

# The Glycemic Index Value of Hipa 7 and The Determination Method

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## Abstract

Carbohydrate content information of food does not enough to describe its physiological effect. Different carbohydrate sources give diverse blood glucose response. The concept of glycemic index (GI) was introduced to fill that gap. It divides food into several classifications according to their postprandial glycemic response. The original method was conducted by observing blood glucose after consuming sample then comparing the result with standard food. Later, miscellaneous *in vitro* digestion models were developed to mimic the *in vivo* condition. Rice is one of food types that have various GI which are related to the rice variety and postharvest processing method. There are some varieties that have low or medium GI, the others have higher. Parboiled and brown rice tend to have lower GI compared to their un-parboiled milled rice form. Hipa 7 is hybrid new superior variety that had been launched by ICRR in 2009 and its milled rice has low glycemic index 49.2. Low glycemic index rice potentially reduced the occurrence of obesity and diabetic mellitus disease.

**Keywords:** glycemic index, Hipa 7, determination, method

## Introduction

Basic Health Research Data (2013) shows that about 6.9 percent of Indonesian population suffer from Diabetes Mellitus (DM) disease characterized by increased blood sugar levels. Indonesia currently ranks 4<sup>th</sup> in the world with the largest number of diabetics after India, China and the United States. Diabetes Mellitus patients aged 20-79% in the world reached 392 million inhabitants (IDF, 2013).

Diabetes Mellitus is a set of symptoms that arise in a person, characterized by blood glucose levels that exceed normal values and impaired insulin metabolism. Blood sugar levels increase as a result of reduced insulin. A person is diagnosed with DM if the blood glucose examination results > 200 mg/dL, while fasting blood glucose > 126 mg/dL (Waspadji, 2007).

One approach to choosing good food sources of energy for health is to apply the concept of glycemic index (IG). The glycemic index is the level of food according to its effect on blood glucose. Foods that raise blood glucose levels slowly have low IG. The value of food IG is defined as the ratio between the areas of the tested blood glucose curve of the tested food containing total carbohydrate equivalent to 50 g of blood glucose area after eating 50 g of glucose on different days, in the same person. Based on that definition, glucose (as a standard) has an IG value of

100. Food IG values are grouped into low (<55), moderate (55-70) and high (> 70) (Rimbawan and Siagian, 2004)

Consumption of rice with a low Glycemic Index is one way of regulating diet-pattern for type 2 diabetics. Several studies link the consumption of rice with increased risk of development type 2 diabetes (Nanri *et al*, 2010 and Villegas *et al*, 2007). The objectives of this paper is to review the Index Glycemic value of Hipa 7 the hybrid rice variety, the factors influence IG value and the determination methods.

## Concept of Glycemic Index

Concept of glycemic index (GI) was developed from fiber hypothesis which described that fiber consumption would decrease nutrient from intestine (Jenkins, 2002). The GI term firstly appeared in the literature in 1981. After the publication, several research groups reported that different starchy foods produced varying glycemic responses both in normal and diabetic subjects. Reducing the GI of the diet could improve glycemic control in diabetes patient (Wolever, 2006).

Foods that have low IG help people to control hunger, appetite, and blood sugar levels. The Glycemic Index helps people who are trying to lose

weight by choosing filling and durable foods. Glycemic index allows diabetics to choose the right type of carbohydrate to control their blood sugar. Diabetic people can choose foods that do not increase blood sugar levels quickly so that blood sugar levels are controlled at a safe level with the information of IG Food.

Nowadays, there are several ways to calculate the area under curve (AUC) of blood glucose response. The most commonly used methods are total AUC, incremental AUC<sub>cut</sub>, incremental AUC, incremental AUC<sub>min</sub>, and net incremental AUC. Using the different methods can produce the different GI values. This method consider the AUC over the baseline (y = fasting blood glucose) and ignore the area beneath the baseline. This approach was used for most GI calculation and recommended by the Food and Agriculture Organization (Brouns *et al*, 2005).

**Factors that Influence Glycemic Index**

Food glycemic index was a unique character of food material. Glycemic Index is affected by the type of material, the processing method, and also the characteristic and composition of biochemical material. Glycemix Index could not be predicted by only one material character. Each food component give a contribution, affected material trait, and produced specific glycemic response (Widowati, 2007). In accordance with the definition of functional food by Gibson and Williams (2000), low GI rice could be regarded as functional food.

**A. Processing**

The way of processing can change the structure and composition of nutrients for food constituents. One of the effects of changes in the structure and composition of this food is the change in nutrient absorption. The longer the carbohydrates are absorbed the lower the food GI. Different rice varieties also have different GI (Table 1), visible GI of rice derived from hybrid rice ranged from 49.2 to 73.5. In the past people generally consume rice that pounded, this is different from the present where many people who consume rice through the milling process. The process of milling causes the structure of the aleurone layer of rice is reduced, whereas the aleurone layer contains many vitamins and minerals. The milling rice milling process will eliminate about 86% of Mg content (Hansen *et al*, 2012). Prospective studies conducted in the US reported that consumption of milled rice tended to provide an increased opportunity prevalence of type 2 DM than those who ate brown rice (Sun *et al*, 2010).

The effect of parboiling process on GI is specific. It appears that the same parboiling process can lead to changes in different molecular structures in each type of rice. There is a decrease in GI due to the partial

synthesis process (30%) in Batang Piaman rice, but the opposite occurs in IR 36 rice. Thermal properties are thought to contribute to changes in GI value of rice (Purwani *et al*, 2007). The parboiling process from milled rice to parboiled rice decreases GI of several rice varieties ie Sintanur, Gilirang, Ciherang, IR64, Mekongga, IR42 and Batang Lembang with a decreasing range of 16-32% (Widowati *et al* 2009).

**Table 1.** Amylose content and Glycemic Index of several hybrid rice varieties.

Variety	Amylose Content (%)	Glycemix Index
Hipa 5 Ceva (Indrasari <i>et al</i> , 2017)	22.9	57.3 (Intermediate)
Hipa 6 Jete (Wibowo <i>et al</i> , 2010)	22.2	57.3 (Intermediate)
Hipa 7 (Indrasari <i>et al</i> , 2017)	22.7	49.2 (low)
Hipa 8 (Wibowo <i>et al</i> , 2010)	19.4	73.5 (high)

**B. Amylose and Amylopectin Content**

There are two forms of starch in the food, namely amylose and amylopectin. Amylose is referred to as the dissolved fraction, whereas amylopectin as the fraction is insoluble. Amylose is a simple, unbranched simple sugar polymer. This unbranched structure enables the amylose to bond more strongly to make it difficult to deflate and consequently difficult to digest. Amylose is a straight-chain glucose polymer connected by an alpha-(1,4)-glycosidic bond. While amylopectin is a simple branched sugar polymer, has a larger and more open molecular size so that amylopectin is easier to be gelatinized and consequently more easily digested (BeMiller and Whistler, 1996). Basically amylopectin resembles amylose, but has an alpha-(1,6)-glycosidic link at its branching point.

The amylose content of starches in milled rice usually ranges from 15 to 35%. Based on amylose content, milled rice is classified as: waxy (0-2% amylose), very low (3-9% amylose), low (10-19%), intermediate (20-25% amylose), and high (>25-% amylose) (Cruz, 2002).<sup>1</sup> Various research results indicated that rice that has a higher amylose proportion than amylopectin has a low GI value, and vice versa. Table 2 shows the amylose and Glycemic Index of several rice varieties.

**Table 2.** Amylose content and Glycemix Index of several rice varieties.

Variety	Amylose Content (%)	Criteria of Amylose Content (%)	Glycemix Index Value
Yunono No.1 (Hu <i>et al</i> , 2004)	1.10	Low	106
JIN1 (Hu <i>et al</i> , 2004)	13.90	Low	89
Fenyouxiangzan (Hu <i>et al</i> , 2004)	14.30	Low	92
Xiungshui 11 (Hu <i>et al</i> , 2004)	20.10	Intermediate	69
Xieyou 46 (Hu <i>et al</i> , 2004)	21.60	Intermediate	63
ZF201 (Hu <i>et al</i> , 2004)	26.80	High	56
JIN3 (Hu <i>et al</i> , 2004)	25.80	High	54
Setail (Indrasari <i>et al</i> , 2008)	7.74	Low	74
Ketonggo (Indrasari <i>et al</i> , 2008)	7.45	Low	79
Aek Sibundong (Indrasari <i>et al</i> , 2008)	21.99	Intermediate	59
Cigeulis (Indrasari <i>et al</i> , 2008)	21.11	Intermediate	64
Martapura (Indrasari <i>et al</i> , 2008)	26.41	High	50
Air Tenggulang (Indrasari <i>et al</i> , 2008)	28.62	High	50
Batang Lembang (Indrasari <i>et al</i> , 2008)	27.61	High	34
Margasari (Indrasari <i>et al</i> , 2008)	25.04	High	39
Cisokan (Indrasari <i>et al</i> , 2008)	26.68	High	34

### C. Starch Digestibility

Starch digestibility is the ability of starch that can be digested and absorbed in the body. According to Mercier and Colonna (1988), starch digestibility to be hydrolyzed by starch breaking enzymes into simpler units (Mercier and Colonna, 1988). Starch-breaking

enzymes can be divided into two groups, namely endo-amylase and exo-amylase. The alpha-amylase enzyme belongs to the endo-amylase group belonging to the endo-amylase group acting on the membrane in the amylose molecule and amylopectin (Tjokroadikoesoemo, 1986).

There are two factors that influence the process of starch digestion i.e. intrinsic factor and extrinsic factor (Tharanthan and Mahadevamma, 2003). The intrinsic factor causes the starch to be digested in the small intestine. The intrinsic factor is closely related to the nature of starch, such as the size of the granule, its presence in the food matrix, as well as the amount and size of the pore on the starch surface. Low starch digestibility means only a small amount of starch that can be hydrolyzed by digestive enzymes within a certain time. Thus, glucose levels in the blood do not increase dramatically shortly after the food is digested and metabolized the body.

Starch digestibility was analyzed using a spectrophotometer. Starch digestibility (in vitro) is determined by calculating the amount of maltose formed by starch hydrolysis by the alpha-amylase enzyme. Indrasari *et al.* (2008) reported that rice starch digestibility varieties Aek Sibundong, Setail, Ketonggo, Air Tenggulang, Martapura, Cigeulis, Batang Lembang, Margasari and Cisokan ranged from 54.34 to 57.45%. The digestibility of rice starch is lower than Cisokan, Batang Piaman, Mamberamo and Taj Mahal rice ranging between 52.21 to 99.08% (Widowati, 2007).

### D. Food Fiber

Food fibers are defined as components in plants that are not enzymatically degraded and become sub-units that can be absorbed in the stomach and small intestine (Ha *et al*, 2000). Total dietary fiber includes water-soluble food fiber and insoluble food fiber. Water-soluble food fiber function is primarily to slow digestion in the intestine, provide longer satiety, and slow the appearance of blood glucose so that the insulin needed to transfer glucose into the cells of the body and convert into less energy. The function is needed by diabetics. The main function of insoluble food fiber is to prevent the occurrence of various diseases, especially those associated with the digestive tract such as hemorrhoids, diverticulosis, and colon cancer (Eckel, 2003; Astawan and Wresdiyati, 2004).

High fiber foods also increase the stomach widening associated with increased satiety. While the coarse fiber thickens the density or thickness of the food mixture in the digestive tract. This slows the passage of food in the digestive tract and inhibits enzyme movement. Thus the digestive process becomes slow resulting in lower blood sugar response. Rice containing high fiber foods will decrease the glycemic response and the glycemic index tends to be

low. Therefore, brown rice generally has a lower glycemic index than milled rice (Foster-Powell *et al*, 2002).

### E. Fat and Protein

High fat and protein foods tend to slow the rate of gastric emptying. Thus, the digestive rate of food in the small intestine is also slowed. Therefore, high-fat foods tend to have lower GIs than similar low-fat foods (Rimbawan and Siagian, 2004). Fat is a more energy source for the body than carbohydrates and proteins. Proteins are sources of amino acids containing elements C, H, O, and N. The main function of proteins is to form new tissues and maintain existing tissues. Protein also serves as a regulator of the body's metabolic processes.

### Determination Method for Index Glycemic

#### A. In Vivo

Glycemic index of samples was measured in accordance with the method established by FAO (1998) with slight modification (FAO/WHO, 1998). Milled rice were cooked in rice cooker (rice: water ratio = 1:2). The number of tested rice equivalent to 50 g of available carbohydrate. The amount was calculated based on the content of total sugar and starch in rice samples. A number of healthy volunteers, were involved for the determination of rice glycemic index. After a 10–12 hours fasting, volunteers took freshly cooked rice samples as breakfast test meals, containing 50 g available carbohydrate per portion. Finger prick blood samples were taken at fasting (0 min) and 30, 60, 90 and 120 minutes after consuming test meal. Blood glucose levels were determined with a Glucose Meter Gluco Dr Test. Glucose response curve was made based on blood glucose levels during fasting (0 min) and 30, 60, 90, 120 minutes after consuming test meal. Incremental area under curve was calculated geometrically. The glycemic index (GI) of rice sample was determined by dividing the incremental area under curve of rice sample with the incremental area under curve of glucose (reference food) then multiplied the value with 100.

#### B. In Vitro

In vitro method basically measure starch digestibility by using several enzymes and condition that mimic human digestive track. The ratio between sample and reference food area under curve (multiplied by 100) from in vitro method is called hydrolysis index (Lalegani *et al*, 2018). This index is used to calculate GI value. There are some different equations in determining GI value (Kale *et al*, 2015 and Lalegani *et al*, 2018). the calculated GI known as predicted or estimated GI.

### Conclusion

Hipa 7 can be categorized as functional food because it has a low GI suitable for consumption by people with type 2 Diabetes Mellitus. This variety should be developed and marketed as variety assurance rice labelled (VARL) due to its specialities as rice with low GI.

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