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# Glycemic Index of Oral Nutritional Supplements in Healthy Adults

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***Abstract:*** **Glycemic index (GI) describes the blood glucose response after consumption of a carbohydrate containing test food relative to a carbohydrate containing reference food, typically glucose or white bread. GI was originally designed for people with diabetes as a guide to food selection, and advice being given to select foods with a low GI. Nonetheless low GI food should not be limited to diabetes patients but healthy individuals too as more recent recommendations on the potential of low GI diets to reduce the risk of chronic diseases and to treat other metabolic syndromes. This study aims to evaluate the GI of 2 oral nutritional supplements, Metabolic Recovery and Metabolic Relievve in healthy adults. Fasted subjects consumed one of the 2 oral nutritional supplements at each visit, with a two day wash out period between visits. Every subject received both oral nutritional supplements and blood glucose at 0, 15, 30, 45, 60, 90 and 120 mins were measured after the consumption of oral nutritional supplements which all containing 50g carbohydrates per serving. The trapezium method was used to compute the area under the curve for blood glucose and GI of both oral nutritional supplements were determined with reference to glucolin. The results show that both oral nutritional supplements has low GI, with Metabolic Recovery having the GI of 46.7 ± 16.4 and Metabolic Relievve with GI of 45.2 ± 16.4. Therefore, both Metabolic Recovery and Metabolic Relievve can be the preferred option for nutritional management of diabetic patients and healthy individuals in need of nutritional support.**

***Keywords:*** **Oral nutritional supplements, glycemic index, blood sugar level, diabetes, meal replacement.**

## I. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic progressive metabolic disorder characterized by hyperglycemia and glucose intolerance. It can lead to numerous and varied complications, such as cardiovascular, nervous and urinary system, and has been termed as the seventh leading cause of death in 2010 according to the World Health Organization [1].

Maintaining glucose levels near the normal range is an important part of keeping your body running effectively and healthily. Numerous studies on lifestyle interventions have observed a low glycemic index (GI) diet could help control glycemia not only in T2DM patients, but also in healthy people [2]. The glycemic index (GI) was introduced by Jenkins to express the rise of blood glucose after eating a food against a standard blood glucose curve after glucose (or white bread) in the same subject [3]. Value is assigned to foods based on how quickly and how high those foods cause increases in blood glucose levels. Foods low on GI scale (<55) tend to release glucose slowly and steadily. Whilst foods high on glycemic index (70 – 100) release glucose rapidly [4]. Numerous studies have documented the health benefits that can be obtained by selecting food of low glycemic index, whilst foods with high glycemic index are detrimental to health and that healthy people should be told to avoid these foods. These benefits are crucial importance in reducing the risk of chronic diseases and to treat conditions other than diabetes [5]. Diets with low glycemic index value improve the prevention of coronary heart disease in both diabetic and healthy subjects. Besides that, several metabolic parameters such as blood lipids were reported to be improved. Thus, several public health organizations have integrated consideration of the glycemic index in their nutritional recommendations for patients with metabolic diseases and for the general population [6].

The objective of this study was to determine the GI of oral nutritional supplements which could be beneficial for both diabetes and general population.

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## II. MATERIALS AND METHODS

### Study design

This was an open labelled, single center study to evaluate the efficacy of 2 oral nutrition supplements on postprandial blood glucose level in healthy subjects. The macronutrient composition of both formula is shown in Table 1. This study was conducted at Alpro Academy.

**Table 1: Nutritional information for each oral nutritional supplement**

| Per serving | Metabolic Recovery | Metabolic Relievve |
|---|---|---|
| Serving Size (g) | 57 | 45 |
| Energy (kcal) | 253 | 182 |
| Protein | 11.4g | 8.1g |
| Fat | 10.4 | 5.0g |
| Saturated fatty acid | 1.6g | 0.6g |
| Monounsaturated fatty acid | 6.2g | 2.6g |
| Polyunsaturated fatty acid | 1.9g | 1.2g |
| Trans fat | 0.0g | 0.0g |
| Carbohydrate | 30.8g | 28.8g |
| Dietary fiber | 4.6g | 5.1g |

Informed consent was obtained from all participants before the start of the study. A total of 18 healthy volunteers (13 Chinese, 2 Malays, 1 Indian; 7 men and 11 women) aged 22 – 41 were recruited from different departments of Alpro Pharmacy Sdn Bhd and screened by height, weight and HbA1C. Cobas b 101 system (Roche, Switzerland) was used to assess HbA1C. BMI is calculated based on the formula: weight in kilograms divided by height in meters squared. Exclusion criteria were: Pregnant and Lactating mothers, BMI > 24.9; HbA1C > 5.7 and those who suffer from diabetes.

### *In vivo* test and blood sample analysis

Volunteers reported at Alpro Academy after an overnight fast of at least 8 hours. Equal amount of available carbohydrate (50g/meal) of the oral nutritional supplement formulas (Metabolic Recovery and Metabolic Relievve) was served with a washout period of two days after the consumption of reference drink (glucolin). Both of the oral nutritional supplements were served with 250 mL of warm water. The volunteers were instructed to consume the drink within a 10-min period at a comfortable pace and were requested to remain seated and not consuming any food or beverage throughout the duration of the study. Capillary blood obtained by finger-prick using Microlet® lancet. Blood samples were collected for estimation of blood glucose at stipulated time points (Baseline at 0 min and post-meal at 15, 30, 45, 60, 90 and 120 min) as per schedule of assessment. Blood glucose was assessed using Contour® Plus blood glucose monitoring system (Ascensia, Switzerland), which has been shown to be precise and reliable [7].

### Data analysis

The area under curve (AUC) of blood glucose from baseline, the incremental area under response curve was calculated for each subject by using GraphPad PRISM (version 9; GraphPad Software Inc, San Diego). All AUCs below the baseline were excluded from calculations. The AUCs were expressed as means ± s.e.m.'s. The average AUC for the diabetes specific formula and glucose was compared using ANOVA, followed by Tukey's multiple comparison test. Differences resulting in P values <0.05 were considered significant.

## III. RESULTS

*Subject characteristics*

The subjects' baseline characteristics are as shown in Table 2. Of the 18 subjects enrolled, one subject had incomplete data, 3 did not meet eligibility criteria and another 2 withdrew consent, leaving 13 subjects with complete data for analysis. Eligible subjects had the mean age of 30 ± 5.6 and a normal BMI of 20.1 ± 2.2 with the mean haemoglobin A1C (HbA1C) 5.2 ± 0.2 (Table 2). There was no day-to-day variation on the subjects' usual daily diet intake and physical activity throughout the study period. Every participant attended all the experiment days and the timing of the blood samples taken was strictly followed by the same person in charge that obtained the blood samples.

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**Table 2: Athropometric characteristics of study participants (n=13)**

| Characteristics | Mean ± SD | Range |
|---|---|---|
| **Gender** | Male 4 (30.8%)<br>Female 9 (69.2%) | |
| **Age (years)** | 30 ± 5.6 | 22 – 41 |
| **Height (m)** | 1.6 ± 5.6 | 1.53 – 1.81 |
| **Body Weight (kg)** | 54 ± 5.9 | 46 – 69 |
| **BMI (kg/m$^2$)** | 20.1 ± 2.2 | 16.2 – 23.9 |
| **HbA1C** | 5.2 ± 0.2 | 4.8 – 5.4 |

*Blood glucose response to diabetes-specific formula*

The change in glucose concentrations from baseline over 120 min for the tested oral nutritional supplements, Metabolic Relievve and Metabolic Recovery were illustrated in Figure 1. The mean blood glucose concentrations for Metabolic Relievve and Metabolic Recovery were 5.99 ± 0.73 and 5.90 ± 0.54 mmol/l respectively, with the glucolin as control, having 6.86 mmol/l as the mean blood glucose concentrations. As shown in Table 3, there was a significant increase in blood glucose concentrations within 15 min in response to a dietary challenge with the oral nutrition supplements and control (glucolin). Both glucolin and Metabolic Relievve reaches its peak at 30 min, with 8.5 mmol/l and 7.1 mmol/l mean blood glucose concentrations respectively. Whilst Metabolic Recovery only reaches its peak at 45 mins, with 6.5 mmol/l mean blood glucose concentration. Blood glucose level for Metabolic Relievve did not have a high increase as compared to glucolin although both blood glucose level increased with the same trend and decreased at the same time, which is at 45 mins, but blood glucose level for Metabolic Relievve remain stabilized and did not further decrease as compared to glucolin. On the other hand, blood glucose level for Metabolic Recovery increased gradually till 30 mins which the blood sugar level remains stable before a gentle decrease at 90 min and remain stable till the end of the study, which is 120 mi-

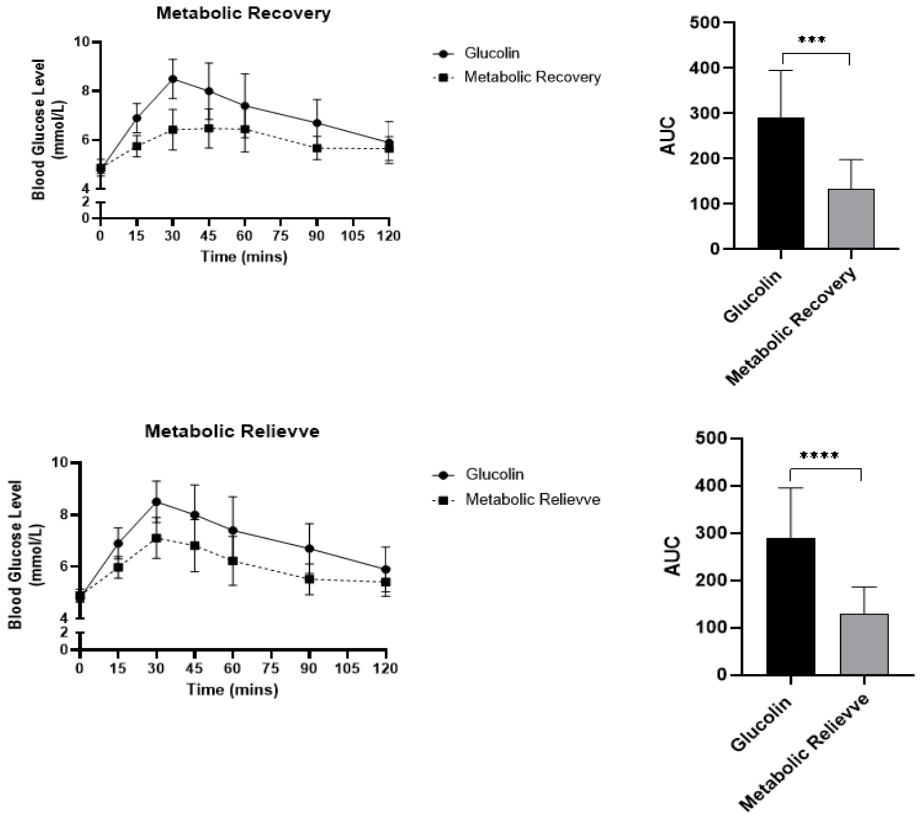


**Figure 1: Mean blood glucose responses of subjects at different time points after consuming oral nutritional supplements, Metabolic Recovery and Metabolic Relievve.**

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**Table 3: Mean blood glucose response of subjects at different time points after consuming respective drink samples.**

| Beverage | 0 min | 15 min | 30 min | 45 min | 60 min | 90 min | 120 min |
|---|---|---|---|---|---|---|---|
| **Glucolin** | 4.8 ± 0.2 | 6.9 ± 0.6 | 8.5 ± 0.8 | 8.0 ± 1.2 | 7.4 ± 1.3 | 6.7 ± 1.0 | 5.9 ± 0.9 |
| **Metabolic Recovery** | 4.9 ± 0.3 | 5.8 ± 0.4 | 6.4 ± 0.8 | 6.5 ± 0.8 | 6.4 ± 0.9 | 5.7 ± 0.5 | 5.7 ± 0.2 |
| **Metabolic Relievve** | 4.9 ± 0.3 | 6.0 ± 0.4 | 7.1 ± 0.8 | 6.8 ± 1.0 | 6.2 ± 0.9 | 5.5 ± 0.6 | 5.4 ± 0.5 |

*Glycemic index (GI) of tested oral nutrition supplements (Metabolic Recovery and Metabolic Relievve)*

The incremental area under curve (iAUC) of both glucolin and oral nutritional supplements were calculated by using the trapezoidal method and the GI for Metabolic Recovery and Metabolic Relievve was calculated based on the assumption of glucolin (reference) with GI of 100. The iAUC reflects changes in blood glucose levels over the 2 hours after consuming different oral nutritional supplements. The mean AUC after glucose consumption was significantly greater than those after consuming oral nutritional supplements. The mean values of GI for Metabolic Recovery and Metabolic Relievve is 46.7 ± 16.4 and 45.2 ± 13.8 respectively, based on 50g available carbohydrates. The AUCs for glucolin and oral nutritional supplements for each subject are shown in Table 4.

**Table 4: Area under curve (AUC), Maximum value ($C_{max}$), and time of maximum value ($T_{max}$) for blood glucose values in individual subject receiving oral nutritional supplements.**

| Subject | AUC: Metabolic Recovery | AUC: Metabolic Relievve | AUC: Glucolin | $C_{max}$: Metabolic Recovery | $C_{max}$: Metabolic Relievve | $C_{max}$: Glucolin | $T_{max}$: Metabolic Recovery | $T_{max}$: Metabolic Relievve | $T_{max}$: Glucolin |
|---|---|---|---|---|---|---|---|---|---|
| 101 | 114.8 | 85.5 | 273.8 | 6.9 | 7.4 | 8.5 | 30 | 30 | 30 |
| 102 | 98.3 | 120.8 | 178.5 | 7.1 | 7.2 | 7.8 | 30 | 30 | 30 |
| 103 | 105.8 | 108.3 | 335.3 | 7.1 | 7.5 | 9.4 | 60 | 60 | 60 |
| 104 | 96.8 | 137.9 | 307.5 | 6.2 | 7.3 | 9.3 | 30 | 30 | 45 |
| 105 | 132 | 212.3 | 428.3 | 6.9 | 7.6 | 10.3 | 60 | 45 | 60 |
| 106 | 97.5 | 130.5 | 258.8 | 5.9 | 6.7 | 8.2 | 45 | 30 | 45 |
| 107 | 111.8 | 112.5 | 172.2 | 6.7 | 7.0 | 7.7 | 15 | 30 | 30 |
| 108 | 93.8 | 30.5 | 173.3 | 5.8 | 5.5 | 7.4 | 30 | 15 | 30 |
| 109 | 29.0 | 78.8 | 159.8 | 5.7 | 6.6 | 7.9 | 45 | 30 | 30 |
| 110 | 201.8 | 211.5 | 414.8 | 8.2 | 9.0 | 9.6 | 60 | 45 | 30 |
| 112 | 277.5 | 226.5 | 415.5 | 7.7 | 8.5 | 9.9 | 45 | 30 | 30 |
| 114 | 178.5 | 102.4 | 228 | 7.8 | 7.6 | 8.1 | 30 | 30 | 30 |
| 115 | 201 | 125.2 | 424.5 | 7.6 | 7.9 | 10 | 30 | 30 | 30 |

The peak blood glucose concentration ($C_{max}$) and time of $C_{max}$ ($T_{max}$) are also shown in Table 4. The peak glucose concentrations of oral nutritional supplements were consistently lower than the reference drink, glucolin for all subjects. The time to achieve the highest glucose value ($T_{max}$) varied between subjects with some achieving their highest values at 15 mins and the rest ranged from 30 – 60 mins. The average $T_{max}$ for Metabolic Recovery, Metabolic Relievve and Glucolin is 39.2 ± 13.8, 33.5 ± 10.4 and 36.9 ± 11.2 respectively, whilst the AUC is 133.7, 129.4 and 290.0 for Metabolic Recovery, Metabolic Relievve and glucolin respectively.

## IV. DISCUSSION

This study aimed to evaluate the glycemic response of 2 different oral nutritional supplements, Metabolic Recovery and Metabolic Relievve. There is currently much scientific and popular interest in the role of low glycemic index (GI) food in the management of weight and metabolic disease risk as induction of rapid initial weight loss is achievable by minimizing carbohydrates intake, an additional potential mechanism by which low GI diets may contribute to reduced risk of metabolic syndrome [8].

Our study has shown that GI value for Metabolic Recovery and Metabolic Relievve is 46.7 ± 16.4 and 45.2 ± 16.4 respectively, as compared with glucolin reference drink. This value is categorized as low GI as determined by international diabetes organizations. Many factors can influence the GI of food, which includes type of sugars, fiber

content and presence of micro- and macro-nutrients [9]. Metabolic Relievve has a lower GI compared to Metabolic Recovery as it contains higher fibre content which is 5.1g. Enrichment of diet using soluble fiber is attractive as it both increases dietary fiber levels of the diet as recommended by the American Dietetic Association and further benefit of lowering the GI of the diet with great potential for health benefits [10]. Dietary fiber present in food could influence the digestion and absorption of the carbohydrate they contain and consequently their blood glucose responses. A recent meta-analysis published in American Journal of Clinical Nutrition has shown significant positive relationship between low GI and type 2 diabetes, coronary heart disease, gallbladder disease and breast cancer [11]. The higher GI value of Metabolic Recovery might due to its carbohydrate content, which is 30.8g per serving as compared to Metabolic Relievve, which provides only 28.8g per serving.

Our results showed Metabolic Recovery a much stable postprandial blood glucose levels as compared to Metabolic Relievve, which demonstrates a spike of postprandial blood glucose. But there was a steady decrease of the blood glucose level before returning to the baseline. Nonetheless, as both oral nutritional supplements have low GI, thus, they can be a suitable option for people with diabetes as they can help to stabilize blood glucose levels as compared to high GI food. A number of studies have shown that low GI diet resulted in greater improvement in glycated haemoglobin and fasting blood glucose compared to higher-GI diet in patients with diabetes. Besides that, a recent study has reported that those who consume high GI diets had up to 33% greater risk of developing type 2 diabetes than those who consume low GI diets [12].

One of the major dietary changes from the ancient to the modern world has been the increased consumption of fiber-depleted processed carbohydrate foods, which coincident with the rising rates of obesity and diabetes, as well as the increasing coronary heart disease (CHD) risk. Scientific evidence is confirming that both the quantity and quality of dietary carbohydrates, proteins and fats in the diet contribute to how much and how fast blood glucose rises after foods are consumed. And the higher rise in glucose in the blood stream will lead more insulin to be produced. Over time this can lead to higher insulin levels causing inflammation, weight gain and resistance to insulin's ability to make the body utilize sugar [13]. The result can be the progression to type 2 diabetes, stroke and CHD. Both Metabolic Recovery and Metabolic Relievve are complete and balanced nutrition that can be used as meal replacement either as prevention and/or management plans for many these conditions, helping to reduce the global disease burden.

## V. CONCLUSION

The determination of GI is an important index to judge whether an oral nutrition supplement formula is suitable for the diabetic population, which can provide reference opinions when giving suggestions to patients. Both Metabolic Recovery and Metabolic Relievve are categorized as low GI which can be used as nutritional management for diabetic population as well as general population for better glucose control.

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