Analysis of glycemic index of “Gula Semut” through blood glucose level test

S Winarni¹*, F Arifan², RTD. W Broto², A Fuadi³, R Ramadhan²

¹Department of Biostatistics and Population Study, Public Health, Diponegoro University, Semarang, 50275, Indonesia
²Programme Diploma of Chemical Engineering, Vocational School Faculty, Diponegoro University, Semarang, 50275, Indonesia
³Faculty of Economics, Diponegoro University, Semarang, 50275, Indonesia
E-mail: winarniwiwin1975@gmail.com

Abstract. The glycemic index is a measure developed to classify carbohydrate foods based on their physiological effects on blood glucose levels. The purpose of this study was to distinguish glycemic index of ant sugar compared to comparator (carbohydrate 50 gram). Respondents involved in the glycemic index test were 5 persons. Prior to treatment (fresh bread and “gula semut”) respondents fasting at least 10 hours. In the first stage respondents were given 50 grams of fresh bread measured blood sugar levels at 0 minutes (fasting), 15, 30, 45, 60, 90, and 120 minutes post giving bread. Respondents were rested for 3 days without heavy activity. The second stage of the respondents was given 50 grams of ant sugar and measured blood sugar level of 0 minutes (fasting), 15, 30, 45, 60, 90, and 120 minutes post giving “Gula semut”. Blood glucose measurement using finger-prick capillary blood samples method. Calculation of glycemic index to bread and “gula semut” obtained through calculation of area under the curve. The total area under the curve on the supply of bread 35.75% while the total area under the curve on the supply of “gula semut” 14.10%. The glycemic index of “gula semut” is low (<55%). Low glycemic index foods improve slowly blood sugar levels. So the “gula semut” does not raise the blood glucose levels quickly.

1. Introduction

Pledokan, Semarang is an area with excellent potential for palm sugar. Palm sugar has low glycemic index compared to other sugar. The product of “gula semut” using raw material same as palm sugar. Therefore, gula semut is a class of food which has a low glycemic index.

“Gula semut” is palm sugar in the form of powder and brownish yellow, known as palm sugar. “Gula semut” is product of palm sugar diversification which have the form of small granules and diameter 0.8-1.2 mm.[1] The advantages of palm sugar is distinctive aroma that stimulates appetite, the form of caramel is smooth and soft, low glycemic index (GI) that is GI 35, which mean Glucose absorption takes place slowly so it lowers blood sugar levels in diabetics, does not cause obesity.[2]

Glycemic index is a measure developed to classify carbohydrate foods based on their physiological effects on blood glucose levels.[3] Foods which has high GI raise blood glucose levels quickly while foods with low GI raise blood glucose levels slowly. The glycemic index values can be classified into three classes, low (<55), middle (55-70), and high GI (>70).[4-5]

“Gula semut” is a food that has a low glycemic index. [6] In this study the objective was to measure the glycemic index of ant sugar in the village of Pledokan. In general, the recommended...
reference food for the GI test is glucose. However, practical purpose for food reference besides glucose like white bread, can also be used. Serving size for test of GI foodstuffs should equivalent to 50 g of available carbohydrates. However foodstuffs with low until middle content of carbohydrates available carbohydrate doses can be reduced to 25 g to avoid serving sizes that are too large (unrealistic) to consume.[7] “Gula semut” tested for glycemic index (GI) were from palm juice.

This study aims to analyze the glycemic index in “gula semut” made from palm juice in Pledokan, Semarang.

2. Materials and Method

2.1. Tools and materials
Blood sampling was carried out using 70 Gluco-Dr tools. The test food material used for the measurement of the glycemic index (GI) test is “gula semut” from Arum Sari KUB in Pledokan and white bread as reference food.

2.2. Research Design and Subject
This study uses the design of one shot case study using 5 subjects selected by non random sampling, namely consecutive sampling. Subjects were 5 respondents consisting of 4 women and 1 man aged between 20-21 years, and respondents did not suffer and did not have a history of diabetes from family, healthy, not taking drugs, not smoking. Before testing, the subject has agreed to the informed consent provided.

2.3. Glycemic Index Test
The procedure for measuring the glycemic index is based on the OGTT (Oral Glucose Tolerance) measurement procedure that is referred to by WHO standards. The first treatment, respondents were asked to consume test food, namely “gula semut” containing 50 grams of available carbohydrate. The second treatment, respondents consumed food that is a reference, 50 g of bread. Blood samples were taken at 0, 15, 30, 45, 60, 90, and 120 minutes after consuming test food for 2 hours. Blood collection is done through capillary blood vessels of the subject’s fingers. Each treatment is given a distance of 3 days to avoid bias from each treatment.[8] One day before treatment the subject is required to fasting (except water is still allowed) for 10 hours, starting at 22:00 until 08:00 the next morning. The data obtained is illustrated in the diagram with the X axis as time and Y axis as fasting blood sugar levels. GI calculations use the Incremental Area Under the Blood Glucose Response Curve (IAUC) method with the following formula:

\[
\text{Glycemic Index} = \frac{\text{the area under the glucose response curve of the test food}}{\text{the area under the glucose response curve for the reference food}} \times 100\%
\]

The glycemic index, or GI, measures how a carbohydrate-containing food raises blood glucose. Foods are ranked based on how they compare to a reference food — either glucose or white bread.

3. Results and Discussion
Data of subject blood glucose measurement results on the test food and reference are illustrated in a curve that shows the blood glucose response to food given. The average results of the respondent’s glycemic response are shown on the following curve:
The calculation of the glycemic index for “gula semut” is obtained by calculating the area under the curve. The area calculation can use triangular, trapezoidal, or rectangular formulas. The way to calculate the area under the curve is to divide the area under the curve into several fields, the area of each field is calculated according to its shape, then the total is calculated.[9] The calculation of the glycemic index of test food ingredients (“gula semut”) which is compared to the reference food (plain bread):

\[
\text{Glycemic Index} = \frac{\text{the area under the glucose response curve of the test food}}{\text{the area under the glucose response curve for the reference food}} \times 100\%
\]

\[
= \frac{14.1}{35.75} \times 100\%
\]

\[
= 39\%
\]

Based on the glycemic response, food is divided into 3 groups, low (<55), middle (55-70), and high GI (>70). [4], [5], [10] “Gula semut” has a low glycemic index (GI) (39%). Trinidad et al (2010) stated that palm sugar has a low glycemic index of 35. This result is higher than the “gula semut” glycemic index value studied. This difference can be caused by differences in the age of palm trees, the season and the height of the land where the palm trees grow. The difference in the glycemic index value is also influenced by the type of simple carbohydrates contained in the sugar products.[11]

GI in food is affected by fiber content, comparison of amylose and amylopectin, starch digestibility, fat and protein content, and processing methods.[12] Each component of food ingredients contributes and influences each other to produce a certain glycemic response.[13] Processing methods will affect the glycemic index in foodstuffs. In the process of producing “gula semut”, high temperatures are used to form granules. High temperatures in the processing process can cause the formation of retrograded starch which is difficult to digest so that it can reduce the glycemic index value of “gula semut”.[14-15]

In general, high food fiber content contributes to low GI values.[16] Fiber content affects food GI by increasing viscosity, giving a longer feeling of satiety and reducing macronutrient absorption so that it will reduce postprandial blood glucose and insulin. The more fiber content, the lower the GI.
value. This causes “gula semut” GI to be low. Foods with high protein content tend to have low GI because the rate of gastric emptying is slow, so digestion and increase in blood glucose become slow. However protein levels does not have a significant influence on the glycemic index even though it has the potential to reduce foodstuffs GI values.[17-18]

Glucose absorption mostly occurs in the upper small intestine (duodenum) and the middle (jejunum). In the end, fluctuations in blood glucose levels were relatively small, which was shown by the glycemic response curve on “gula semut” as test food. Foodstuffs with low GI will be digested and converted into glucose gradually and slowly, so that the peak blood sugar levels will also be low, and fluctuations in sugar levels increase relatively short. Based on these metabolic characteristics, low-GI foods can reduce glycemic and insulin responses, so that overall can improve glucose and blood fat levels, both in patients with diabetes mellitus 2, and in healthy people, the reverse process occurs in high-GI foods. High glycemic index foods induce insulin secretion and suppress glucagon releasing. [18] Insulin inhibits lipolysis and glyconeogenesis, and stimulates lipogenesis and glycogenesis. [19] In this case, the rate of emptying of the stomach, carbohydrate digestion and glucose absorption takes place quickly.[20-21]

4. Conclusion
The results of the calculation show that the glycemic index of “gula semut” is low, which is 39%. Low GI foods increase blood sugar levels slowly, so that “gula semut” will not raise blood glucose levels quickly. The process of glucose absorption takes place slowly so it can reduce the glycemic and insulin response. Overall, “gula semut” have low-GI can decreased the markers of blood glucose control [6], both in patients with diabetes mellitus type II and in healthy people. Factors affecting the level of glycemic index are fiber content, ratio of amylose and amylopectin, starch digestibility, fat and protein content, and processing methods.

Acknowledgements
We are indebted to all the patients who participated in this study. We also thank Diponegoro University Center for excellent language editing. This work is supported by the grants from the Ministry of Research, Technology and Higher Education of the Republic of Indonesia.

References
[1] Heryani, H. 2016. Keutamaan Gula Aren dan Strategi Pengembangan Produk
[2] Rahim A., and Lamusa A. 2015. e-J. Agrotekbis 3. 3 (4) 427–432
[3] Trinidad T.P., Mallillin A.C., Sagum R.S., and Encabo R.R. 2010. J. Funct. Foods. 2 (4) 271–274
[4] Foster-Powell K., Holt S., and Miller J. 2002. Am J Clin Nutr. 76, 5–56
[5] Lang V and F. D. 2004. Development of range of industrialised cereal-based foodstuffs high in slowly digestible starch. Washington DC: CRC Press
[6] Kirpitch A.R. and Maryniuk M.D. 2011. Clin. Diabetes. 29 (4) 155–159
[7] Hoerudin. 2012. Bul. Teknol. Pascapanen Pertan. 8 (2) 80–98
[8] Avianty S. and Ayustaningwarno F. 2014. J. Apl. Teknol. Pangan. 3 (3) 98–102.
[9] Gavrila R. 2017. Analisis Indeks Glikemik dan Kandungan Gizi serta Uji Daya Terima Mi dari Beras Merah dengan Penambahan Umbi Garut. USU
[10] Dodd H., Williams S., Brown R., and Venn B. 2011. Am. J. Clin. Nutr. 94 (4) 992–996
[11] Ariawan A. 2017. Indeks Glikemik Gula Aren Cetak dan Kristal. IPB
[12] Siagian R. 2004. Faktor Faktor yang Mempengaruhi Indeks Glikemik Pangan, Indeks Glikemik dan Beban Glikemik Beberapa Jenis Pangan Indeks Glikemik Pangan: Cara Mudah Memilih Pangan yang Menyehatkan. Jakarta: Penebar Swadaya
[13] Widowati S. 2007. Pemanfaatan Ekstrak Teh Hijau (Camellia Sinensis O.Kuntze) Dalam Pengembangan Beras Fungsional Untuk Penderita Diabetes Melitus
[14] Ayustaningwarno F. 2015. J. Nutr. Coll., 3 (4) 783–790
[15] Cambier L., Ghazzi W, Veuillot J.P., and Vivian H. 2004. Brazilian Arch. Biol. Technol. 47 513569–574
[16] Hill C. et al. 2015. *N. Engl. J. Med.* **124** (23) 841–851
[17] Istiqomah A. and Rustanti N. 2015. *J. Nutr. Coll.* **4** (2) 620–627
[18] Rouhani M.H., Kelishadi R., Hashemipour M., Esmailzadeh A., and Azadbakht L. 2013. *Lipids*. **48** (12) 1197–1205
[19] Barba G. et al. 2012. *Nutr. Metab. Cardiovasc. Dis.* **22** (1) 28–34
[20] Bin Arif A. and Budiyanto A. *J. Litbang Pertan.* **32** (2) 91–99
[21] Gumus H., Akdeveliolgu Y., and Bulduk S. 2014. *Determination of Factors Effected Dietary Glycemic Index in Turkish University Students.* **3** (1) 1–7