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Research Article

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Measurement of glycemic index of West Sumatera local rice genotypes for healthy food selection

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ABSTRACT

Basically, patients with diabetes mellitus (DM) is not curable, but they can still a life if controlled. Diabetes can be controlled through management that includes education, food, exercise and medication therapy. Diabetes mellitus is a disease associated with lifestyle. Therefore, success depends on the management of diabetes mellitus patients themselves in changing behavior. One of the changes in behavior is very significant in controlling diabetes is the choice of foods that have a glycemic index or glycemic activity (GI) is low. Reviews these are foods, glucose of able to control blood levels because of decay takes place slowly, and the fluctuation is not high. Rice as the main staple of the Indonesian population has a major role in controlling diabetes, as glycemic activity is varied from low to high. Therefore, glicogenic activity information from a source of staple food consumption is needed. Until the present time, the glycemic index or glycemic activity of various genotypes of rice paddy rice in West Sumatra is still limited.The study was conducted in a laboratory, using experimental animals (mice). Treatments are six types of rice paddy rice genotypes with four replications. The results Showed that Among the six genotypes of the dominant local paddy rice grows in West Sumatra has a glycemic index ranges from moderate to high. Three genotypes were classified as moderate glycemic index is Randah Putiah (63) and Mundam (65). In contrast, Cantiak Manih (66), Ciredek (76), Bakwan (77) and Anak Daro (71) has a glycemic index are relatively high.

Keywords*:* glycemic index, diabetes mellitus, rice genotypes.

INTRODUCTION

Diabetes mellitus (DM) is a disease that is very important metabolic disorders. IDF (2013), estimates the world population that diabetes increased from 366 million in 2011 to 552 million by 2030. The same was found in people living in the developing world(1). IDF reported, in 2012 Indonesia ranks 8th in the number of diabetic patients is 7.6 million people(2).

Diabetes mellitus is determined by genetic besides also influenced by the consumption of particular foods that have a high glycemic index. According to Fitzgerald, the glycemic index is a relative measure of the ability of carbohydrates in foods to raise blood sugar levels after eating(1). Food that has a high glycemic index will raise blood glucose levels quickly and vice versa(3). Foods that have a low glycemic index are digested and absorbed much longer so that the blood sugar levels and insulin secreted also occurs slowly. Foods with a low glycemic index has been shown to improve glucose and fat levels in patients with diabetes mellitus and improve insulin resistance. In addition, foods with a low glycemic index also help control appetite, slow emergence of hunger that can help control the patient's weight.

Rice is the staple food of nearly half of the world population, more than 90% of the rice consumed in Asia. Indonesia's population makes rice as a staple food. As a staple food, a rice glycemic index is varied. Fitzgerald *et al* (2011) reported that rice glycemic index ranges from 48 to 92, with an average of 64(1).

Information glycemic index (GI) of rice is very important for consumers, especially for people with diabetes. Foster-Powell reported the Glycemic Index rice cannot be predicted based on grain size (long or short), or how to cook it(4). Indrasari et al (2008) showed a tendency the lower amylosa rice has a high glycemic index (74-79), intermediate amylose content having moderate glycemic index (59-64), and high amylase rice has a low glycemic index (34-50)(5). However, IG determined by a gene(1). This is supported by Purwani et al. (2007) who reported IG rice variety IR36, the Taj Mahal, Trunk Piaman and Mekongga respectively 45, 60, 86 and 96(6). Swarna genotypes are widely cultivated in India has a low GI, whereas Doongara and Basmati varieties from Australia has a GI value being Fitzgerald et al. (2011). Rice has a glycemic index varies. Therefore, it needs to be tested locally(4).

In West Sumatra enough rice genotypes grown in the form of national and local superior varieties with good taste. Anhar (1996) research results showed that the preservation of local varieties of paddy caused partly because the rice taste better than the national superior varieties(7). Until now, except varieties Batang Piaman, the GL value of other genotypes of rice cultivated in the area are relatively not being reported. It certainly is not very profitable for people with diabetes to choose the type of rice that is safe for their consumption. Animals such as mice are often used in pharmacology research as cheap and easy to do(8). Rats have been used for screening in vivo antidiabetic(9).

Despite the rice GL determined by genetics, but the expression of a gene is influenced by the environment. Research results Anhar (2009) showed that the results of several varieties of paddy rice is influenced by planting location(7). Thus, unstable genotype will adapt specifically so it will only display the optimal properties when grown in a specific location. Conversely, stable genotype will produce the same phenotype in a spacious environment that can be planted at various locations without significant phenotypic changes.

This study aims to determine the glycemic index of paddy rice genotypes consumed dominant population of West Sumatra. By knowing the genotypes of rice which have a low glycemic index, then the people with diabetes mellitus can choose the type of rice for consumption. Thus, this study is very beneficial for consumers with diabetes mellitus in controlling blood sugar. The result of this research can also be useful for consumers who could potentially suffer from diabetes mellitus, so that they can reduce the risks that may arise as a result of an improper selection menu.

EXPERIMENTAL SECTION

Research conducted in two phases. The first stage begins with the collection of data in the form of the dominant genotypes grown paddy rice production four centers in West Sumatera were Solok, Padang Pariaman, Bukittinggi and South Coast(7). Based on a survey conducted in previous studies it is known that the variety of the most popular and dominant cultivated at all four locations, namely the variety Ciredek, Anak Daro, Randah Putiah, Cantiak Manih, Bakwan and Mundam. Six varieties of rice from paddy rice originating from the location of the four locations were collected to be analyzed in the laboratory structures animal development, Department of Biology, Padang State University. Prior to testing, first in the form of mice preparation of test animals and test materials, such as rice. For each treatment takes four mice as experimental replicates. Thus, for all the treatment needed 24 mice. The mice were prepared by the students who participated in the study.

Preparation of the test material in the form of 6 varieties of rice is done by preparing extracts of rice flour in accordance with the procedures performed Widowati(8). Samples of rice pounded into flour and sifted using a sieve size of 80 mesh. Weighed 100 g rice flour and mixed with distilled water. Then filtered with 2 layers of gauze and squeezed by hand. The residue left in the filter cloth rinsed again and filtered. The solution was stirred and precipitated flour. Supernatant was discarded and the wind dried starch. Furthermore used for hypoglycemic assay.
Mice were used to study the hypoglycemic assay is male mice weighing 150-200 g. Experiments using a completely randomized design with 6 treatments plus one control (glucose) and 4 replications. Before adminis-tering treatment, the mice were fasted the night but still be drinking. The next morning, the blood glucose levels of mice were measured using a Gluco DR. Furthermore, mice fed rice flour with a dose of 4.5 g / kg body weight. Mice blood glucose was measured in minutes at 120, 240 and 360 after the treatment. Changes in glucose concentration (mg/dL) before and after treatment was calculated for each treatment(8). As supporting data, also analyzed the content of amylose and protein from each genotype.

Amylose content was determined by the method of iodo calorimetry(10). Weighed 200 mg of rice flour and put in a 100 ml volumetric flask, then add 1 ml of 95% ethanol and 9 ml of NaOH 1 N Heat in a water bath temperature of 100^{o}C for 10 minutes and refrigerate for 1 hour. The solution was diluted with distilled water to 100 ml, about 5 ml pipette, then put in a flask 100 containing 60 ml of water, then add 1 ml of 1 N acetic acid and 2 ml of 2% I2 and dilute to volume of 100 ml. Shake the solution and let stand for 20 minutes, then measuring absorbance with spetrophotometer at a wavelength of 620 nm. Amylose content was calculated by the formula:

$$\text{Amylose content }(\%) = \frac{A620 \times f.k \times 100 \times 100\%}{100 - k.a}$$

$$\text{which } f.k = \frac{1}{\text{abs 1 ppm}} \times \frac{100 \times 20}{1.000.000}$$

$$= \frac{1}{\text{abs 1 ppm} \times 50}$$

Explanation:
A620 = absorbance example
k.a = water content
20 and 1,000 = dilution factor
f.k = conversion factor

Rice protein content was determined by the Kjeldahl method. Weigh 1 g of rice that has been crushed and put into the Kjeldahl flask. Add 7.5 g and 0.35 g $K_2S_2O_4$ last HgO and add 15 ml of concentrated H_2SO_4. Heat all ingredients in a Kjeldahl flask in a fume hood until the smoke stops. Continue to simmer over high heat until it boils and the liquid becomes clear. Continue heating until about 1 hour. Turn off the heat and allow the heater to cool down the materials. Next, add 100 ml of distilled water into a Kjeldahl flask cooled in the fridge, add 15 ml of solution also K_2S 4% (in water) and finally slowly add 50% NaOH solution 50 ml chilled in the refrigerator. Post a pumpkin Kjehdahl immediately on the distillation apparatus Heat Kjehdahl pumpkin slowly until two liquid layers mixed, then heats rapidly to boiling. Distiller accommodated in erlenmeyer that has been filled with 50 ml of standard HCl solution (0.1 N) and 5 drops of methyl red indicator. Doing destilation until the distillate being stored in 75 ml. Titrate the distillate with standard NaOH (0.1) until the yellow color. Create also blank solution by replacing the material with distilled water, do destruction, distillation and titration as an example material. The percentage of N is calculated by the formula:

$$\%\,N = \frac{\text{ml NaOH Blanko} - \text{ml NaOH sample}}{\text{G sample} \times 1000} \times 100 \times 14008$$

Percentage of Protein = % N x factor conversion (for rice value 5.95) (11)

RESULTS AND DISCUSSION

Amylose Content of Rice

Results of laboratory analysis showed that the content of amylose genotypes tested ranged from 31,2- 34.6 percent. Genotype Ciredek, Bakwan, Randah Putiah and Anak Daro Value containing amylose 31.2 to 31.8%. While amylose content Cantiak Manih and Mundam respectively 32.1 and 34.6% as shown in Table 1. Based on the amylose content, grouped rice fluffier if amylose content of 1-2%, 2-12% is very low, low 12-20 %, 20-25% and higher are 25 to 33%(10). Thus, the amylose content of all genotypes studied, including high. Nevertheless, the amylose content was lower than the red rice rice genotypes originating from West Pasaman. Anhar (2013) reported that the local varieties of red rice containing amylase Heroes and Nabara 39.54 and 40, 13%)(7). These results are also higher than the research Dipti et al (2002) for some rice varieties are only found amylose content ranged from 18.6 to 28.0%(12). Setyaningsih research results (2008) to the amylose content of 11 lowland rice genotypes showed that the amylose content was moderate and it ranged from 20.5 to 24.6%(13).

Table 1. Amylose Content of six Rice Genotypes

No.	Genotypes	Amylose (%)
1.	Ciredek	31,2 (± 0.9)
2.	Bakwan	31,5 (± 1.1)
3.	Randah Putiah	31,7 (± 0.8)
4.	Anak Daro	31,8 (± 1.2)
5.	Cantiak Manih	32,1(± 0.9)
6.	Mundam	34,6(± 0.6)

Differences in amylose content between genotype caused by genetic and environmental variation in the nature. Inheritance of seed quality in grain crops is more complex than other agronomic characteristics. Quality properties are some system controlled by the gene(14). Amylose content is controlled by two pairs of genes which high amylose dominant to low amylose(15). Lee et al (2000) stated that the three QTL for amylose content located on chromosomes 1,6, and 11. among the three, QTL located on chromosome 6 is the greatest role in determining the phenotype variation in amylose content(16). QTLs for amylose content that is located on chromosome 6 express 91.1% of the total variation.

Amylose synthesized by granule-bound starch synthesis (GBSS). The relationship between levels of GBSS and amylose has been studied in some cultivars. According Aung et al. (2000), cultivars with amylosa 0-8% does not contain GBSS. Cultivars with the amylose content of 6-24 containing GBSS with the concentration is low. While cultivars with moderate to high levels of GBSS containing 6-24 and 11-30% amylose(17).

The fluffier rice gene encoding the GBSS are responsible for the synthesis of amylose in rice endosperm. There are two forms of the wild allele, Wxa and Wxb predominant in cultivated rice Wx locus. Wxa expression levels 10 times higher than Wxb in RNA. Wxa expression resulted in a high amylose content in rice texture pera. Wxb expression resulted become sticky or fluffier rice(18).

When compared with the amylose content of some rice genotypes grown in countries staple food rice, it is known that consumers generally prefer rice with low-to-high amylose content. Amylase content correlated positively with water absorption and velome development as the process of cooking the rice into the rice, so it also affects the physical quality of rice. According to Juliano (1967), rice from rice pera are all composed of amylose starch will produce a very hard rice(19). In contrast, rice cooked rice with low amylose content will be obtained rice softer.

Amylose content are preferred most consumers, including in Indonesia and Myanmar. Consumer preference for rice quality criteria vary. These differences are influenced by ethnic (tribal). For example, the Toraja/Bugis liked very fluffier rice, Javanese/Sundanese like half fluffier rice, while the people of West Sumatera like rice pera. This resulted in rice genotypes grown int West Sumatra in general has a high amylose content as seen from the results of the research. In contrast, the results Larasati (2012) showed that Inpari 2 with rice is shiny with a high level of fluffier most preferred by consumers(20). Varieties IR 42 with relatively high amylose content and more dull colors just not preferred by consumers because of the structure of the rice has a low fluffier.

Content of Protein

The protein content of rice from paddy rice genotypes ranged six of the highest found in genotype Randah Putiah (7.6%) and the lowest in Bakwan genotypes (5.9%). Variations in the protein content of the six genotypes can be seen in Table 2. The protein content is lower than the local varieties of red rice Dolok Nabara (8.25%) and Cimarisik (8.72%) derived from Pasaman(7).

The protein content can also affect the texture of the rice produced. Mentioned that the rice with a high protein content usually results in less soft rice (tend to be hard). Rice protein is inhibiting the absorption of water and development (swelling) when rice starch granules cooked, thus limiting the ability of starch gelatinization optimum form. Genetic factors, technology of cultivation, fertilization, and the agroecosystem rice planting area known to many influences quantity of rice protein content.

Table 2. Protein content of six Rice genotypes

No.	Genotype	Protein (%)
1.	Ciredek	6,1 (± 07)
2.	Bakwan	5,9 (± 1.1)
3.	Randah Putiah	7,6 (± 0.8)
4.	Anak Daro	6,7 (± 0.9)
5.	Cantiak Manih	7,0 (± 1.3)
6.	Mundam	7,4 (± 1.2)

Glycemic index

The glycemic index of six genotypes of rice paddy ranged from 63 to 77. Based on these values, the Son Daro, Ciredek and Bakwan belongs to the group of rice with a high glycemic index. Meanwhile, genotype Randah Putiah, Cantiak Manih and Mundam including groups with moderate glycemic index. Thus, there are no varieties that belonged to a low glycemic index. Nevertheless, three varieties were classified as having the glycemic index can also significant information for consumers, especially in the area of West Sumatra. The glycemic index genotype local varieties of each genotype are shown in Table 3.

Table 3. Glycemic Index of six Rice Genotypes

No.	Genotype	Glycemic Index
1.	Ciredek	76 (± 2.9)
2.	Bakwan	77 (± 1.8)
3.	Randah Putiah	63 (± 1.5)
4.	Anak Daro	71 (± 2.1)
5.	Cantiak Manih	66 (± 2.6)
6.	Mundam	65 (± 2.0)

Based on the data in the Table 3, glycemic index Randah Putiah, Cantiak Manih and Mundam relatively low (under 70) compared with the other three varieties belonging to genotypes with high glycemic index (above 70). The glycemic index is essentially influenced by several factors. Factors affecting the value of IG according Setyaningsih (2008) are fat, insoluble dietary fiber, soluble dietary fiber, resistant starch and ailosa(13). The higher the insoluble dietary fiber, soluble dietary fiber and amylose, and the lower the fat and resistant starch causes the lower GI value. Meanwhile, Foresters and Siagian (2004) stated that the factors that influence the glycemic index on food crops such as the way of processing, amylose and amylopectin ratio, acidity, osmotic power, fiber content, fat, and protein(3).

Based on the analysis and Mundam containing high amylose among genotypes tested. Cantiak Manih containing amylose 32.1, while Mundam containing high amylose (34.6). If the observed glycemic index of these two types of genotypes, it appeared that both have a low glycemic index. Cantiak Manih have a glycemic index of 66, while Mundam 65. Thus, it appears that the amylose content and glycemic index in both genotypes are inversely proportional. The higher the amylose content the lower the glycemic index. Vice versa, the higher amylose content the higher glycemic index. It can be known from Ciredek, Bakwan and Anak Daro. All three of these genotypes containing amylose is lower than comparable with Cantiak Manih and Bakwan. It also a higher glycemic index and includes categories genotypes with high glycemic index. These results are consistent with the black rice amylose content of the high yield snack bar with the low GI, whereas brown rice amylose lower-yielding snack bar with IG is highest among the three types of snack bars(20). Denardin et al (2012), also reported that the animal body weight gain was significantly higher in the cultivar mochi (low amylose content) and Irga 416 (intermediate amylose) compared with high amylose content (Irga 417)(21).

High amylose rice has a low glycemic index, except rice varieties Batang Piaman and Ciliwung. Rice IR36, Logawa, Batang Lembang, Cisokan, Margaret juice, and water Tenggulang have a low glycemic index so it can be consumed by diabetics. Rice with low glycemic index generally has pera rice texture that is less favored by diabetics, particularly those accustomed to eating rice fluffier, such as people from ethnic Sundanese and Javanese. However, this is not a problem for people with diabetes who are accustomed to eating rice inflammation, such as people of West Sumatra and South Kalimantan(5).

According to Forester and Siagian (2004), blood glucose levels and lower insulin response after consuming food high amylose levels of the food grade high amylopectin. Conversely, if the level is higher than the food amylopectin amylose, the higher the blood sugar levels(3). Miller et al (1992) reported that white rice varieties Doongala with an amylose content of 28% have a lower Glycemic Index than white rice varieties Calrose and Niles containing 20% amylose(22). The glycemic index Doongala recorded 64 varieties, while varieties Calrose and Niles respectively 83 and 93. Rice varieties containing high amylose shows the rate of decomposition is slower than rice with lower amylose content.

If observed in the six genotypes, amylose content of Randah Putiah (31.7%) were relatively lower than Bakwan and was also included genotypes with low glycemic index. As such, the amylose is not the only determinant of the glycemic index of a genotype. Food high in fat and high in protein tends to slow the rate of gastric emptying(3). Thus the rate of digestion in the small intestine also slowed. Therefore, high-fat foods tend to have a lower GI than lower-fat kind. The low glycemic index genotype Cantiak Manih and Mundam also allegedly because both of these genotypes also contain relatively high protein respectively 7.4 and 7.0%.

CONCLUSION

Based on the research results, it can be concluded that all of paddy rice genotypes studied there that contain a low glycemic index. However, it was found that two genotypes Randah Putiah and Mundam have relatively moderate glycemic index. In contrast, four other genotypes are Cantiak Manih, Son,, Bakwan Daro and Ciredek including genotypes with high glycemic index. Limited research conducted on the glycemic index value owned several rices. Glycemic index rice genotypes sometimes also influenced by the interaction of genotype and environment. Therefore, it is necessary to study the stability of the glycemic index of rice in various environmental conditions in West Sumatra.

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