The Effect of Different Types of Sugar and Sweetener on Postprandial Glycemic Response

ผลของการบริโภคน้ำตาลและสารให้ความหวานต่างชนิดกันต่อการเปลี่ยนแปลงของระดับน้ำตาลในเลือด

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ABSTRACT

Excessive sugars intake is one of causes of obesity which is increasing throughout the world . Thanks to high sugars consumption maybe induces hyperglycemia which maybe elevate a risk of developing of obesity. Thereby, consumption of sugars or sweeteners which delay postprandial plasma glucose maybe another alternative choice for weight management. The objective of the study was to investigate the effect of different types of sugar and sweetener on postprandial glycemic response in healthy men. A randomized crossover study was used in the study. On each test day, each participant recieved a sandwich with sugars or sweeteners dissolved in 400 ml of water. Blood samples were collected before and after a test meal for 240 minutes. No significant changes in comparing at individual time points with different type of sugars and sweeteners.

บทคัดย่อ

การบริโภคน้ำตาลในปริมาณสูงก่อให้เกิดภาวะระดับน้ำตาลในเลือดสูง ซึ่งนับเป็นอีกหนึ่งสาเหตุสำคัญของการเกิดโรคอ้วน ดังนั้น การรับประทานน้ำตาลหรือสารให้ความหวานที่ช่วยชะลอการเพิ่มขึ้นของระดับน้ำตาลในเลือดจึงเป็นอีกทางเลือกหนึ่งในการควบคุมน้ำหนัก วัตถุประสงค์ของการวิจัย คือ เพื่อศึกษาผลของการบริโภคน้ำตาลและสารให้ความ-หวานต่างชนิดกันต่อการเปลี่ยนแปลงของระดับน้ำตาลในเลือดในอาสาสมัครเพศชายที่มีสุขภาพดี การวิจัยนี้เป็นการศึกษาแบบ randomized crossover study อาสาสมัครจะได้รับประทานแซนวิชพร้อมกับเครื่องดื่มที่มีน้ำตาลหรือสารให้ความหวานชนิดต่างๆละลายอยู่ในน้ำปริมาตร 400 มิลลิลิตร ตัวอย่างเลือดจะเริ่มเก็บก่อนและหลังรับประทานอาหารทดลองเป็นเวลา 240 นาที จากผลการทดลอง พบว่า ณ เวลาที่แตกต่างกัน การเปลี่ยนระดับน้ำตาลในเลือดภายหลังการรับประทานน้ำตาลและสารให้ความหวานต่างชนิดกันไม่มีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ

Key Words: Sugar, Sweetener, Glycemic

คำสำคัญ: น้ำตาล สารให้ความหวาน ระดับน้ำตาลในเลือด

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Introduction

The prevalence of obesity is dramatically increasing in tendency every year and becomes one of Public Health problems throughout the world. World Health Organization (WHO) reported that in 2008 people all over the world at least 400 million adults were obese and further project that, by 2015, adults will be obese over than 700 million (World Health Organization [WHO], (2008)). Thailand also found the escalating prevalence of obesity in Thais. During 2003-2004, the percentage of prevalence of obesity in women and men were 34.4 and 22.5, respectively and during 2008-2009, the percentage accreted to 40.7 and 28.4, respectively (Health Information System Development Office [HISO], 2010). Obesity is one of deleterious chronic diseases that can induces numerous of parlous health conditions, for instance, diabetes mellitus, cancer, cardiovascular disease (CVD) and hypertension. Possible causes of obesity are genetic predisposition, environmental factors, hormones, social factors and one more pivotal cause is high amount of sugars consumption (WHO, 2002).

International Sugar Organization (ISO) revealed that the quantity of sugar consumption from people across the world elevated from 168 million tons during 2011-2012 and gained to 171 million tons during 2012-2013 (Office of the Cane and Sugar Board [OCSB], 2012). As well as Thailand, which also found that Thai population consumed sugar around 2.7 million tons during 2011-2012 and elevated to 2.8 million tons in 2013 (Rey, 2014).

Popular types of sugar and sweetener which generally consumed are high-fructose syrup (HFS), organic brown rice syrup (BRS), honey, sucrose, stevia leaves extract (SLE) and aspartame (Anderson, 2006; Anton et al., 2010; Horio et al., 2014; Jackson et al., 2012; Roman et al., 2013). After sugars consumption, sugars were digested in the mouth and intestinal lumen to generate monosaccharides. Thereafter, it was absorbed into the bloodstream which generated rising postprandial plasma glucose levels. On the other hand, consumption of non-nutritive sweeteners may be another choice for consumers since sweeteners are high intensity of sweetness while used in small amounts and do not provide calorie intake because they are not metabolized in human body (Chattopadhyay et al., 2011). In addition, BRS is one of the syrup which was made from brown rice and used as a healthier sweetener but it has not been any studies to investigate the effect of BRS on postprandial blood glucose yet. Accordingly, this study investigated the effect of different types of sugar including sweetener on postprandial glycemic response in healthy men.

Objective of the study

To investigate the effect of different types of sugar and sweetener on postprandial glycemic response in healthy men.

Methodology

Subjects

Thirteen healthy men between 18 and 25 years of age were recruited for this study. To qualify participants following inclusion criteria: (1) had a normal BMI between 18.5 and 22.9 kg/m^2, (2) had to have a normal fasting blood glucose concentration (< 100 mg/dL), (3) had to have normal lipid profile, blood urea nitrogen (BUN) including creatinine, (4) non-smoking, (5) no allergy to foods, sugars and sweeteners that were used in test meals, (6) had not taking and dietary supplements or hormones which

potentially influence blood glucose concentration, and (7) had not any chronic diseases.

Participants were excluded following these: (1) cannot participate for all period of testing, and (2) acute illness. The study was approved by Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University. Written informed consent was obtained from all participants.

Study Design

The study was performed as a randomized crossover study. Participants were separated into 6 groups for receiving 6 treatments which were provided by a week. In the morning of each test day, participants arrived to the laboratory at 7.30 AM following a 10 h overnight fast. At 8.00 AM (t = 0 minute), each participant was inserted an intravenous (IV) catheter into a hand or forearm vein for blood sample collection by the registered nurse. Blood samples were collected before (baseline, t = 0 minute) and after breakfast test meal at 15, 30, 60, 90, 120, 180, and 240 minutes. After baseline blood sample collection, participants received sandwiches together with 40 g of carbohydrate sugars (HFS, BRS, honey and sucrose) or sweetener (SLE and aspartame) which equated their sweetness with 40 g of sucrose sweetness (control) dissolved in 400 ml of water (Table 1). Participants were asked to consume breakfast test meals within 5 minutes.

Table 1 Composition of breakfast meals

	HFS	BRS	Honey
Amount of sugars or sweeteners (g)	40	40	40
White bread (slices)	2	2	2
Tuna steak in brine (g)	75	75	75
Margarine (g)	12.5	12.5	12.5
Total calories (kcal)	570	570	570

Table 1 Composition of breakfast meals (Con't)

	Sucrose	SLE	Aspartame
Amount of sugars or sweeteners (g)	40	0.8	0.2
White bread (slices)	2	2	2
Tuna steak in brine (g)	75	75	75
Margarine (g)	12.5	12.5	12.5
Total calories (kcal)	570	570	570

Blood Analysis

Blood samples were collected in Sodium-fluoride (NaF) tubes for glucose analysis and were centrifuged at 3,000 rpm for 15 minutes at 4 °C. After centrifugation, plasma was separated and stored at -80 °C until analysis. Plasma glucose was analyzed using a glucose oxidase method (HUMAN GmbH, Germany).

Statistical Analysis

The data were expressed as mean ± standard error of mean (S.E.M). Plasma glucose concentrations were assessed using one sample Kolmogorov-Smirnov test to test normality of data. Incremental data at each time points of plasma glucose concentrations were analyzed using Two-way repeated measures ANOVA, followed by Bonferroni's correlation to account for post hoc comparisons. All statistical analyses were conducted using SPSS for Window software (version 18.0). *P*-value < 0.05 was considered statistically significant difference.

Results

The effect of different types of sugar and sweetener on the incremental plasma glucose concentrations are shown in Figure 1. After breakfast test meals consumption, incremental plasma glucose concentrations were peaked at 30 minutes, followed by slightly declined thereafter. Consumption of sugars increased higher postprandial plasma glucose than sweeteners.

Repeated measures analysis demonstrated a significant difference in glycemic response by treatment ($P = 0.001$), by time ($P < 0.0001$) and by interaction between treatment and time ($P < 0.0001$).

Comparing at individual time points with different type of sugars and sweeteners found that no significant changed in the incremental plasma glucose concentration after consumption of breakfast containing different type of sugars and sweeteners.

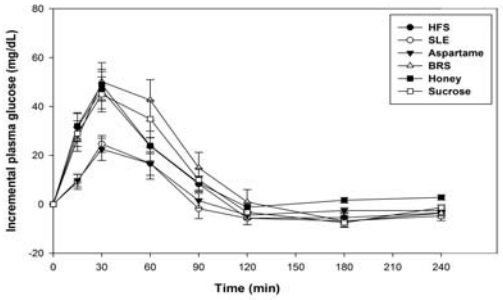

Figure 1 The changes in postprandial plasma glucose concentrations after consumed HFS, BRS, honey, sucrose, SLE and aspartame containing breakfasts. The baseline line of plasma glucose concentration in the groups received HFS, BRS, honey, sucrose, SLE and aspartame were 89.60 ± 2.07 mg/dL, 88.88 ± 1.64 mg/dL, 88.35 ± 1.07 mg/dL, 86.95 ± 0.89 mg/dL, 89.94 ± 7.97 mg/dL and 86.13 ± 1.57 mg/dL, respectively. Data were expressed as mean ± standard error of mean (S.E.M).

As shown in Figure 2, the incremental area under the curves (iAUCs) of plasma glucose concentration after consumption of HFS, BRS, honey, sucrose, SLE and aspartame were not different significantly.

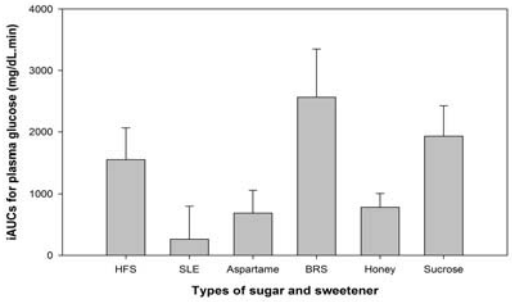

Figure 2 The incremental area under the curves (iAUCs) for plasma glucose concentration after consumption of breakfast test meals containing HFS, BRS, honey, sucrose, SLE and aspartame. Data were expressed as mean ± standard error of mean (SEM).

Discussion and Conclusion

This is the first to investigate the effects of organic brown rice syrup (BRS) on postprandial glycemic response in human. BRS is a syrup which produced by steeping brown rice fermented with enzymes after that the brown rice are converted into sweet liquid extract. BRS is one of sugars that effect on plasma glucose levels as other sugars. This study found that consumption of breakfast mixed with different type of sugars generated higher postprandial glycemic response more than sweeteners.

These results are in agreement with previous studies in healthy people (Anton et al., 2010; Ma et al., 2009; Steinert et al., 2011). In this regard, Steinert RE et al. (2011) investigated the effect after the intragastric infusion of glucose, fructose, aspartame, acesulfame K, sucralose as well as water which found that both sugars increased plasma glucose concentrations but the sweeteners did not effect on plasma glucose concentrations. Furthermore, these results are also in agreement with Anton et al., (2010) which revealed that postprandial plasma glucose levels were significantly decreased in the stevia condition compared to the sucrose condition ($P < 0.01$).

Our finding of lower plasma glucose response after consumed sweeteners than sugars is consistent with the results of crucial cause which resulted in the sweeteners created lower glycemic response because they are not metabolized in human body. Plasma glucose levels after consumed sweeteners may be increased from sandwiches in breakfast test meals. On the contrary, sugars increased plasma glucose concentrations since they are composed of mainly glucose and fructose which both are energy metabolism sugars but sweeteners are not. Nevertheless, the consumers should to select to consume the sugar that not only offers the sweetness but also provides nutrition value such as energy, vitamins and minerals whereas the sweeteners are not.

Nonetheless, Consumption of sugars created higher postprandial blood glucose than sweeteners which generated lower postprandial blood glucose but sugars may be beneficial on the other sides. Eventually, not only consumption of sugars and sweeteners are effect on glycemic but they also effect on satiety response which potentially influences on appetite control which required to investigate for further studies.

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