The Study of Glycemic Index of Gen-Premium

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Objective: *To determine the glycemic index of Gen-Premium.*
Material and Method: *Ten healthy volunteers were included for testing glycemic index of Gen-Premium. After the overnight fast, the subjects consumed 50 grams of glucose (reference food) within five minutes. The blood samples were collected at 0, 30, 60, 90, and 120 minutes for measuring of plasma glucose. One day later, the same subjects consumed 50 grams of carbohydrate from Gen-Premium (test food) within five minutes. After complete the data, the glycemic index was calculated by the standard method.*
Results: *The glycemic index of Gen-Premium was 27.29, which classify in low GI food.*
Conclusion: *According to the methodology of glycemic index determination, the glycemic index of Gen-Premium is 27.29, which is considered to be favorably low.*

Keywords: *Plasma glucose level, Gen-premium, Glycemic index*

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To accomplish blood glucose levels as close to normal as possible was fundamental for the prevention of long-term diabetic-related complications. Nutrition was of the preponderance in intensive diabetes management and had been described as a key factor of diabetic care. A major emphasis of the nutritional management of diabetes was the improvement of glycemic control by balancing food consumption with endogenous and/or exogenous insulin level. Substantial efforts had been made to regulate the glycemic response to diet, particularly to carbohydrate-rich food.

Carbohydrate is the nutrient with the most relation to diabetic patients. It also serves for the storage of energy. Foods high in carbohydrate include starch, fruits, sweets, breads, pastas, beans, potatoes, bran, rice, and cereals. Even if these come from different patterns, their main component is sugar, which is also the basic structure of carbohydrate. The carbohydrates have been classified as either simple or complex. Simple carbohydrate comprises of one or two sugar molecules such as glucose, fructose, dextrose, and sucrose while complex carbohydrate has more than two sugar molecules. However, a complex carbohydrate may be easier to be digested and absorbed into the blood circulation than a simple one. To characterize food behavior during digestion is an important factor to select the proper choice. A system for ranking carbohydrates according to their effects on postprandial glucose concentrations was the glycemic index (GI)[1]. Glycemic index is a measure of the effects of carbohydrates in food on blood glucose levels. It estimates how much each gram of available carbohydrate in food raises a person's blood glucoses level following consumption of the food, relative to consumption of pure glucose[2]. GI was universally advocated by the World Health Organization (WHO) and the Diabetes Associations in Europe, Canada, Australia, and South Africa. Practically, the use of GI and the use of low-GI diets in particular was reinforced in a report prepared by the joint Food and Agriculture Organization (FAO/WHO) Expert Consultation Committee[3]. Glycemic index is based on the rapidity and magnitude of food effect on blood glucose levels when compare to reference food. The reference foods, white bread or glucose, when glucose has been used as reference food, GI is of 100. GI values can be interpreted as percentages on an absolute scale and are commonly interpreted as follows[4,5].

1. Low GI (55 or less): 100% stone-ground whole wheat, oat bran, peas, legumes, most fruits, non-starchy vegetables, low-fat and low-sugar yogurts, apples, grapefruit, and tomatoes.

2. Medium GI (56-69): white and sweet potatoes, corn, white rice, and breakfast cereals such as cream of wheat and mini wheats.

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3. High GI (70 or more): white bread, corn-flake, shortgrain white rice, macaroni, pretzels, popcorn, most crackers, bagels, cakes, doughnuts, croissants, waffles, and most packaged breakfast cereals.

A high-GI food causes a more rapid rise in blood glucose levels and is suitable for energy recovery after exercise or for a person experiencing hypoglycemia. A low-GI food will release glucose more slowly and steadily, which leads to more suitable postprandial blood glucose readings.

In the management of diabetes, postprandial glycemia should be considered because it was a risk factor in the development of diabetes-related complications including cardio vascular disease (CVD)[6]. Significantly, the growing body of clinical evidence demonstrated that lower glycemic index diet was more effective in blood glucose reduction than higher glycemic index diet[7,8].

Gen-Premium was a clinical nutrition formula developed from Gen-DM. Its composition was altered by not only minimizing carbohydrate ratio but also increasing fat ratio in order to attain the targeted ratio of carbohydrate:protein:fat as 40:20:40, respectively. Furthermore, the sources of carbohydrate used in Gen-Premium were maltodextrin, isomaltulose, and maltitol. In addition, soluble fibers was tailored to delay the emptying of stomach. Selected poly-unsaturated fat such as eicosapentaenoic acid (EPA) and docasahexaenoic acid (DHA) from canola oil, high-oleic safflower oil, fish oil, and rice bran oil were included in the formula according to European Association for the study of Diabetes (EASD) recommendation. Slower stomach emptying may also affect blood sugar levels and have a beneficial effect on insulin sensitivity. Regarding protein, soy protein isolate and whey protein isolate were used for postprandial plasma glucose.

The present study aimed to determine the glycemic index of Gen-Premium to prove the advantage on glycemic optimization.

Material and Method

The present study was done at the Research Center of the Phramongkutklao Hospital, which was formally permitted by the Institutional Review Board, Royal Thai Army Medical Department on January 10, 2012. Eleven healthy volunteers were initially informed of the study overview and voluntarily signed consent form. Inclusion criteria were those who were healthy and at least 18 years of age with body mass index 18.5-24.9 kg/m^2. Subjects also had no history of a family member with diabetes mellitus (DM). Exclusion criteria were those who had chronic diseases such as DM, hypertension, cardiovascular diseases, liver disease, renal disease, gastrointestinal related to absorption process, and metabolic diseases. Furthermore, subjects did not take any drugs, supplements, or vitamins for seven days before enrollment. Eligible subjects fasted 12 hours for laboratories check (hepatic, renal, and thyroid function). Subsequently, standard oral glucose tolerance test (OGTT) was done. Only one subject was higher blood glucose, 10 subjects who had normal hepatic, renal, thyroid functions and normal OGTT result continued to take the glycemic index test. On the day of the reference food test, at least 12 hours overnight fast was required. Subjects on normal saline solution lock consumed the reference food, the solution of glucose 50 grams in 400 mL of water, in 5 minutes. Blood drawing were taken at the time 0 (baseline), 30, 60, 90, and 120 minutes, respectively. The same processes were done on the next day, the same subjects consumed Gen-Premium 100.92 grams (50 gm carbohydrate) in 400 mL of water. The reference food, glucose from Hebei Shengxue Glucose Co., Ltd., Batch No.201107281, was easily dissolved and prepared by dissolving in 400 mL of water. The test food, Gen-Premium produced by Thai Otsuka Pharmaceutical Co., Ltd. for this clinical study purpose only, prepared by adding Gen-Premium portion to portion in 200 mL of water, continue to stir until dissolved and slowly added water until 400 mL was reached.

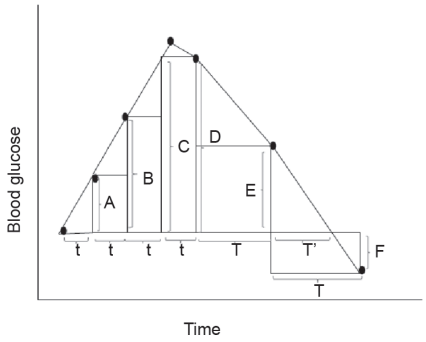
Plasma samples were centrifuged after collection. Quantitative determination of glucose in plasma was analyzed by Cobas Integra®. The test principle was an enzymatic reference method with hexokinase.

$$\text{D-Glucose} + \text{ATP} \xrightarrow{\text{HK}} \text{D-glucose-6-phosphate} + \text{ADP}$$

$$\text{D-glucose-6-phosphate} + \text{NAD}^+ \xrightarrow{\text{G6PDH}} \text{D-6-phosphogluconate} + \text{NADH} + \text{H}^+$$

The rate of NADH formation was directly proportional to the glucose concentration and was measured photometrically. Plasma glucose values were calculated by using slope and intercept of rate mean values of calibrator.

The glycemic index and incremental area under the curve (AUC) calculations were calculated as follow.



$$\text{Area} = \left(A + B + C + \frac{D}{2}\right)t + \frac{(D + E)T}{2} + \frac{E^2T}{2(E + F)}$$

Fig. 1 Area under the curve calculation.

The calculation of GI[9,10] was as follows;

$$GI = \frac{\text{Incremental blood glucose area of 50 g test carbohydrate}}{\text{Incremental blood glucose area of 50 g reference carbohydrate}} \times 100$$

The effect of test food, Gen-Premium, on blood glucose level was calculated using the area under the curve (AUC) which was compared to the same area after the reference food, 50 grams of glucose.

According to the GI calculation, AUC included the area above the fasting level called "incremental blood glucose area". Hence, the overall equation of AUC calculation[9] was as shown in Fig. 1.

It was the sum of areas of triangles and rectangles that were geometrically calculated. A, B, C, D, E, and F represented the blood glucose increments, differences between the blood glucose concentration fasting, and at times t, 2t, 3t, 4t, 4t+T, and 4t+2T after the start of the meal. The 't' and 'T' represented different time intervals between blood samples. When the blood glucose concentration at F was less than the fasting concentration, solely the area represented by the triangle ET' was above the fasting level. Thus, only this portion was included in the total area. T' represented the portion of the time interval T when the blood glucose level between E and F was above the fasting level[9].

Results

Ten volunteers were analyzed. The mean age of subjects was 27.4±4.3 years with the minimum of 23 years and maximum of 33 years. Subject characteristics were shown as healthy persons in Table 1 and 2.

Blood glucose response data and curve of 10 enrolled subjects who followed the methodology of GI determination are shown in Table 3, Fig. 2.

According to the data above, AUC of both glucose and Gen-Premium were calculated as follows;

Glucose, area $= (58.6+52.9+(23/2))x30+\frac{23^2x30}{2(23+12.9)}$

$= 3,911.03$

Gen-Premium, area $= (23.1+(9/2))x30+\frac{9^2x30}{2(9+2)}+½x(2+6.6)x30$

$= 1,067.45$

Thus, GI determination of Gen-Premium was calculated accordingly as follows;

Glycemic index $= \frac{1,067.45x100}{3,911.03}$

$= 27.29$

Discussion and Conclusion

The GI 27.29 obtained from 10 healthy subjects in this trial was used as the GI rating for Gen-Premium. Consequently, Gen-Premium could be classified as the low-GI nutrition. Data from clinical studies found that the GI of food could predict glycemic

Table 1. Subject characteristics and vital signs (n = 10)

Characteristic	Mean ± SD	Median (Q1-Q3)
Age (year)	27.40±4.30	27.00 (24-32)
Weight (kg)	59.91±8.85	59.10 (53.9-63.1)
Height (cm)	165.30±6.82	164.00 (162-165)
Body mass index	21.85±2.06	22.25 (19.5-23.3)
Temperature (°C)	36.93±0.08	36.95 (36.9-37)
Systolic BP (mmHg)	121.70±6.96	119.00 (117-129)
Diastolic BP (mmHg)	76.00±6.58	77.00 (71-80)
Pulse rate (beats/min)	71.80±8.85	76.00 (66-79)

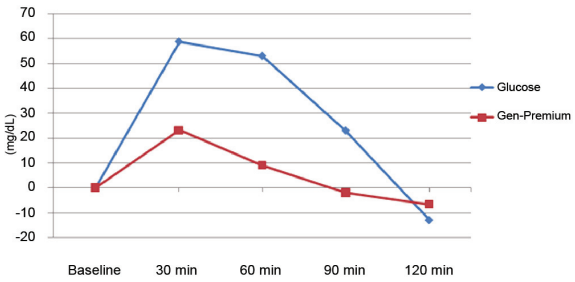


Fig. 2 Blood glucose increment after taking glucose and Gen-Premium.

Table 2. Laboratory assessment

Variables	Normal range	Mean ± SD	Median (Q1-Q3)
FPG (mg/dL)	70-110	83.00±5.62	85.00 (77-87)
OGTT (mg/dL)	<140	89.40±25.43	77.50 (68-112)
Total bilirubin (mg/dL)	0-1.0	0.67±0.33	0.55 (0.4-0.8)
Direct bilirulin (mg/dL)	0-0.4	0.25±0.10	0.20 (0.2-0.3)
Albumin (g/dL)	2.6-5.2	4.49±0.26	4.50 (4.3-4.6)
AST (U/L)	Male 0-37 Female 0-31	18.70±3.20	18.50 (16-22)
ALT (U/L)	Male 0-41 Female 0-31	14.20±2.82	14.50 (12-16)
Uric acid (mg/dL)	<8.4	5.24±1.11	5.20 (4.5-5.3)
Creatinine (mg/dL)	Male 0.67-1.17 Female 0.50-0.95	0.82±0.12	0.85 (0.7-0.9)
BUN (mg/dL)	6-20	10.78±2.21	9.75 (8.9-12.8)
TSH (mU/L)	0.27-4.20	2.16±1.11	1.63 (1.43-2.54)

FPG = fasting plasma glucose; OGTT = oral glucose tolerance test; AST = aspartate aminotransferase; ALT = alanine aminotransferase; BUN = blood urea nitrogen; TSH = thyroid stimulating hormone

Table 3. Blood glucose concentration and increment after taking glucose and gen-premium

Time (minutes)	Taking glucose (reference food)		Taking gen-premium (test food)	
	Blood glucose concentration (mg/dL)	Blood glucose increment (Δmg/dL)	Blood glucose concentration (mg/dL)	Blood glucose increment (Δmg/dL)
0	79.6	-	82.6	-
30	138.2	58.6	105.7	23.1
60	132.5	52.9	91.6	9.0
l90	102.6	23.0	80.6	-2.0
120	66.7	-12.9	76.0	-6.6

and insulin response when applied to mixed meals of diabetes patients[11,12]. Interestingly, postprandial glucose was a radical factor in etiology of type 2 diabetes and its complications. Currently, it has an emerging role as the predictor of morbidity and mortality[13]. Data from the DECODE study[14] showed that an increase of 1 mmol/L in postprandial blood glucose resulted in a seven percent increase in total mortality over a 5 to 10 year period. As a result of this, strategies that aim to reduce postprandial blood glucose, both low-GI diets and pharmacological approaches, may have robust benefits in the management of diabetes and its complications.

Gen-premium was proved in the present study that it had a low-GI profile; nevertheless, real integrated implementation in day-to-day practices is also needed. Moreover, further study of Gen-Premium in diabetes patients to understand other benefits related to glycated haemoglobin reduction and plasma lipid level optimization are still required.

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Potential conflicts of interest

I certify that there is no conflict of interest with any financial or personal relationship regarding the material discussed in the manuscript. This includes employment, consultancies, stock ownership,

honoraria, paid expert testimony, patent applications, and travel grants.

As the corresponding author, I also had full access to all the data in the present study and had final responsibility for the decision to submit for publication.

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การศึกษาหาค่าดัชนีน้ำตาลของอาหารทางการแพทย์เจ็นพรีเมี่ยม

อภัสนี บุญญาวรกุล

วัตถุประสงค์: *เพื่อศึกษาหาค่าดัชนีน้ำตาลของอาหารทางการแพทย์เจ็นพรีเมี่ยม*
วัสดุและวิธีการ: *ทำการศึกษาในอาสาสมัครที่มีสุขภาพดีจำนวน 10 ราย โดยทดสอบระดับน้ำตาลในเลือด ณ เวลาต่าง ๆ หลังการอดอาหารอย่างน้อย 10 ชั่วโมง อาสาสมัคร 10 ราย รับประทานสารละลายน้ำตาลกลูโคส 50 กรัม (อาหารอ้างอิง) ให้หมดใน 5 นาที มีการเจาะเลือดเพื่อทำการวิเคราะห์หาระดับน้ำตาลในเลือดที่เวลา 0, 30, 60, 90 และ 120 นาที ตามลำดับ ในวันถัดมาอาสาสมัครกลุ่มเดิมได้ปฏิบัติตามขั้นตอนวิธีการศึกษาเหมือนในวันแรกทุกประการ ยกเว้นได้รับประทานสารละลายอาหารทางการแพทย์เจ็นพรีเมี่ยม ซึ่งเป็นอาหารที่ต้องการทดสอบหาค่าดัชนีน้ำตาล ในปริมาณที่มีคาร์โบไฮเดรต 50 กรัม ให้หมดใน 5 นาที แทนการรับประทานสารละลายน้ำตาลกลูโคส ค่าดัชนีน้ำตาลคำนวณได้จากพื้นที่ใต้เส้นกราฟของระดับน้ำตาลในเลือดที่ได้จากการรับประทานอาหารทดสอบ (อาหารทางการแพทย์เจ็นพรีเมี่ยม) หารด้วยพื้นที่ใต้เส้นกราฟของระดับน้ำตาลในเลือดที่ได้จากการรับประทานอาหารอ้างอิง (สารละลายน้ำตาลกลูโคส) คูณด้วย 100*
ผลการศึกษา: *ค่าดัชนีน้ำตาลเฉลี่ยของอาหารทางการแพทย์เจ็นพรีเมี่ยม มีค่าเท่ากับ 27.29 จัดอยู่ในค่าดัชนีน้ำตาลต่ำ*
สรุป: *ตามวิธีการมาตรฐานในการหาค่าดัชนีน้ำตาล อาหารทางการแพทย์เจ็นพรีเมี่ยม มีค่าดัชนีน้ำตาลเท่ากับ 27.29 ซึ่งจัดเป็นอาหารที่มีค่าดัชนีน้ำตาลต่ำ*