* (GI=57), *Cekodok Pisang* (GI=56) and Noodles (GI=55). Only the adjusted GI was significantly associated with measured GI ($r=0.43$, $p<0.01$) but not the predicted GI ($p> 0.05$). In conclusion, the iAUC of Noodles Group were significantly lower as compared to reference food. Rice, Noodles and *Kuih* Groups fall into medium GI categories, except for Wet Spring Roll which was categorized into high GI food. Addition of fat and protein into the meal cause a further reduction in iAUC. GI in mixed meals was a valid measure to estimate GI value in mixed meals as it provides significant association between the measured GI in mixed meals and adjusted GI in mixed meals but no significant association found between measured GI in mixed meals and predicted GI in mixed meals.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Master Sains

PENENTUAN DAN JANGKAAN INDEKS GLISEMIK MAKANAN MALAYSIA

Oleh

NUR MAZIAH HANUM BINTI OSMAN

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Pengerusi: Prof Madya Dr. Barakatun Nisak Mohd Yusof, PhD
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Indeks Glisemik (GI) digunakan untuk mengkelaskan makanan berkarbohidrat atas keupayaannya meningkatkan aras glukosa darah selepas makan. Penyelidikan ke atas Indeks Glisemik (GI) untuk makanan di Malaysia masih di peringkat awal dan penggunaan dalam makanan campuran masih diperdebatkan. Oleh itu, eksperimen ini telah dijalankan bagi menentukan dan menganggarkan GI makanan terpilih di Malaysia termasuk makanan campuran. Seramai 33 subjek yang sihat (15 lelaki dan 18 wanita, purata IJT 22 ± 2.25 kgm^{-2}, purata umur 23 ± 2 tahun) telah dipilih melalui iklan di Universiti Putra Malaysia. Subjek dibahagikan kepada tiga kumpulan iaitu Kumpulan Nasi (Beras Wangi, Beras Merah dan Beras Rebus), Kumpulan Mee (Mee) dan kumpulan Kuih (Keropok Lekor, Cucur Bilis, Cekodok Pisang, Popia Basah dan Popia Goreng). Selain itu, makanan campuran (Nasi Goreng Beras Wangi, Nasi Goreng Beras Merah, Nasi Rebus Goreng, Mee Goreng, Mee Sup dan Spagheti Sup) telah diberikan kepada subjek mengikut Kumpulan Nasi dan Mee. Subjek diberikan makanan secara rawak untuk makanan ujian dan tiga kali makanan rujukan (larutan glukosa). Glukosa diukur sebelum makan dan selama dua jam selepas makan. Kawasan luas dibawah graf (iAUC) dikira dan nilai GI makanan ujian diukur. Semua prosedur mematuhi Piawaian Australia 2007©. GI anggaran dikira menggunakan teknik ramalan atau teknik pelarasan. Jika GI adalah ukuran yang sah untuk menganggarkan GI dalam makanan campuran, ia perlu mempunyai hubungan yang signifikan antara GI ukuran dengan teknik ramalan GI atau GI ukuran dengan teknik pelarasan GI. Julat iAUC makanan ujian adalah dari 72.15 ± 8.96 hingga 161.09 ± 15.14 mmol.min / L dengan Popia Basah mempunyai iAUC paling tinggi, manakala Nasi Rebus Goreng mempunyai iAUC yang paling rendah. Walau bagaimanapun, terdapat perbezaan yang tidak signifikan antara iAUC setiap makanan ujian dan makanan rujukan (202±7.75mmol.min/L) ($p<0.05$) kecuali Kumpulan Mee yang menunjukkan signifikan iAUC yang lebih rendah berbanding makanan rujukan. Menambahkan lemak dan protein dalam makanan campuran mengurangkan iAUC sebanyak 18 hingga 36%. Terdapat perbezaan yang signifikan antara GI makanan rujukan dan makanan ujian. Popia Basah mempunyai perbezaan yang signifikan dengan Beras Merah, Beras Rebus, Mee , Keropok Lekor, Cucur Bilis dan Cekodok Pisang ($p<0.05$). GI (glukosa = 100) mengikut urutan menurun adalah; Popia Basah (GI = 78), Beras Wangi (GI = 65), Popia Goreng (GI = 63), Beras Merah (GI = 62), Cucur Bilis (GI = 58), Beras Rebus (GI = 57), Keropok Lekor (GI = 57), Cekodok

Pisang (GI = 56) dan Mee (GI = 55). Hanya teknik pelarasan mempunyai perbezaan ketara dengan GI diukur ($r = 0.43$, $p < 0.01$) tetapi tidak teknik ramalan ($p > 0.05$). Kesimpulannya, terdapat perbezaan yang signifikan diantara iAUC Kumpulan Mee dan makananan rujukan. Kumpulan Nasi, Mee dan Kuih berada dalam kategori GI sederhana kecuali Popia Basah dikategorikan di dalam kelas tinggi GI. Penambahan lemak dan protein dalam makanan menyebabkan penurunan iAUC. GI dalam makanan campuran adalah cara yang sahih untuk menganggarkan nilai GI dalam makanan campuran kerana ia mempunyai hubungan yang signifikan antara GI yang diukur dan GI diselaraskan dalam makanan campuran tetapi tiada hubungan yang signifikan didapati antara GI diukur dan GI ramalan dalam makanan campuran.

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I certify that a Thesis Examination Committee has met on (November 2015) to conduct the final examination of Nur Maziah Hanum Binti Osman on her thesis entitled Glycemic Index Determination of Selected Foods in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15March 1998. The Committee recommends that the student be awarded the Master of Science

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree Of Master Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

ANNOVA	: Analysis of Variance
BMI	: Body Mass Index
BGR	: Blood Glucose Response
Carbohydrates- FFQ	: Carbohydrates Food Frequency Questionnaires
FABP2	: Fatty Acid Binding Protein
GDM	: Gestational Diabetes Mellitus
GI	: Glycemic Index
GL	: Glycemic Load
%CV	: Reference Food Coefficient Variation
WHO	: World Health Organisation
iAUC	: Incremental Area Under The Curve
T2DM	: Type 2 Diabetes Mellitus
JKEMUPM	: Human Ethical Committee Universiti Putra Malaysia

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CHAPTER 1

INTRODUCTION

1.1 Background

The concept of glycemic index (GI) has been introduced since the last 40 years as a method to classify carbohydrate foods based on their effect to postprandial blood glucose level after meal (Jenkin et al, 1981). This concept was drawn based on the potential factors such as nature of carbohydrates and dietary fiber that affect the postprandial blood glucose level after meal which finally influence the management of diabetes (Jenkins et al., 1981). The concept is considered as an extension of fiber hypothesis which suggested that fiber consumption reduces the rate of nutrient influx from the gut (Jenkins et al., 2002).

The GI concept is now widely recognized and applied in research, dietary guidelines as well as commercial application purposes. The use of GI concept has been integrated in several country dietary guidelines including United Kingdom (Connor et al., 2003), Australia Diabetes (Australia Guidelines Development Consortium, 2001), Canada (Canadian Diabetes Association, 1999) and American (Bantle et al., 2008). The growing interest in GI from research, public health and industrial bodies might be due to the positive evidence related to GI on human health and performance in various ways (Brouns et al., 2005; Wolever, 2006).

GI has been used for dietary management of Type 2 Diabetes Mellitus (Mohd Yusof, Abd. Talib, Norimah, Gilbertson, & Azmi, 2010), prevention of Type 2 Diabetes Mellitus (Shyam et al., 2013), weight management (Gustafson & Nitka, 2008; Larsen et al., 2010), cognitive function (Micha, Rogers, & Nelson, 2010; Renata Micha, Rogers, & Nelson, 2011), cardiovascular diseases (Lin, 2011; McKeown et al., 2009; Msc et al., 2013), athletic performance (O'Reilly, Wong, & Chen, 2010; Stevenson et al., 2009) and cancer such as breast cancer (Bertuccio et al., 2009; Dong & Qin, 2011b).

The first International Table of GI has almost 600 foods (Foster-Powell & Miller, 1995). Later, the amount of food being tested were increasing from year to year (Foster-Powell, Holt, & Brand-Miller, 2002). Currently there were about 2480 of food being compiled (Atkinson, Foster-Powell, & Brand-Miller, 2008). Most of the food being tested were staple food, fruits, vegetables, legumes and dairy product (Atkinson et al., 2008). The data quality has been improved for the last

few years but precaution is needed to assign GI values to food because this requires knowledge of local foods (Shyam et al., 2012).

GI is a properties of individual food. An early study in mixed meal discuss the ability to predict glycemic responses to mixed meals from the GI of the constituent foods (Hollenbeck, Coulston, & Reaven, 1986). GI in mixed meals usually predicted based on the sum of the GI contributions of each carbohydrate component of the meal (Wolever & Jenkins, 1986). Some studies revealed, that the predicted GI in mixed meals overestimate the GI value of the meals (Dodd, Williams, Brown, & Venn, 2011; Hatonen et al., 2011). Hence, a new technique has been established to adjust the GI in mixed meal so it is similar to the measured GI in mixed meal. Recently, only one study done by Sun et. al (2014), discuss the similarity found between measured GI and adjusted GI in mixed meal.

1.2 Problem Statement

The applied research on the GI is growing in recent years (Brouns et al., 2005). In Malaysia the applied research on GI (Loh, Daniel Robert, & Jan Mohamed, 2013; Shanita, Hasnah, & Khoo, 2011; Shyam, Kock Wai, & Arshad, 2012) has growing but yet the established GI database for Malaysian foods is still absence. The research in GI testing on Malaysian foods is still at its infancy. There were about 783 foods in food composition table (Tee, 1997) but only 0.06 % had a known GI value. While, from 2,480 data from International Table of Glycemic Index only 0.0004% of food is Malaysian foods which is biscuit (Atkinson, Foster-Powell, & Brand-Miller, 2008). This not absolutely be able to represent Malaysia foods as Malaysian culture comprises of multi-ethnical races. Even a food with known GI value is a similar food from Malaysia, but food that originated from Malaysia is not available. Health professional needs to carefully look into GI International Table to replace it with the similar food (Shyam et al., 2012).

This study choose rice, noodles and *kuih* as test foods based on the survey conducted among GDM mother which are described in details in the methods section. While GI values of rice was previously determine, rice were chosen because over 97% of population in Malaysian consumed rice with average twice daily consumption (A Karim, 2008). Meanwhile, *kuih* were chosen due to limited GI testing done on *kuih* and it is one of the top ten of commonly consumed foods daily (A Karim, 2008). While noodles has been a popular choice among Chinese in Malaysia and as a good alternative for substituting rice among diabetics patients due to its GI value (Robert, 2012).

Furthermore, GI in mixed meal has initiated a controversial as it showed that GI of the individual foods does not apply to mixed meals which contain a combination of carbohydrates along with the protein and fat (Coulston et al.,

1984). Since then, studies has been done to understand the addition of fat and protein in meals as meal is usually consumes as a whole rather than single meal (Brand-Miller & Buyken, 2012). Some study supported that by adding a certain amount of fat and protein to the meal, the GI in mixed meal were lowered than the single meal (George, Garcia, & Edwards, 2014; Kendall, Josse, Esfahani, & Jenkins, 2011; Sun, Ranawana, Leow, & Henry, 2014). However, study in Malaysia showed that the GI in mixed meal were almost similar to the single meal (Daniel Robert & Ismail, 2012). A further study need to be done to confirm this.

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1.3 Significance of the Study

As the research on GI values of Malaysian food is still at its early stage, thus the findings from this study is believed to contribute to the GI values database of local foods. Along with the establishment of GI database Malaysia, health professionals can use it wisely in dietary guidelines and health recommendation.

On the other hand, with the increasing interests of applied research in GI, the findings of this study and along with the development of local GI database, is believed to serve as a basis for GI intervention and health recommendations in the future.

This study has also provided useful information on the methods/ techniques of the GI estimation when to be used in mixed meals. Most of the foods tested in the International Table of GI are single carbohydrate containing food (Atkinson et al., 2008). Health professional need to look carefully to assign GI of food as this require the knowledge of the food to be assigned to food (Shyam et al., 2012).

1.4 Objectives

1.4.1 General Objective

To investigate and estimate the Glycemic Index values of selected commonly consumed foods in Malaysia

1.4.2 Specific Objectives

1. To determine the intra variability within the subject as quality control for the glycemic index testing procedure

2. To determine the glycemic response calculated as incremental area under the curve (iAUC) of healthy subjects after consuming the reference food and test food groups
3. To determine GI value of selected commonly consumed foods in Malaysia
4. To estimate the GI value in mixed meal using predicted and adjusted techniques

1.5 Hypotheses

- Ho 1: There is no significant different between glycemic response calculated as incremental area under the curve raised by the reference food (glucose) and test food groups
- Ho 1: There is no significant different between glycemic index of the reference food (glucose) and test food groups
- Ho 1: The GI in mixed meal cannot be estimated if there was a significant association between prediction techniques and measured GI or adjusted techniques and measured GI.

REFERENCES

S. U. G. I. R. S. (2014). Retrieved 13 May 2015, from Sydney University Glycemic Index Research Service (SUGiRS) http://www.glycemicindex.com/foodSearch.php

A Karim, N., Mohd Yusof, S., Hashim, J. K., Din, M., Haslinda, S., Harun, Z., . . . Norazlin, S. (2008). Food consumption patterns: findings from the Malaysian Adult Nutrition Survey (MANS). Malaysian Journal of Nutrition, 14(1):25-39.

Amira, N. H. (2010). Penentuan Indeks Glisemik Bagi TIga Jenis Kuih Manis Tempatan (Tesis Sarjana Muda), Universiti Kebangsaan Malaysia.

Arvidsson-Lenner, R., Asp, N.-G., Axelsen, M., Bryngelsson, S., Haapa, E., Anette, J., . . . Thorsdottir, I. (2004). Glycaemic index. Relevance for Health, Dietary Recommendations and Food Labelling. Food and Nutrition Research, 48(2):84-94.

Association, C. D. (1999). Guidelines for the Nutritional Management of Diabetes Mellitus in the New Millennium: A Position Statement: The Association.

Atkinson, F. S., Foster-Powell, K., & Brand-Miller, J. C. (2008). International Tables of Glycemic Index and Glycemic Load Values: 2008. Diabetes Care, 31(12):2281-2283.

Bantle, J. P., Wylie-Rosett, J., Albright, A. L., Apovian, C. M., Clark, N. G., Franz, M. J., . . . Mooradian, A. D. (2008). Nutrition Recommendations and Interventions for Diabetes: a Position Statement of the American Diabetes Association. Diabetes Care, 31:S61-S78.

Behall, K. M., & Scholfield, D. J. (2005). Food Amylose Content Affects Postprandial Glucose and Insulin Responses. Journal of Cereal Chemistry, 82(6):654-659.

Bertuccio, P., Praud, D., Chatenoud, L., Lucenteforte, E., Bosetti, C., Pelucchi, C., . . . La Vecchia, C. (2009). Dietary Glycemic Load and Gastric Cancer Risk in Italy. The British Journal of Cancer, 100(3):558-561.

Black, D.D. (1995) Intestinal lipoprotein metabolism. Journal of Pediatric Gastroenterology and Nutrition 20:125–147.

Bornet, F. R., Cloarec, D., Barry, J. L., Colonna, P., Gouilloud, S., Laval, J. D., & Galmiche, J. P. (1990). Pasta Cooking Time: Influence on Starch Digestion and Plasma Glucose and Insulin Responses in Healthy Subjects. The American Journal Of Clinical Nutrition, 51(3):421-427.

Brand, J. C., Nicholson, P. L., Thorburn, A. W., & Truswell, A. S. (1985). Food processing and the Glycemic Index. The American Journal Of Clinical Nutrition, 42(6):1192-1196.

Brand-Miller, J. C., & Wolever, T. (2005). The Use of Glycaemic Index Tables to Predict Glycaemic Index of Breakfast Meals. British Journal of Nutrition, 94(01):133-134.

Brand-Miller, J., & Buyken, A. E. (2012). The Glycemic Index Issue. Current Opinion in Lipidology, 23(1):62-67.

Brand-Miller, J., McMillan-Price, J., Steinbeck, K., & Caterson, I. (2009). Dietary Glycemic Index: Health Implications. Journal of the American College of Nutrition, 28(sup4):446S-449S.

Brennan, C. S., & Brennan, M. A. (2009). Processed Food Products, p511–518.

Brouns, F., Bjorck, I., Frayn, K., Gibbs, A., Lang, V., Slama, G., & Wolever, T. (2005). Glycaemic Index Methodology. Nutrition Research Reviews, 18(01):145-171.

Chen, Y.-J., Sun, F.-H., Wong, S. H.-s., & Huang, Y.-J. (2010). Glycemic Index and Glycemic Load of Selected Chinese Traditional Foods. World Journal of Gastroenterology, 16(12):1512-1517.

Cohen, J. (1977). Statistical Power Analysis for the Behavioral Sciences (rev. Lawrence Erlbaum Associates, Inc.

Connor, H., Annan, F., Bunn, E., Frost, G., McGough, N., Sarwar, T., & Thomas, B. (2003). The Implementation of Nutritional Advice for People with Diabetes. Diabetic Medicine: A Journal of the British Diabetic Association, 20(10):786-807.

Consortium, D. A. G. D. (2001). National Evidence Based Guidelines for the Management of Type 2 Diabetes Mellitus. Primary Prevention. Case Detection and Diagnosis. National Health and Medical Research Council. .

Coulston, A. M., Hollenbeck, C. B., Liu, G., Williams, R., Starich, G., Mazzaferri, E., & Reaven, G. (1984). Effect of Source of Dietary Carbohydrate On Plasma Glucose, Insulin, and Gastric Inhibitory Polypeptide Responses to Test Meals in Subjects with Noninsulin-Dependent Diabetes Mellitus. The American Journal of Clinical Nutrition, 40(5):965-970.

Danaei, G., Finucane, M. M., Lu, Y., Singh, G. M., Cowan, M. J., Paciorek, C. J., . . . Ezzati, M. National, Regional, and Global Trends in Fasting Plasma Glucose and Diabetes Prevalence Since 1980: Systematic Analysis of Health Examination Surveys and Epidemiological Studies with 370 Country-Years And 2·7 Million Participants. The Lancet, 378(9785):31-40.

Dodd, H., Williams, S., Brown, R., & Venn, B. (2011). Calculating Meal Glycemic Index by Using Measured and Published Food Values Compared with Directly Measured Meal Glycemic Index. The American Journal of Clinical Nutrition, 94(4):992-996.

Dong, J.-Y., & Qin, L.-Q. (2011a). Dietary Glycemic Index, Glycemic Load, and Risk of Breast Cancer: Meta-Analysis of Prospective Cohort Studies. Breast Cancer Research and Treatment, 126(2):287-294.

Ebert, R., & Creutzfeldt, W. (1980). Gastric Inhibitory Polypeptide. Clinics in Gastroenterology, 9(3):679-698.

Dong, J.-y., & Qin, L.-q. (2011b). Dietary Glycemic Index, Glycemic Load, and Risk of Breast Cancer: Meta-Analysis of Prospective Cohort Studies. Breast Cancer Research and Treatment, 126(2):287-294.

Foster-Powell, K., Holt, S. H., & Brand-Miller, J. C. (2002). International Table of Glycemic Index and Glycemic Load Values: 2002. The American Journal of Clinical Nutrition, 76(1): 5-56.

Foster-Powell, K., & Miller, J. B. (1995). International Tables of Glycemic Index. The American Journal of Clinical Nutrition, 62(4):871S-890S.

Frei, M., Siddhuraju, P., & Becker, K. (2003). Studies on the in Vitro Starch Digestibility and the Glycemic Index of Six Different Indigenous Rice Cultivars From the Philippines. Journal of Food Chemistry, 83(3):395-402.

George, R., Garcia, A., & Edwards, C. (2014). Glycaemic responses of staple South Asian foods alone and combined with curried chicken as a mixed meal. Journal of Human Nutrition and Dietetics, 28(3):283-291.

Gustafson, R. P., & Nitka, M. (2008). The Glycemic Index and Weight Control. Strength and Conditioning Journal, 30(3):15-16.

Hätönen, K. A., Virtamo, J., Eriksson, J. G., Sinkko, H. K., Sundvall, J. E., & Valsta, L. M. (2011). Protein and Fat Modify the Glycaemic and Insulinaemic Responses to a Mashed Potato-Based Meal. British Journal Of Nutrition, 106(02):248-253.

Hishamuddin A, A. K. G., Easa A.M. (2005). Postprandial Plasma glucos Response and Glyceamic Index of Different Form of a Sago Meal.Paper presented at the Conference of Nutrition Society Malaysia 2005, Kuala Lumpur.

Hollenbeck, C. B., Coulston, A. M., & Reaven, G. M. (1986). Glycemic Effects of Carbohydrates: A Different Perspective. Diabetes Care, 9(6):641-647.

Idris, N., Hatikah, C. C., Murizah, M., & Rushdan, M. (2009). Universal Versus Selective Screening For Detection of Gestational Diabetes Mellitus in a Malaysian Population. Journal of Malaysian Family Physician, 4(2&3):83-87.

Itoh, K., Kawamura, S., & Ikeuchi, Y. (1985). Processing and Milling of Parboiled Rice. Journal of the Faculty of Agriculture-Hokkaido University (Japan), 62(3):312-324.

Jenkins, D., Wolever, T., Taylor, R. H., Barker, H., Fielden, H., Baldwin, J. M., . . . Goff, D. V. (1981). Glycemic Index of Foods: A Physiological Basis for Carbohydrate Exchange. The American Journal of Clinical Nutrition, 34(3):362-366.

Jenkins, D. J., Kendall, C. W., Augustin, L. S., Franceschi, S., Hamidi, M., Marchie, A., . . . Axelsen, M. (2002). Glycemic Index: Overview of Implications in Health and Disease. The American Journal of Clinical Nutrition, 76(1):266S-273S.

Jones, J. M. (2012). Glycemic Index: The State of the Science, Part 1—The Measure and Its Variability. Journal of Nutrition Today, 47(5):207-213

Juliano, B., Perez, C., Komindr, S., & Banphotkasem, S. (1989). Properties of Thai Cooked Rice and Noodles Differing In Glycemic Index in Noninsulin-Dependent Diabetics. Plant Foods for Human Nutrition, 39(4):369-374.

Kaur, B., Ranawana, V., & Henry, C. J. K. (2014). The Glycaemic Index of Rice and Rice Products: A Review, and Table Of GI Values. Critical Reviews In Food Science And Nutrition, 56(2):215-236

Kelly, K. R., Haus, J. M., Solomon, T. P. J., Patrick-Melin, A. J., Cook, M., Rocco, M., . . . Kirwan, J. P. (2011). A Low-Glycemic Index Diet and Exercise Intervention Reduces TNF[alpha] in Isolated Mononuclear Cells of Older, Obese Adults. The Journal of Nutrition, 141(6):1089-1094.

Kendall, C., Josse, A., Esfahani, A., & Jenkins, D. (2011). The Impact of Pistachio Intake Alone or in Combination with High-Carbohydrate Foods on Post-Prandial Glycemia. European Journal of Clinical Nutrition, 65(6):696-702.

Larsen, T. M., Dalskov, S.-M., van Baak, M., Jebb, S. A., Papadaki, A., Pfeiffer, A. F., . . . Pihlsgård, M. (2010). Diets with High or Low Protein Content and Glycemic Index for Weight-Loss Maintenance. New England Journal of Medicine, 363(22):2102-2113.

Lee M.C & Nik Shanita S. (2005). Determination of Glyceamic Index in Three Types of Dumplings with Red Bean, Lotus Seed and Curry Chicken in Local Market. Paper presented at the Conference of Nutrition Soceity Malaysia 2005, Kuala Lumpur.

Lee, S. & Nik Shanita. S. (2005). Determination of Glycemic Index of Three Commercial Rice Varieties Eaten Together with Curr y Chicken in Local Market. Paper presented at the Conference of Nutrition Society of Malaysia 2005, Kuala Lumpur.

Letchuman, G., Wan Nazaimoon, W., Wan Mohamad, W., Chandran, L., Tee, G., Jamaiyah, H., . . . Ahmad Faudzi, Y. (2010). Prevalence of Diabetes in the Malaysian National Health Morbidity Survey III 2006. Med Journal of Malaysia, 65(3):180-186.

Loh, B.-l., Sathyasurya, D. R., & Jan Mohamed, H. J. (2013). Plasma Adiponectin Concentrations are Associated with Dietary Glycemic Index in Malaysian Patients With Type 2 Diabetes. Asia Pacific Journal of Clinical Nutrition, 22(2):241.

Magalona, M., Solivas, J., Merca, F., & Fitzgerald, M. (2012). Physicochemical Characterization and Grain Quality Evaluation of Three varieties of Red Rice from Bohol, Philippines. Philippine Journal of Crop Science (Philippines).

Malaysian Dietitians' Association, M. o. H. (2013). Medical Nutrition Therapy for Type 2 Diabetes Mellitus (T2DM) (2nd Edition ed.).

McKeown, N. M., Meigs, J. B., Liu, S., Rogers, G., Yoshida, M., Saltzman, E., & Jacques, P. F. (2009). Dietary Carbohydrates and Cardiovascular Disease Risk Factors in the Framingham Offspring Cohort. Journal of the American College of Nutrition, 28(2):150-158.

Micha, R., Rogers, P., & Nelson, M. (2010). The Glycaemic Potency of Breakfast and Cognitive Function in School Children. European Journal of Clinical Nutrition, 64(9):948-957.

Micha, R., Rogers, P. J., & Nelson, M. (2011). Glycaemic Index and Glycaemic Load of Breakfast Predict Cognitive Function and Mood in School Children: A Randomised Controlled Trial. British Journal of Nutrition, 106(10):1552-1561.

Miller, J. B., Pang, E., & Bramall, L. (1992). Rice: A High or Low Glycemic Index Food? The American Journal of Clinical Nutrition, 56(6):1034-1036.

Mitchell, Suzanne H. (1999). Measures of Impulsivity in Cigarette Smokers and Non-Smokers." Journal of Psychopharmacology. 146(4): 455-464.

Ministry of Health, M. (2009). Clinical Practice Guidelines (CPG) on Management of Type 2 Diabetes Mellitus (T2DM)

Mohd Yusof, B. N., Abd. Talib, R., Karim, N. A., Kamarudin, N. A., & Arshad, F. (2008). Glycaemic Index of Four Commercially Available Breads in Malaysia. International Journal of Food Sciences and Nutrition, 60(6):487-496.

Msc, S., Sohrab, G. M., Asghari, G. M., Mirmiran, P. P., Moslehi, N. M., & Azizi, F. M. D. (2013). Dietary Glycemic Index, Glycemic Load, and Cardiovascular Disease Risk Factors: Tehran Lipid and Glucose Study. Archives of Iranian Medicine, 16(7):401-407.

Ngan, H., Barakatun Nisak, MY. , Amin Ismail , Mohd Faez, hB., Jeevetha, S. . (2012, 24-25 May 2012). Glycemic Index Values of Selected Commercialized Rice in Malaysia. Paper presented at the Current Concerns and Challenges in Nutrition, Crowne Plaza Mutiara Hotel, Jalan Sultan Ismail, Kuala Lumpur.

Nik Shanita, S. (2005 (Unpublished)). Pembangunan dan Penentuan Indeks Glisemik Serta Jenis Karbohidrat Makanan Pilihan Atlet Ketahanan Tinggi. Tesis Dr. Falsafah. Jabatan Pemakanan dan Dietetik, Universiti Kebangsaan Malaysia.

Nisak, M. Y. B., Abd. Talib, R., Norimah, A. K., Gilbertson, H., & Azmi, K. N. (2010). Improvement of Dietary Quality with the Aid of a Low Glycemic Index Diet In Asian Patients With Type 2 Diabetes Mellitus. Journal of the American College of Nutrition, 29(3):161-170.

Nor Muaiza, A. N. S., S. . (2005). Determination of Glycaemic Index of White Bread with Different Types of Spreads. Paper presented at the Youth & Nutrition, the Future of the Nation, Kuala Lumpur.

O'Reilly, J., Wong, S. H., & Chen, Y. (2010). Glycaemic Index, Glycaemic Load and Exercise Performance. Journal of Sports Medicine, 40(1):27-39.

Organisation, I. S. (2010). ISO 26642–2010. Food Products—Determination of the Glycaemic Index (GI) and Recommendation for Food Classification.

Owen, B., & Wolever, T. M. (2003). Effect of Fat on Glycaemic Responses in Normal Subjects: A Dose-Response Study. Nutrition Research, 23(10):1341-1347

Sara, P, . (2011). Acute Effect on Selected Four Common Beverages on Blood Glucose in Healthy Adult. (Master Thesis), Universiti Kebangsaan Malaysia.

Pieters, M., & Jerling, J. C. (2005). Measuring the Glycaemic Index-Consensus and Issues of Debate. South African Journal of Clinical Nutrition, 18(3):232-236.

Radulian, G., Rusu, E., Dragomir, A., & Posea, M. (2009). Metabolic Effects of Low Glycaemic Index Diets. Journal of Nutritions, 8(5):5-9.

Ramlah, G. G., AL. Edwards, C. (2013). Glyceamic Index of A Rice And Chicken Curry Meal. Paper presented at the Promoting Better Nutrition For All, Renaissance Hotel,Kuala Lumpur.

Rani, M. R., and K. R. Bhattachrya. (1995). Microscop of Rice Starch Granules During Cooking. Starch-Stärke 47(9): 334-337.

Rashmi, S., & Urooj, A. (2003). Effect of Processing on Nutritionally Important Starch Fractions in Rice Varieties. International Journal of Food Sciences And Nutrition, 54(1):27-36.

Richieri, G.V., Ogata, R.T., Zimmerman, A.W., Veerkamp, J.H. and Kleinfeld, A.M. (2000) Fatty Acid Binding Proteins from Different Tissues Show Distinct Patterns of Fatty Acid Interactions. Journal of Biochemistry, 39:7197–7204.

Robert, S. D., & Ismail, A.-S. (2011). Glycemic Responses of Patients with Type 2 Diabetes to Individual Carbohydrate-Rich Foods and Mixed Meals. Annals of Nutrition and Metabolism, 60(1):27-32.

Robert, S. D., & Ismail, A. A.-S. (2009). Two Varieties of Honey that are Available in Malaysia Gave Intermediate Glycemic Index Values when Tested Among Healthy Individuals. Biomedical Papers of the Medical Faculty of Palacky University in Olomouc, 153(2):145-147.

Robert, S. D., Ismail, A., Winn, T., & Wolever, T. (2008). Glycemic Index of Common Malaysian Fruits. Asia Pacific Journal of Clinical Nutrition, 17(1):35-39

Salmeron, J., Manson, J. E., Stampfer, M. J., Colditz, G. A., Wing, A. L., & Willett, W. C. (1997). Dietary Fiber, Glycemic Load, and Risk Of Non—Insulin-Dependent Diabetes Mellitus In Women. Journal of American Medical Association, 277(6):472-477.

Sathyasurya, D. R., Ismail, A. A.-s., Nik, W. S. B. W., & Muda, W. M. W. (2006). Determination of the Glycaemic Index of Selected Malaysian Foods. International Medical Journal Tokyo, 13(4):255-259.

Shanita, S., Hasnah, H., & Khoo, C. (2011). Amylose and Amylopectin in Selected Malaysian Foods and its Relationship to Glycemic Index. Journal of Sains Malaysiana, 40(8):865-870.

Shyam, S., Arshad, F., Abdul Ghani, R., Wahab, N. A., Safii, N. S., Barakatun Nisak, M., . . . Kamaruddin, N. A. (2013). Low Glycaemic Index Diets Improve Glucose Tolerance and Body Weight in Women with Previous History of Gestational Diabetes: A Six Months Randomized Trial. Nutrition Journal, 12(1):68.

Shyam, S., Kock Wai, T. N., & Arshad, F. (2012). Adding Glycaemic Index and Glycaemic Load Functionality to Dietplus, A Malaysian Food Composition Database and Diet Intake Calculator. Asia Pacific Journal of Clinical Nutrition, 21(2):201.

Sieri, S., Krogh, V., Berrino, F., Evangelista, A., Agnoli, C., Brighenti, F., . . . Sacerdote, C. (2010). Dietary Glycemic Load and Index and Risk of Coronary Heart Disease in a Large Italian Cohort: the EPICOR Study. Archives of Internal Medicine, 170(7):640-647.

Standard, A. (2007). Glycemic Index of Food. Sydney: Standards Australia.

Stevenson, E. J., Thelwall, P., Thomas, K., Smith, F., Brand-Miller, J., & Trenell, M. I. (2009). Dietary Glycemic Index Influences Lipid Oxidation but Not Muscle or Liver Glycogen Oxidation During Exercise. American Journal Of Physiology Endocrinology and Metabolism, 296(5):1140-1147.

Sugiyama, M., Tang, A., Wakaki, Y., & Koyama, W. (2003). Glycemic Index of Single and Mixed Meal Foods Among Common Japanese Foods with White Rice as a Reference Food. European Journal of Clinical Nutrition, 57(6):743-752.

Sun, L., Ranawana, D. V., Leow, M. K.-S., & Henry, C. J. (2014). Effect of Chicken, Fat and Vegetable on Glycaemia and Insulinaemia to a White Rice Based Meal in Healthy Adults. European Journal Of Nutrition, 53(8): 1719-1726.

Syahariza, Z. A., Sar, S., Hasjim, J., Tizzotti, M. J., & Gilbert, R. G. (2013). The Importance of Amylose and Amylopectin Fine Structures for Starch Digestibility in Cooked Rice Grains. Journal of Food Chemistry, 136(2):742-749.

Tan, P. C., Ling, L. P., & Omar, S. Z. (2007). Screening for Gestational Diabetes at Antenatal Booking in a Malaysian University Hospital: The Role of Risk Factors and Threshold Value For The 50g Glucose Challenge Test. Australian And New Zealand Journal of Obstetrics and Gynaecology, 47(3):191-197.

Vrolix, R., & Mensink, R. P. (2010). Variability of the Glycemic Response to Single Food Products in Healthy Subjects. Journal of Contemporary Clinical Trials, 31(1):5-11.

Walter, M., da Silva, L. P., & Denardin, C. C. (2005). Rice and Resistant Starch: Different Content Depending on Chosen Methodology. Journal of Food Composition and Analysis, 18(4):279-285.

Wan Mohamud, W. N., Musa, K. I., Md Khir, A. S., Ismail, A. a.-S., Ismail, I. S., Kadir, K. A., . . . Ali, O. (2011). Prevalence of Overweight and Obesity Among Adult Malaysians: an Update. Asia Pacific Journal Of Clinical Nutrition, 20(1):35.

Wolever, T., Vorster, H., Björck, I., Brand-Miller, J., Brighenti, F., Mann, J., . . . Perry, T. (2003). Determination of the Glycaemic Index of Foods: Interlaboratory Study. European Journal of Clinical Nutrition, 57(3):475-482.

Wolever, T. M., Yang, M., Zeng, X. Y., Atkinson, F., & Brand-Miller, J. C. (2006). Food glycemic index, as given in Glycemic Index Tables, is a Significant Determinant of Glycemic Responses Elicited by Composite Breakfast Meals. The American Journal of Clinical Nutrition, 83(6):1306-1312.

Wolever, T. M., Brand-Miller, J. C., Abernethy, J., Astrup, A., Atkinson, F., Axelsen, M., . . . Brynes, A. (2008). Measuring the Glycemic Index of Foods: Interlaboratory Study. The American Journal of Clinical Nutrition, 87(1):247S-257S.

Wolever, T. M., & Jenkins, D. (1986). The Use of the Glycemic Index in Predicting the Blood Glucose Response to Mixed Meals. The American Journal Of Clinical Nutrition, 43(1):167-172.

Wolever, T. M. S. (2006). The Glycaemic Index: A Physiological Classification of Dietary Carbohydrate: CABI.

Wolever, T. M. S. (2013). Is Glycaemic Index (GI) a Valid Measure Of Carbohydrate Quality & Quest. European Journal Of Clinical Nutrition, 67(5):522-531.

Wolever, T. M. S., Jenkins, D. J., Kalmusky, J., Jenkins, A., Giordano, C., Giudici, S., . . . Wong, G. S. (1986). Comparison of Regular and Parboiled Rices: Explanation of Discrepancies Between Reported Glycemic Responses To Rice. Nutrition Research, 6(4):349-357.

Wolever, T. M. S., Vorster, H. H., Bjorck, I., Brand-Miller, J., Brighenti, F., Mann, J. I., . . . Xiaomei, W. (2003). Determination of the Glycaemic Index of Foods: Interlaboratory Study. European Journal of Clinical Nutrition, 57(3):475-482.

Yusof, B. N. M., Talib, R. A., & Karim, N. A. (2005). Glycaemic Index of Eight Types of Commercial Rice in Malaysia. Malaysian Journal of Nutrition, 11(2):151-163.