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The Glycemic Index of Partially Refined Yellow Sugar and Plantation White Sugar: A comparative Study

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Abstract- The Glycemic index (GI) is a measure of the effects of carbohydrates in food on blood sugar levels. It estimates how much each gram of available carbohydrate (total carbohydrate minus fiber) in a food raises a person's blood glucose level following consumption of the food, relative to consumption of glucose. Cane sugar requires further processing to provide the free-flowing white table sugar required by the consumer. The completely refined white sugar product is now over 99.9% sucrose and for all practical purposes contains no nutritional elements such as vitamins, minerals, proteins or fibers. Refined sugar is lethal when ingested by humans because it provides only that which nutritionists describe as "empty" or "naked" calories. It lacks the natural minerals which are present in the sugar beet or cane. The main objective of this study was to estimate and compare the GI values of the Partially Refined Yellow Sugar and PlantationWhite Sugar. *In - vivo* study was conducted by using Male wistar rats as a model and blood glucose analysis was done on semiautoanalyser by GOD – POD method. In this study, it was observed that the GI value of the Partially Refined Yellow Sugar was 84% and GI value of the PlantationWhite Sugar was 100%. From this we concluded that Partially Refined Yellow Sugar has low GI value as compared to the PlantationWhite Sugar and thus it can be used for the preparation of food items for the diabetic patients and for the weight loss program.

Key words- Glycemic Index, Partially Refined Yellow Sugar, Plantation White Sugar, Glucose

I. INTRODUCTION

The Glycemic index (GI) is an indicator for the classification of carbohydrate containing food based on their blood-glucose-raising potential. It is defined as 'the incremental area under the glucose response curve to a test food providing a fixed amount of carbohydrate, relative to the response to a standard control food (glucose or white bread) providing the same amount of carbohydrate' (Jenkins et al. 1981). The concept was developed by Dr. David J. Jenkins and colleagues (1980–1981) to find out which food was best for people with diabetes (Jenkins et al, 1981). Foods with a high GI produce a higher peak and greater overall blood glucose response than those with a low GI, which release glucose into the blood at a slower rate. A low-GI food is defined as having a GI of ≤55, and a high-GI food has a GI of P≥70.(Aston, 2006) A lower glycemic index suggests slower rates of digestion and absorption of the foods' carbohydrates and may also indicate greater extraction from the liver and periphery of the products of carbohydrate digestion (Jenkins et al, 1981). A lower Glycemic response usually equates to a lower insulin demand but not always, and may improve long-term blood glucose control (Jenkins et al, 2008) and blood lipids too. The GI is a ranking of carbohydrates on a scale from 0 to 100 according to the extent to which they raise blood sugar levels after eating. Foods with a high GI are those which are rapidly digested and absorbed and results in marked fluctuations in blood sugar levels. Low-GI foods, by virtue of their slow digestion and absorption, produce gradual rises in blood sugar and insulin levels, and have proven benefits for health. Low GI diets have been shown to improve both glucose and lipid levels in people with diabetes (type 1 and type 2). They have benefits for weight control because they help control appetite and delay hunger. Low GI diets also reduce insulin levels and insulin resistance in the body (Bjorck and Ehmstal, 2003).

Sugar was first manufactured from sugar cane in India, and its manufacture has spread from there throughout the world. Chemically, sugar is the polysaccharide sucrose, which can be hydrolyzed in acidic solution (i.e. below pH 7) to form the monosaccharides glucose and fructose. It is in the sugar mills that the raw sugar is separated from the plant and shipped to a refinery. Refined sugar has been depleted of its life forces, vitamins and minerals. What is left consists of pure, refined carbohydrates. The body cannot utilize this refined starch and carbohydrate unless the depleted proteins, vitamins and minerals are present. Nature supplies these elements in each plant in quantities sufficient to metabolize the carbohydrate in that particular plant. There is no excess for other added carbohydrates. Incomplete carbohydrate metabolism results in the formation of 'toxic metabolite' such as pyruvic acid and abnormal sugars containing five carbon atoms. Pyruvic acid accumulates in the brain and nervous system and the abnormal sugars in the red blood cells. These toxic metabolites interfere with the respiration of the cells. They cannot get sufficient oxygen to survive and function normally. In time, some of the cells die. This interferes with the function of a part of the body and is the beginning of degenerative disease."(Duffy, 1975). Sugar taken every day produces a continuously over acid condition, and more and more minerals are required from deep in the body in the attempt to rectify the imbalance. Finally, in order to protect the blood, so much calcium is taken from the bones and teeth that decay and general weakening begin. Excess sugar eventually affects every organ in the body. Initially, it is stored in the liver in the form of glucose (glycogen). Since the liver's capacity is limited, a daily intake of refined sugar (above the required amount of natural sugar) soon makes the liver expand like a balloon. When the liver is filled to its maximum capacity, the excess glycogen is returned to the blood in the form of fatty acids. These are taken to every part of the body and stored in the most inactive areas: the belly, the buttocks, the breasts and the thighs. Excessive sugar has a strong adverse effect on the

functioning of the brain. The key to orderly brain function is glutamic acid, a vital compound found in many vegetables. The vitamin B plays a major role in dividing glutamic acid into antagonistic-complementary compounds which produce a "proceed" or "control" response in the brain. Vitamin B is also manufactured by symbiotic bacteria which live in our intestines. When refined sugar is taken daily, these bacteria wither and die, and our stock of B vitamins gets very low. Too much sugar makes one sleepy; our ability to calculate and remember is lost.(Brand-Miller et al, 1995). Refined white sugar is void of nutrition because it is bleached and over processed. However Raw Sugar is not bleached or heated and contains all the nutrition. *Cane sugar* is rich in a variety of minerals and vitamins, including calcium, magnesium and riboflavin (vitamin B2). It also has a high potassium content, which makes it a natural laxative good for digestion. Cane sugar juice has been found to be beneficial in preventing and treating sore throats, colds and flu. It also improves kidney function by clearing the urinary flow and is believed to be a good treatment for fevers, as it boosts the body's protein levels. Increasingly, studies suggest that its alkaline nature can make it a key product in the fight against cancer, particularly the prostate and breast varieties. (Brand-Miller et al, 1995).

It is observed from various studies as mentioned above that certain raw sugars have an advantage over processed sugars in terms of benefit to the body. Thus, this Study was an attempt to compare the Glycemic indices of Partially Refined Yellow Sugar and Plantation White Sugar.

II. MATERIAL AND METHODS

Partially Refined Yellow Sugar [Ys] and Plantation White Sugar [Ws] were procured from Parle products Pvt. Ltd, Mumbai. Model of this study i.e. Male wistar rats (260-280 gm) were procured from Bharat serum Ltd., Mumbai. The animals were kept at room temperature (25°C - 27°C) at 75-80 % humidity and were acclimatized for a week.

After the period of acclimatization, animals were distributed into three groups i.e. Partially Refined Yellow Sugar (n=6), Plantation White Sugar(n=6) and standard (n=6). Each animal was given an oral dosage of 0.2 gm of Sugar sample / standard. Blood collection was done by Retro-orbital puncture at the specific time intervals i.e. Fasting blood sample (0 min), and further blood samples at 15, 30, 45, 60, 90 and 120 minutes after dosing. Blood glucose levels were estimated with a Semi-automated analyzer by GOD-POD method. Anhydrous glucose was used as a Standard.

The Glycemic index of a sample was calculated by dividing Area under the Curve (AUC) of the sample by the Area under the Curve (AUC) of the standard and multiplied by 100.

Area Under the Curve (AUC):

$$\underset{n}{AUC}=\sum_{x=1} A_x$$

Where;

Times t_0, t_1, ... t_n (0, 15 ... 120 min, respectively),

The blood glucose concentrations are G_0, G_1, ... G_n, respectively.

A_x = AUC for the x^{th} time interval (x^{th} time interval is the interval between times $t_{(x-1)}$ and t_x)

III. RESULTS

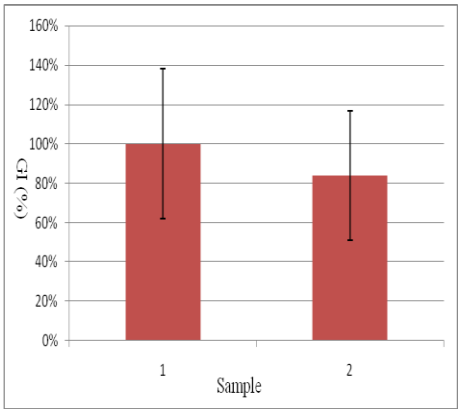

Figure 1: Glycemic index (%) of 1: Plantation White Sugar [Ws]; 2: Partially Refined Yellow Sugar [Ys].

As shown in Fig-1 Glycemic index of Partially Refined Yellow Sugar is 20% less than that of Plantation White Sugar. Consistently low GI value of Partially Refined Yellow Sugar as compared to Plantation White Sugar in all animals indicates slow absorption and digestion of Ys as compared to Ws.

IV. DISCUSSION AND CONCLUSION

The white crystalline substance we know of as sugar is an anomalous substance produced by industrial processes (mostly from sugar cane or sugar beets) by refining it down to pure sucrose, after stripping away all the vitamins, minerals, proteins, enzymes and other beneficial nutrients. It quickly passes through the stomach wall causing blood sugar levels to rise, and then drop rapidly. First, the blood sugar level increases rapidly and causes the pancreas to secrete insulin to compensate for the excess blood sugar. Afterward, the blood sugar level drops below normal. This state has been coined the sugar blues. The downside of the sugar blues is a state of depression, lethargy and irritability. Sugar is pure chemical and through refining has been stripped of all the natural food nutrition it originally had in the plant itself. Similarly, sugar is first pressed as a juice from the cane (or beet) and refined into molasses. Then it is refined into brown sugar, and finally into strange white crystals $C_{12}H_{22}O$, which is an alien chemical to the human system. A second reason why sugar harms is its addictiveness. Starting with sugar in the baby formula, people not only develop a strong taste for sugar but an insatiable craving that never recedes. A third reason is the slow and insidious damage caused by sugar. (Sugar: the sweetest poison*Helen Cannington*). One of the best sources of natural sugar is found in raw fruits and vegetables. These sugars are bound up with essential vitamins, minerals, fiber, oils and enzymes which are present in whole plant foods. These aid in the metabolic process necessary for digestion of the sugars. In addition, the sugars in natural whole foods arrive in the body diluted in a large volume of water to assist in its metabolism. The glycaemic index (GI) concept was originally introduced as a means of classifying different sources of carbohydrate (CHO) and CHO-rich foods in the diet, according to their effect on postprandial glycaemia (Jenkins et al. 1981). It was assumed to apply to foods that primarily deliver available CHO such as potatoes, rice, cereals, etc. usually having an energy content of 80% from CHO. The usual 50 g CHO test load has traditionally referred to available CHO providing sugars for absorption from the small intestine at a certain rate. As such, low-GI CHO were classified as those that are digested and absorbed slowly and lead to a low glycaemic response, whereas high-GI CHO are rapidly digested and absorbed and show a high glycaemic response. It has been proposed that the glycaemic index of foods can influence body-weight control (Acheson, 2004) Short-term studies suggest that low-glycaemic index carbohydrates and fiber intake could delay hunger and decrease subsequent energy intake compared with high-glycaemic index foods (Roberts, 2003). Since its development in 1981, the GI has had a pivotal role in highlighting the variation in physiological responses associated with different carbohydrate containing foods (Jenkins et al. 1981). This ranking of foods by the glycaemic responses elicited when equi-carbohydrate portions are consumed has provided a unique, and at times controversial, perspective on the issue of carbohydrate quality (Wolever, 1997; Bellisle, 2001).

In our study we compared the GI of raw and processed sugars to compare which of them had the most digestive outcome on consumption. We found out the GI of Raw sugar was lower than the GI for Plantation Sugar. Similar outcomes were reported in other studies. From a health standpoint low GI foods are at an advantage because of their beneficial effect on insulin sensitivity. Low-GI diets have been successfully applied as a dietary therapy in diabetes mellitus and other conditions exhibiting derangements in carbohydrate and lipid metabolism (Brand-Miller, 1994). In these studies, the major dietary alterations were to the starch-containing foods, with the substitution of slowly digested low-GI products, such as pasta, wholegrain cereal and legumes, for rapidly digested high-GI products, such as bread, breakfast cereals and potatoes. It has been proved, however, that - sugar is a major factor in dental decay; sugar in a person's diet does cause overweight; removal of sugar from diets has cured symptoms of crippling, worldwide diseases such as diabetes, cancer and heart illnesses. Sir Frederick Banting, the co discoverer of insulin, noticed in 1929 in Panama that, among sugar plantation owners who ate large amounts of their refined stuff, diabetes was common. Among native cane-cutters, who only got to chew the raw cane, he saw no diabetes. GI has been shown to be positively associated with the prevalence of the metabolic syndrome and insulin resistance in a cross -sectional study of 2834 subjects from the Framingham Offspring cohort (McKeown et al, 2004). Odds of having metabolic syndrome were reported to be 41% higher in the highest quintile of dietary GI compared with the lowest quintile (median GI values 84 and 72 respectively), and insulin resistance was found to be increased across quintiles ($p < 0.001$) (Aston 2006). Weight loss is an additional potential mechanism by which low-GI diets may contribute to reduced risk of metabolic syndrome. Induction of a rapid initial weight loss with low-carbohydrate diet may be partly explained by a reduction in overall caloric intake, which may be the result of a great limitation of food choices by the requirements of minimizing carbohydrates intake (Brehm et al, 2003; Sondike et al, 2003)], to the initial increase in circulating â-hydroxybutyrate, which may suppress appetite (Meckling et al, 2002) and to the satiating effect of low-carbohydrates diets containing relatively high amounts of protein (Johnston et al, 2004; Layman et al, 2003).

The rate of glucose entry into blood and the duration of the elevated blood glucose is known to induce many hormonal and metabolic changes that may affect health and disease parameters. In this respect, low-GI foods were often found to induce benefits on risk factors for certain chronic diseases. Because of these observations it was proposed that GI data for foods could be used to make priorities for food selection within food groups. This study was an attempt to demonstrate the effectiveness of raw sugar on the digestion of a mammal (i.e. Wistar Rat) and observe the response of the animal in terms of the Glycemic Index as compared to Plantation or Processed Sugar. The conclusion obtained was that raw sugar had a low GI which makes it favorable for use in everyday meals as compared to processed sugar.

APPENDIX

GI	:	Glycemic Index
Ys	:	Partially Refined Yellow Sugar
Ws	:	Plantation White Sugar
Min	:	Minutes
No.	:	Number
%	:	Percent
AUC	:	Area under curve
Gm	:	Grams

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