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Impact of Diabetes-Formulated Oral Nutritional Supplement versus Instant Cocoa Drink and 3-in-1 Oatmeal on Postprandial Glucose

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Abstract: **The glycemic index (GI) is a numerical index that ranks carbohydrates based on their rate of glycemic response, the conversion of glucose within the human body as well as their effect on postprandial glycemic. It was assumed to apply to foods that primarily deliver available carbohydrate, causing hyperglycemia. Low-GI foods were classified as being slowly digested and absorbed and high-GI foods as being rapidly digested and absorbed, resulting in different glycemic responses. Thus, a cross sectional study was conducted to determine the impact of diabetes-formulated oral nutritional supplement versus instant cocoa drink and 3-in-1 oatmeal on postprandial glucose. A total of 39 individuals were selected (mean age 30.74 ± 5.75 years) through a convenient sampling. Participants were given different drink samples and their respective blood glucose levels were measured in a specific time frame within 2 hours. Based on the assumption of glucolin (GC) with the GI of 100, diabetes-formulated oral nutrition supplement, Metabolic® Sauver (MS) has a low GI value of 26.84 ± 16.53, whereas instant cocoa drink (CC) and 3-in1 oatmeal (OM) both have a medium GI value of 68.95 ± 36.38 and 60.49 ± 20.37 respectively. In conclusion, high GI value food were associated fluctuation blood glucose and higher risk of various diseases whereas low GI value food are particularly useful especially in diabetic patient for better control of glucose levels.**

Keywords: **diabetes formula, glycemic index, post-prandial blood glucose.**

1. INTRODUCTION

Diabetes is a public health concern worldwide. According to World Health Organization (WHO), the number of diabetic has increased from 108 million in 1980 to 422 million in 2014, and the prevalence of diabetes among adults age 18 and above has doubled from 4.7% in 1980 to 8.5% in 2014. (WHO, 2016) In recent studies, researchers indicate that elevated blood glucose is an independent and clinically proven significant risk factor for cardiovascular disease in diabetic and non-diabetic individuals. (O'Keefe & Bell, 2007) Thus, isolated 2-hour postprandial glucose level more than 7.8 mmol/L in spite of normal fasting plasma glucose and normal HbA1c values is associated with an increased risk of death from cardiovascular disease by 2-folds. (Gerich, 2003)

Since 1998, glycemic index (GI) has been recommended to guide in making correct food choices (FAO/WHO, 1998) because low GI foods have shown to improve blood glucose control in diabetics (Brand-Miller et al., 2003). The glycemic index (GI) is a measure of the extent to which the carbohydrate in a food can raise blood glucose concentration; it also helps in identifying foods which may be beneficial to diabetics. (Hermansen et al., 2006) Carbohydrates in different foods produce different blood glucose curves after ingestion. The GI was introduced to express the rise of blood glucose after eating a food against a standard blood glucose curve after glucose. GI ranges from as low as about 20 for fructose and

whole barley to as high as about 100 for glucose and baked potato. GI of a food can be affected by its physical form and processing. GI can be reduced by adding fat or protein into the food, presumably by delayed gastric emptying. (Truswell, 1992)

Most studies have found that the GI of a meal of mixed foods can be predicted from the (weighted) GI of its constituent foods. The GI concept is proving efficacy in dietary planning and design for the management of diabetes mellitus. (Hermansen et al., 2006) In long-term trials, low-GI diets result in modest improvements in overall glycaemic control in patients with diabetes mellitus (Brand-Miller et al., 2003). Furthermore, one of the great therapeutic importances is the ability of low-GI diets in reducing insulin secretion by the liver and lower blood lipid concentrations in patients with hypertriglyceridemia. (Wolever et al., 1991)

2. STUDY DESIGN AND SAMPLING

A total of 39 individuals (16 Malays, 15 Chinese and 8 Indians; 16 men and 23 women), with mean age 30.74 ± 5.75 years participated in this cross-sectional study through a convenient sampling. The study was conducted at different departments and outlets of Alpro Pharmacy Sdn. Bhd. in Malaysia (ie: Seremban, Port Dickson, Kuantan, and Jasin). The inclusion criteria were aged 18 years and above, males and non-lactating females, non-diabetic and fasting blood glucose range from 3.9 to 5.5mmol/L. Whereas the exclusion criteria were pre-diabetic or impaired glucose tolerance where blood glucose range from 7.8mmol/L to 11.0mmol/L after a 2-hour oral glucose tolerance test OGTT and those who are suffer from diabetes. Informed consent was obtained from all subjects.

3. DATA COLLECTION

Selected participants underwent the study procedures in four separate occasions. Study procedures were conducted after an overnight fast of at least 8 hours. The sequence of the three sample drinks were randomly assigned with a washout period of at least two days after the reference drink was tested. Study procedures were completed within a four-week period in order to minimize any variability in dietary and physical activity patterns. The participants' daily diet was not controlled. One of four beverages, either glucolin (GC), instant cocoa drink (CC), 3-in-1 oatmeal (OM) and Metabolic® Sauver (MS) was served for breakfast and all were equal in the amount of available carbohydrate (50 g/meal).

A fasting blood glucose test was conducted before commencement of the study. Prior to testing, subjects were required to undergo fasting for at least 8 hours without food or liquid (except plain water). Drink samples were served with 250mL of water. Subjects were required to consume the drink samples within 10 minutes after preparation. Capillary blood was obtained via finger pricking using sterile lancets. Blood glucose testing was conducted using Freestyle Lite glucose meter. Capillary blood glucose levels were measured at 7 time points which includes baseline (0 minutes), 15 minutes, 30 minutes, 45 minutes, 60 minutes, 90 minutes and 120 minutes.

A graph of blood glucose against time was plotted for each individuals for each food sample. Incremental area (iAUC) for each individual's 2-hour blood glucose response for glucose solution (reference test) were calculated. Likewise, the iAUC for each individual's 2-hour blood glucose levels for each food samples are calculated. A GI value for the food samples were calculated for each person by dividing food sample iAUC (iAUCf) by glucose iAUC (iAUCg). The final GI value for the food sample was the average GI value of the test subjects.

4. STATISTICAL ANALYSIS

Statistical Products and Service Solution (SPSS) program version 22.0 was used to analyse the data. The difference of postprandial blood glucose impact between reference drink and test drinks were explored using t-test.

Results were presented as area under the curve between 0 and 120 min which calculated using the trapezoidal formula. Positive AUC representing the area above the fasting blood glucose level was calculated (Pruessner J.C., 2003).

5. RESULTS

Thirty nine healthy subjects were participated in this study. Out of 39 subjects, 16 subjects were men (41.0%) and 23 subjects are women (59.0%). There were 16 Malays (41.0%), 15 Chinese (38.5%) and 8 Indians (20.5%). As shown in Table 1, the mean age of the subjects is 30.74 ± 5.75 years old. The mean height, body weight and body mass index (BMI) were 165.79 ± 8.75, 63.37 ± 13.50 and 22.91 ± 3.71 respectively. The subjects were non-smokers and non-

alcoholic. The subjects were requested to maintain their usual daily diet intake and physical activity throughout the study period.

TABLE 1: Age and anthropometry characteristics

Characteristics	Mean ± SD	Range
Age (years)	30.74 ± 5.75	23-45
Height (cm)	165.79 ± 8.75	151-186
Body Weight (kg)	63.37 ± 13.50	46.9-88.0
BMI (kg/m^2)	22.91 ± 3.71	18.1-33.1

Blood sample from subjects were collected for blood glucose test at 0 minutes, 15 minutes, 30 minutes, 45 minutes, 60 minutes, 90 minutes and 120 minutes, results as shown in Table 2. The mean post-prandial blood glucose level after consuming diabetes-formulated oral nutrition supplement, MS is significantly lower than the reference beverage, GC at 15 minutes (p-value<0.0001), 30 minutes (p-value<0.0001), 45 minutes (p-value<0.0001), 60 minutes (p-value<0.0001), 90 minutes (p-value<0.0001) and 120 minutes (p-value<0.05). The AUC of reference and test beverages are presented in Figure 1.

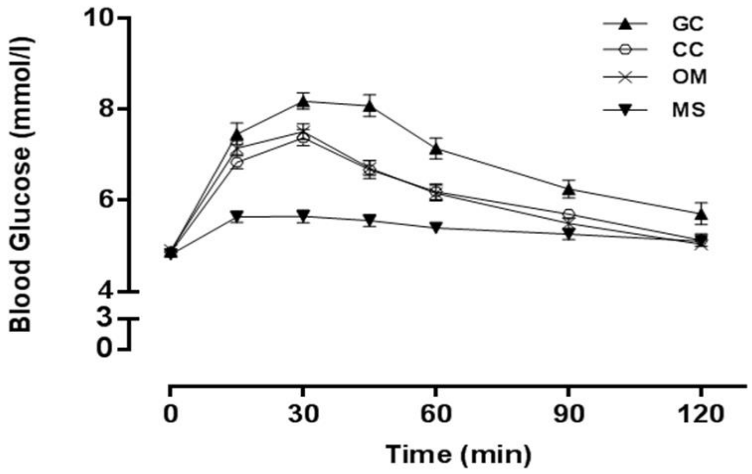

FIGURE 1: Mean blood glucose responses to reference drink (GC) compared with CC, OM, and MS. (n=39, p<0.05)

TABLE 2: Mean blood glucose responses of subjects at different time point after consuming the drinks and the reference drink.

Foods	*0 min*	*15 min*	*30 min*	*45 min*	*60 min*	*90 min*	*120 min*
GC (Reference Drink	4.88 ± 0.07	7.46 ± 0.24	8.18 ± 0.18	8.08 ± 0.24	7.14 ± 0.23	6.25 ± 0.19	5.71 ± 0.24
CC	4.87 ± 0.06	6.84 ± 0.13α	7.38 ± 0.18$^{\beta}$	6.68 ± 0.20$^{\delta}$	6.19 ± 0.17$^{\gamma}$	5.70 ± 0.12$^{\alpha}$	5.13 ± 0.14$^{\alpha}$
OM	4.91 ± 0.05	7.15 ± 0.15	7.51 ± 0.17$^{\alpha}$	6.71 ± 0.16$^{\delta}$	6.16 ± 0.17$^{\gamma}$	5.50 ± 0.12$^{\gamma}$	5.04 ± 0.10$^{\beta}$
MS	4.82 ± 0.06	5.64 ± 0.12$^{\delta}$	5.65 ± 0.14$^{\delta}$	5.56 ± 0.13$^{\delta}$	5.40 ± 0.11$^{\delta}$	5.26± 0.11$^{\delta}$	5.11 ± 0.10$^{\alpha}$
α Significantly difference than the reference drink (p<0.05)							
β Significantly difference than the reference drink (p<0.01)							
γ Significantly difference than the reference drink (p<0.001)							
δ Significantly difference than the reference drink (p<0.0001)							

The iAUC of reference and test beverages were calculated by using trapezoidal method and the GI of each beverage was calculated based on the assumption of GC with GI of 100. The GI of CC, OM and MS are 68.95 ± 36.38, 60.49 ± 20.37 and 26.84 ± 16.53 respectively, were presented in Table 3. From result presented in Table 3, CC and OM has medium GI whereas MS has low GI.

TABLE 3: AUC and GI of GC (reference drink), CC, OM and MS

Beverage with 50g Available Carbohydrate	AUC Mean ± SD	GI Index
GC (Reference drink)	241.00 ± 94.36	100 ± 0.00
CC	157.26 ± 84.54	68.95 ± 36.38
OM	145.62 ± 73.26	60.49 ± 20.37
MS	67.11 ± 58.19	26.84 ± 16.53

6. DISCUSSION

The results of the study show that diabetes-formulated oral nutrition supplement is contributing to a lower spike of postprandial blood glucose level as compared to other breakfast drinks and glucose solution in healthy individual. Postprandial blood glucose response is an important factor that contributes to overall glycemic control, and HbA1c level. Studies have highlighted the importance of targeting postprandial hyperglycaemia for diabetes care as elevated postprandial glucose is associated with the risk of various diabetes-related complications. (Woerle et al., 2007)

Brand-Miller et al. reported that low-GI dietary pattern reduced HbA1c by 0.43% over high-GI dietary pattern. Both pharmacological and non-pharmacological approaches are needed in lowering the postprandial blood glucose level in diabetics. Dietary and lifestyle habits are the main factors that lead to postprandial hyperglycemia. (Brunetti & Kalabalik, 2012) American Diabetes Association (ADA) highlighted that nutrition approach plays an important role in managing blood glucose and body weight for effective diabetes management and diabetes-related complications. (Evert et al., 2014)

Recent studies indicated that low-GI foods in meal planning were beneficial in diabetes mellitus patients and result in a significant reduction in fructosamine, Hb1Ac and total cholesterol levels compared with high-GI foods. (Opperman et al., 2004) The GI concept was developed to provide a numeric classification of carbohydrate foods in impaired glucose tolerance situations. (Jenkins et al., 2002) GI of food is divided into 3 categories which include low range from zero to 55; medium range from 56 to 69 and high which is more than 70. In GI concept, a value of 100 represents the standard, an equivalent amount of pure glucose. (Glycemic Index Foundation, 2017)

Based on the assumption of GC with GI of 100, MS is a low GI sample, whereas CC and OM are medium GI samples. GI was measured using 50g of available carbohydrate that are readily digested, absorbed and metabolized by body. Available carbohydrate possesses a greater impact on blood sugar level than general carbohydrates such as dietary insoluble fiber which are not readily digested by the body. (Glycemic Index Foundation, 2017) GI value represents the source of carbohydrate that is present in a food but does not correlate to the amount of carbohydrate typically eaten. The main practical limitation of the glycemic index is that it does not take into account the amount of carbohydrate ingested and insulin production due to rises in blood sugar. (Brouns et al., 2005)

High GI food are rapidly digested and absorbed which causes significant fluctuations in blood sugar levels. Thus, long term consumption of high glycemic index (GI) food were associated with higher risk of cardiovascular disease, type 2 diabetes, metabolic syndrome, stroke and chronic kidney disease whereas low GI food intake were associated with lower risk of diseases. (Barelay et al., 2008) Low GI food are slowly digested and absorbed which produces gradual rise in blood sugar and insulin level which showed to be beneficial to health. Intake of low GI diet is crucial to improve glucose and lipid levels in diabetic patients and weight control. (Brouns et al., 2005)

Food trend and eating culture of Malaysians has undergone a form of transformation. A couple of years back, people tend to have their meals at home. Nowadays, most Malaysians have their meals outside (away from home). Factors such as working far from home, having working mothers, and preferences for different food varieties (both local and international) which are served at many places encourage the practice of having meals away from home. Restaurants, cafes, food courts and food stalls servicing not only those who want to eat at meal times, but also those who want to enjoy food with their kith and kin during a festive season and in a relaxed manner also influence this trend greatly. However, a lack of consideration of sugar contents might expose the practitioners to health risks like diabetes.

In this study, GC was chosen as the reference sample whereas CC, OM and MS as the test samples. Instant cocoa powder and 3 in 1 oatmeal were selected due to the common trend of food that can be easily available in any food courts, restaurants and cafe in Malaysia. Moreover, these two beverages are the most famous drinks that Malaysian used to have during their breakfast or teatime. Whereas, Metabolic® Sauver is a complete and balanced nutrition supplement which specially designed for people with metabolic syndrome and diabetes. It has a low glycemic index (26.8) and supported by clinical evidences in improving insulin sensitivity and optimizing energy metabolism. Glucolin (Original Flavour) was selected as the control.

There are various methods used to calculate AUC which yields different GI values. Thus, standardization is required. (Brouns et al., 2005) Methods mostly assessed are shown in Figure 2: (a) Total AUC, (b) Incremental area until first return to baseline, (c) Incremental area over baseline, ignoring area beneath curve, (d) Incremental area using lowest glucose as baseline, and (e) Net incremental AUC.

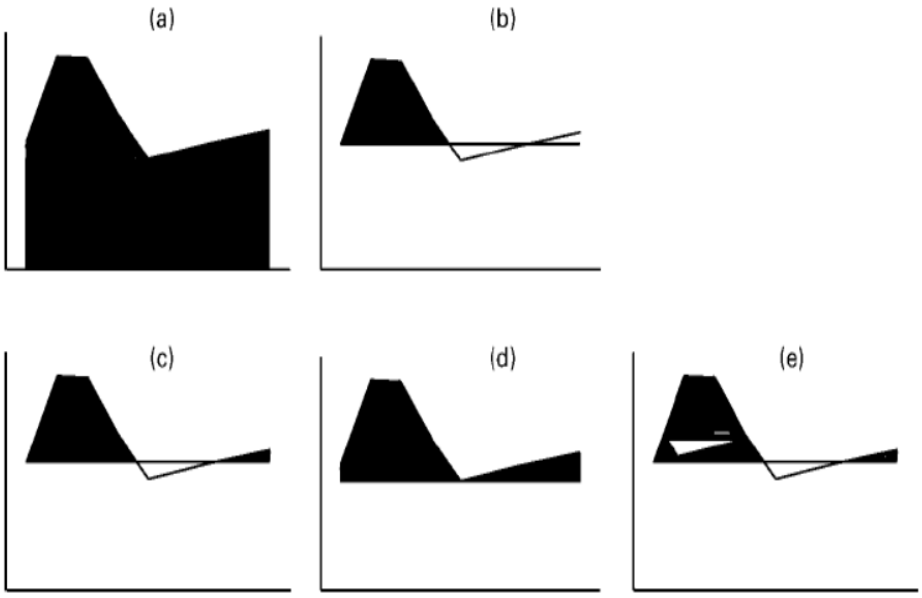

FIGURE 2: (a) Total AUC, (b) Incremental area until first return to baseline, (c) Incremental area over baseline, ignoring area beneath curve, (d) Incremental area using lowest glucose as baseline, and (e) Net incremental AUC

World Health Organization and Food and Agriculture Organization (FAO) have recommended the incremental AUC method (Method (c)) for calculating GI. Method (a) is insensitive for distinguishing foods with different glucose-raising effects as area above fasting glucose occupies only a small portion of the total AUC. (WHO/FAO, 1997) Wolever et al. conducted a study in 2004 to evaluate the suitability of GI calculations based on different methods of calculating AUC. The results showed that the GI values calculated from Method (d) and Method (e) were significantly different from the recommended method. Method (b) yielded GI values which were similar to the recommended method but it had a greater SD between GI values and the difference was statistically significant. Therefore, this study was conducted by using method (c) based on the recommendation of the FAO.

7. CONCLUSION

In a nutshell, choosing low-GI drinks over conventional high-GI drinks is clinically proven effective in glycaemic control. Thus, Metabolic® Sauver is a more preferable choice as compared to instant cocoa drink and 3-in-1 oatmeal as it is considered as low GI drink. Low GI diet is associated with decreased risk of diseases such as cardiovascular diseases, diabetes and stroke. Furthermore, low GI diet leads to better control of blood sugar levels especially in diabetic patients.

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