GLYCEMIC INDEX AND POST-PRANDIAL BLOOD GLUCOSE RESPONSE OF NON DIABETIC INDIVIDUAL TO SOME COMMONLY CONSUMED FRUITS

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Abstract

This study examined the glycemic index and post prandial blood glucose response of non-diabetic students of The Federal Polytechnic Ilaro to ripe banana, water melon and pineapple. A total number of ten (10) students were conveniently selected for the study anthropometry (height and weight) measurement was taken using standard procedure. Blood glucose test was done with the aid of Accu-Check glucometer. The glycemic response curve was calculated using trapezoidal rule and the glycemic index (GI) of the sample was estimated by the relationship between the area under the curve for the test fruit and the area under the curve for the glucose D (standard – 100%). Postprandial blood glucose was obtained 30 minute, 60 minute, 90 minute and 120 minute respectively. Data obtained was analyzed using SPSS v.20.0. The result showed that, watermelon had the highest glycemic index (84.74), followed by pineapple (79.92) while banana had the least glycemic index (64.95). Watermelon had the mean postprandial blood glucose response (PBGR) of 107.75±15.0 mmol (30 min), 97.0±16.77mmol (60 min), 90.0±16.77mmol (90 min) and 97.5±10.21mmol (120 min). Pineapple had the mean PBGR of 111.50±14.74mmol (30 min), 86.0±9.02mmol (60 min), 84.25±7.94mmol (90 min) and 74.0±48.50mmol (120 min) respectively while banana had the mean PBGR of 96.25±12.02mmol (30 min), 60.75±20.53mmol (60 min), 65.0±3.31mmol (90 min) and 60.75±2.85mmol (120 min). In conclusion, highest glycemic index was discovered in watermelon and the postprandial blood glucose response of all the samples studied was highest at 30 min with pineapple and banana having the highest and the least value of 112 mmol and 61mmol respectively.

Keywords: Blood glucose, Diabetics, Post-prandial

Introduction

World Health Organization (WHO) defines diabetes as a chronic disease condition that occurs when the pancreas does not produce enough insulin or when the body cannot effectively utilize the insulin the body produces. Type 2 diabetes mellitus (T2DM) is one of the main causes of mortality and morbidity worldwide. The major effect of type II diabetes mellitus is its significant impact on the quality of life, there posing a serious threat to community (WHO, 2010). Thus, it's necessary to identify, know and modify the risk factors that would eventually lead to preventing the development of this major health issue, one of the major risk factor been diet. Diet modification is one of the key areas in the management of diabetes mellitus. Diet has played a major role in the prevention and management of diabetes and adequate knowledge about the right combination of these foods can also help to either prevent or predispose an individual to diabetes. Foods have different levels of glycemic index, and glycemic index is the level at which food increases the blood glucose level. Many of studies have been done to determine the glycemic index of different Nigerian foods and its effect on postprandial blood glucose (Balogun, 1992, Ohwovoriole & Johnson, 1983), but only a few has been done on the plasma glucose response to fruits. Fruit is a very important component of an adequate diet, and adequate diet is one of the ways of preventing the onset and development of type II diabetes. There are various types of fruits widely available in Nigeria, which are often used as desserts, snacks, and also in mixed meals. Edo & Oladele (2005), studied that pineapple had higher postprandial glycemic response than apple in normal glucose tolerant Nigerians. However, it yet to be known which commonly available fruits in Nigeria are suitable for inclusion in the diet of persons with diabetes mellitus especially with regards to their plasma glucose responses. Majority of Nigerian populace consumes fruit often, because it's readily available in the environment without knowing the effect it has on their blood glucose level and how some of these fruits can increase their blood glucose level. Fructose is the sugar gotten from fruit, and individual consuming high fructose diet have increased the likelihood of weight gain and its associated metabolic disorders (Elliott *et al.,* 2002). Thus, this study evaluates the post prandial glucose response of some fruits commonly eaten in in Nigerian with a view of identifying suitable fruits for the diet of persons with diabetes mellitus using non-diabetes students of The Federal Polytechnic Ilaro students.

Methodology

Sample Selection

Ten (10) healthy students (five male and female between the eighteen and twenty two years old) were randomly selected from The Federal Polytechnic, Ilaro. Informed consent was provided to the respondents and their consent was given. Ethical approval was obtained from the ethical committee of the Polytechnic, Ilaro. Anthropometric measurements (Height and weight) of the study population was taken using standard procedure, body mass index was calculated and compared to that of reference standard.

Sample Preparation and Reference Food Standard

The fruits were gotten from the popular market in Ilaro (Saydero). The fruits were washed, peeled and served fresh. Only edible part of the fruit was eaten. Glucose D manufactured by Evans was used as the control food sample. The nutritional composition of the fruits was extracted from food composition table and the quantity of the fruits that is equivalent to 50g of carbohydrate was consumed by the subjects. Also the quantity of glucose D that contain 50g equivalent of carbohydrate was also measured and dissolved in 250ml water and was used as the control food sample

Research Procedure:

The subjects were asked to fast overnight (for at least 12 hours) and visited the dietetic kitchen of the Nutrition and Dietetics Department, the Federal Polytechnic Ilaro on four separate days to consume the control sample (glucose D), sample 1(watermelon), sample 2(pineapple) and sample 3(banana) on a separate day and the test day was separated by one week. On the test day, the subject were asked to rest for thirty minute before the commencement of the procedure, followed by the measurement of the fasting blood glucose of each of the subject, after which the quantity of each sample that is equivalent to 50g of carbohydrate (table 1) was consumed by the subjects on the stipulated day within the period of fifteen minute. The postprandial blood glucose level was then measured using Acu check glucometer at thirty (30) minute, sixty (60), ninety (90) minute and one hundred and twenty (120) minute after the consumption of the test sample. The result was then used to construct a glycemic response curve, to determine the glycemic index (G.I) and glycemic load (GL). Glycemic response curve was calculated using trapezoidal rule and glycemic index was calculated as:

$$GI = \frac{blood\ glucose\ area\ under\ the\ test\ curve\ of\ fruit\ sample}{blood\ glucose\ area\ under\ the\ curve\ of\ the\ equivalent\ carbohydrate} \times 100$$

The glycemic load (GL) of each food was calculated according to the following equation:

$$GL = \frac{\text{Glycemic index (glucose as standard)}\, g \times \text{available carbohydrate (g) per portion}}{100}$$

Anthropometry measurement

The weight was taken while standing with both hands by the side and with only light clothing. It was ensured that the pointer of the weighing scale was adjusted to the point zero before each weight measurement and was recorded to the nearest kilogram. In measuring the height of the respondents, a locally constructed but standardized height meter was used and it was placed at the back of the heel of each subject, the height was taken while standing with the head placed against the height meter and the level just above the hair mark was recorded to the nearest meter. Body mass index (BMI) was calculated which is weight in kilogram divided by the square of the subject's height in meters (kg/m^2) was computed using the measurement gotten from the height and weight measurement and was compared with that of WHO reference standard (WHO, 2000)

Data Analysis

Data obtained was subjected to statistics analysis using S.P.S.S. version 20.00. Descriptive statistics like mean, standard deviation was used to describe the variables.

Ethical considerations

Ethical clearance was gotten from the Research and ethical clearance committee of the Federal Polytechnic, Ilaro.

Informed consent

Informed consent was obtained from the respondents and the purpose of the research work was made known to the respondents.

RESULTS

Table 1 shows the quantity of the sample consumed by the study population. 50g of glucose (control sample) was dissolved in 250mls of water while 769g, 417g and 219g of the test sample (watermelon, pineapple and banana) was consumed respectively.

Table 1: Weight of test fruits fed to subjects

S/N	Samples	Carbohydrate content (g)	Available carbohydrate(g)	Sample Fed (g)
1	Glucose solution	50	50	50
2	Watermelon	22.84	50	769
3	Pineapple	12.0	50	417
4	Banana	6.50	50	219

Table 2 shows the mean and anthropometry measurement of the respondents based on gender. The female respondent mean age, weight, height and BMI was 22±3.03 years, 55.8±3.01kg, 1.61±0.06m, and 21.32±1.46kg/m^2 respectively, while the male respondent was 24.3±0.37 years, 66±4.97kg, 1.71±0.01m and 22.63±1.39kg/m^2 respectively.

Table 2: Mean Age and anthropometric measurement of respondents based on gender

Gender	Age (years)	Weight (kg)	Height (m)	Body mass index (kg/m^2)
Female	22±3.03	55.8±3.01	1.61±0.06	21.32±1.46
Male	24.3±0.37	66±4.97	1.71±0.01	22.63±1.39

Table 3 shows the glycemic index and incremental area under the curve for glucose solution and the test food sample, the area under the curve for glucose was 13,545, which is the highest among the sample, it also has the highest glycemic index 100; watermelon follows closely with 11,479 as its area under the curve and 84.74 as its glycemic index; for pineapple, the area under the curve was 10,826, while its glycemic index is 79.92; banana however has the lowest area under the curve with 8798 and its glycemic index is also the lowest 64.95.

Table 3: Glycemic index and incremental Area under the curve for glucose and fruit samples

S/N	Samples	Area under the curve	GI(Sample/area of glucose)×100
1	Glucose	13545	100
2	Watermelon	11479	84.74
3	Pineapple	10826	79.92
4	Banana	8798	64.95

Table 4 shows mean and standard deviation of blood glucose response of respondents to the control and the test sample. The mean and standard deviation of the fasting blood glucose of the respondents on day one, two, three and four were 68.0±5.2mmol (glucose), 78.0±9.4mmol (watermelon), 84.25±3.34mmol (pineapple) and 81.75±4.08mmol (banana) respectively. Also postprandial blood glucose response of the respondent at 30min , 60min, 90 min and 120 min to watermelon was 107.75±15.0mmol, 97.0±16.77mmol, 90.0±16.77mmol and 97.5±10.21mmol respectively. At 30 min, 60 min, 90 min and 120 min after the consumption of pineapple, the mean postprandial blood glucose level of 111.50±14.74mmol, 86.0±9.02mmol, 84.25±7.94mmol and 74.0±48.50mmol was discovered among the study population. Lastly postprandial blood glucose level of the respondent to banana was 96.25±12.02 (30min), 60.75±20.53 (60min), 65.0±3.31 (90 min) and 60.75±2.85 (120 min).

Table 4: Mean and standard deviation of blood glucose response of respondents base on different fruit samples

Samples	FBG (mmol)	30 minutes (mmol)	60 minutes(mmol)	90 minutes (mmol)	120 minutes (mmol)
Glucose	68.0±5.2	108.25±13.74	145.5±42.15	113.75±4.96	98.5±12.25
Watermelon	78.0±9.4	107.75±15.0	97.0±23.71	90.0±16.77	97.5±10.21
Pineapple	84.25±3.34	111.5±14.74	86.0±9.02	84.25±7.94	74.0±48.5
Banana	81.75±4.08	96.25±12.02	60.75±20.53	65.0±3.31	60.75±2.85

Table 5 shows the glycemic load of glucose and fruit samples, it shows that glucose has the highest glycemic load 25, followed by watermelon with 11.4, then followed by pineapple 6.0, of all the fruit samples, banana has the lowest glycemic load with 3.3.

Table 5: Shows the glycemic load of fruit samples

S/N	Samples	Glycemic Load
1	Glucose	25
2	Watermelon	11.4
3	Pineapple	6.0
4	Banana	3.3

Discussion

The glycemic index for watermelon, pineapple and banana are 84.74, 79.92 and 64.95 respectively. According to this study, banana has the lowest glycemic index among the fruit samples. The glycemic index of banana was 64.95 which was lower to 74.9 and 79 for over-ripe banana documented by Hermansen *et al.,* 1992 and Jenkins *et al.,* 1987 respectively. This tropical fruit is different in their postprandial glucose responses and may have arisen because of differences in the monosaccharide composition, fiber content, how ripe the fruit is and might also be due to the amount of fruit that was eaten. However, according to Ercan *et al.,* 2009, there was little difference in blood glucose responses to bananas of various ripping degree thereby indicating that other factors may be responsible for the variation in blood glucose responses to the fruits. There was no trusted way of ensuring that the same degree of ripeness of all the fruits was consumed in this study which could be responsible for the variation in the values obtained.

Watermelon was classified as high sugar fruits (Yativ *et al.,* 2012) and its glycemic index according to International glycemic index Tables (Foster-Powell *et al.*, 2002) was recorded to be 72 which is lower to the value obtained in the present study. Also, the glycemic index value obtained in this study is higher than the value reported by Trinidad *et al.,* 2010, Robert *et al.,* 2008 and Barakatun *et al.,* 2005 and this give credence to the findings of Yativ *et al.,* 2010 that watermelon is a high in sugar. These notable differences in the glycemic index maybe as a result of many factors that can affect the value of the glycemic index, such as the component of the sugar, the matrix structure of the sample and can also be as a result of the quantity of watermelon that was consumed by the subjects. Other internal factors such as fiber content, maturity stage, fat content and presentation of anti-nutrient can also affect the glycemic index (Yativ *et al.,* 2010). According to Robert *et al.,* (2008), the component of dietary fiber might influence the glycemic index by delaying the digestion and slow the blood glucose response. Significant differences were noted in the glucose responses of the test fruits (Watermelon, Pineapple and Banana) and were discovered at some points in time when test fruits were compared to glucose. This discovery was then compared to the study of Wolever & Miller, (1995) where the glucose responses of the fruits eaten were significantly lower than those after tests using glucose at one or more points in time. The result was attributed to the sugar content of fruits consisting mainly of fructose, and sucrose, all of which were found to lower blood glucose responses than glucose (Wolever *et al*., 1993). The sugar gotten from fruit is fructose. It is absorbed slowly into the body and its ability to increase the postprandial blood glucose is definitely lower when compared to than that of the other carbohydrate sources (Wills *et al.,* 1998). When the body is in normal conditions, fruit sugar (fructose) is converted mainly to glucose, glycogen and lactate, and to a small extent triglycerides. It was note that the natural sugars present in fruit and also fruit juices resulted in reduced blood glucose level when compared with most starchy carbohydrate foods that are refined, because it is easily used and metabolized by the liver in both normal and type II diabetic patients (Uusitupa, 1994).

The portions of the fruits that was served had 50g of carbohydrate content which were quite large especially those of watermelon and pineapple. If the portion of the fruits were smaller, it would probably have given smaller blood glucose responses. In subsequent studies on fruits, 25g carbohydrate equivalent portions should be used. The limitations of this study was the inability to determine the monosaccharide composition of the fruits and to determine the degree of ripeness of the fruits, although this did not stop it from getting useful data on the postprandial response to the consumption of watermelon, pineapple, and banana.

In conclusion, among the three fruit samples, banana was found to have a low glycemic index and lower post prandial blood glucose response compared to the other fruits used in the study, then followed by pineapple and lastly watermelon.

References

Balogun, A. O. (1992). Glycemic indices of some common Nigerian meals. *Part II dissertation of the National Postgraduate Medical College of Nigeria, Lagos*

Barakatun, M. Y., Ruzita, A. T. & Norimah, A. K. (2005). A Study of Blood Glucose Response Following Temperate and Tropical Fruit Ingestion in Healthy Adults. *Malaysian Journal of Nutrition* 11(1): 47-57.

Edo, A. E & Oladele C. (2005). Blood glucose responses to pineapple and apple: Two fruits with similar nutrient compositions. *Nigeria Journal of General Practice*.; 7: 21–27

Elliott, S. S., Keim, N. L., Stern, J. S., Teff K., & Havel, P. J. (2002). Fructose, weight gain, and the insulin resistance syndrome. *Am. J. Clin. Nutr*. **76**: 911–922.

Ercan, N., Nuttall, F. Q., Gannon, M. C., Lane, J. T., Burmeister, L. A. & Westphal, S.A., (2009) Plasma glucose and insulin responses to bananas of varying ripeness in persons with noninsulin-dependent diabetes mellitus. *J Am Coll Nutr. X*; 12: 703- 9.

Foster-Powell, K., Holt, S. H. & Brand-Miller, J. C., (2002). International table of glycemic index and glycemic load values. *American Journal of Clinical Nutrition* 76: 5-56

Hermansen, K., Rasmussen, O., Gregersen, S., Larsen, S., (1992) Influence of ripeness of banana on the blood glucose and insulin response in type 2 diabetic subjects. *Diabet Med*. ; 9:739-43.

Hulme, A. C. (2010) the biochemistry of fruits and their products. New York: McGraw Hill Book *International Journal of Food Properties*. 2010; 13(3):486-497.

Jenkins, D. J. A., Wolever, T. M. S., Collier, G. R., Ocana, A., Rao, A. V. & Buckley, G. (1987) metabolic effects of a low glycemic- index diet. Am J Clin Nutr; 46: 968_75. *Journal of Chromatography A* 1078: 196–200.

Ludwig, D. S (2003) Dietary glycemic index and the regulation of body weight. *Cross RefGoogle ScholarPubMed* 38, 117–121.

Ohwovoriole, A. E. & Johnson, T. O. (1983) Glycaemic response to some Nigerian meals: A comparison with oral glucose tolerance test. *W Afr Med J*., 2: 81–86.

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

Trinidad, P. T., Aida, C. M., Rosario, S. S. & Rosario, R. E. (2010). Glycemic index of coconut flour products in normal and diabetic subjects. *Journal of Functional Foods* 2: 271-274.

Uusitupa, M., (1994) Fructose in the diabetic diet *Am J Clin Nutr*; 59: 753s–757

Wills, R. B. H., Brand Miller, J. C. & Matawie, K. M., (1998) Relationship between glycaemic index and nutrient composition of fruits and vegetables. *Int J Food Prop*; 1: 89–94.

Wolever, T. M. S., & Miller, J. B. (1995) Sugars and blood glucose control. *Am J Clin Nutr*; 62: 212s–217

Wolever, T. M. S., Vuksan, V., Relle, L., Jenkins, A., Josse, R., Wong, G. & Jenkins, D., (1993) Glycemic index of fruits and fruit products in patients with diabetes. *Int J Foods Sc Nutr* ; 43: 205–212.

World Health Organization (2000). Turning the tide of malnutrition: Responding to the challenges of the 21st ceuntry. Geneva: WHO (WHO/NHD/00.7)

World Health Organization (2010). Global Status Report on Non-communicable Diseases; World Health Organization: Geneva, Switzerland.

Yativ, M., Harary, I. & Wolf, S. (2010). Sucrose accumulation in watermelon fruits: Genetic variation and biochemical analysis. *Journal of Plant Physiology* 167: 589-596.