Glycemic Index, Glucose Value and Dietary Fiber on Local Foods-Based Analogous Rice Formulations

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KEYWORDS

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ABSTRACT

The food consumed is expected to be useful in maintaining health and preventing disease, even if it is possible that food can cure or eliminate the negative effects of certain diseases. The higher the glucose content in food, the higher the blood glucose levels produced after consumption. Starch-type carbohydrate sources in food can be digested more simply, namely glucose, so that a higher starch content in a food will produce more glucose. One product made from various new carbohydrate sources is analog rice. Analog rice can be used as a food diversification product that can be consumed like eating rice made from rice. Combination cereals and tubers are easy to use to produce food with healthier carbohydrates sources. The purpose of this study is to evaluate the effect of blood glucose and glycemic index after consuming rice analog with various proportions of konjac flour. The result showed that the glycemic index values on analog rice with supplemented konjac flour 2%, 3%%, 4% and 5% were 43.47, 35.26, 25.71, and 19.89, respectively. These values can be categorized as normal GI values, so it can be inferred that the consumption of analogue rice with additional konjac flour does not increase virgin sugar rapidly.

INTRODUCTION

The food consumed is expected to be useful in maintaining health and preventing disease, even if it is possible that food can cure or eliminate the negative effects of certain diseases (of a functional nature) [1]. The choice of food ingredients consumed daily and consumption patterns are determinants of the emergence of degenerative diseases [2]. One of the diseases that occurs due to routine consumption patterns is choosing food sources of simple carbohydrates (glucose), which is a determinant of diabetes mellitus. Indonesia is one of the 10 countries in Asia with the highest number of DM sufferers. Epidemiologically, it is estimated that in 2030 the prevalence of DM (Diabetes Mellitus) in Indonesia will reach 21.3 million people [1]. Glucose type carbohydrates are easily absorbed by the body and converted into blood sugar levels [3]. In contrast to polysaccharide type carbohydrates which take longer to digest, they also take longer to increase blood sugar levels. The higher the glucose content in food, the higher the blood glucose levels produced after consumption. Starch-type carbohydrate sources in food can be digested more simply, namely glucose, so that a higher starch content in a food will produce more glucose. Food sources of carbohydrates in Indonesia are very diverse, originating from cereals and tubers. These foods contain simple carbohydrates (monosaccharides) and polysaccharides. Cereals and tubers are easy to find as plantation and

agricultural crops in Indonesian society, making it possible to process them into new products, a combination of various food sources of healthier carbohydrates. One product made from various new carbohydrate sources is analog rice. Analog rice can be used as a food diversification product that can be consumed like eating rice made from rice. The composition consisting of various ingredients allows the formation of carbohydrates with a more complex chemical structure or composed of polysaccharides. Analog rice research was carried out by Budijanto & Yulianti, using raw materials in the form of corn flour, sorghum and sago using 2% glycerol monostearate (GMS) as a binder [4]. The results of the research on analog rice showed that analog rice was similar to real rice because GMS binds amylose to form a helical structure. Some non-rice raw materials that have been used in making analog rice are sorghum [4], yellow corn, rice bran and soybeans [5], cassava and coconut dregs [6], mocaf and sago [7], as well as white corn and arrowroot [8]. Apart from that, analog rice can also have a low GI value, namely 54 with a fiber content of 13.3% and an antioxidant capacity of 7.51 µg CEQ/mg sample [5].

Analog rice using local food ingredients used in this research, namely mocaf (modified cassava flour), cornstarch, and porang flour were chosen because they have advantages. Mocaf has a distinctive aroma and taste, brighter color and higher soluble fiber content compared to cassava flour. Mocaf also has the advantage that its swelling power is almost equivalent to medium protein wheat flour compared to cassava flour, and the soluble fiber content in mocaf is higher [9]. Cornstarch has a high amylose content, namely >25%, the high amylose content affects the texture of the analog rice produced. The higher the amylose content, the resulting analog rice will have a hard or springy texture [10]. Cornstarch is used to improve the shape of rice during cooking and reduce stickiness due to the high fat content, namely 4.93% [11]. Konjac flour contains glucomannan, which has a high water absorption rate so that glucomannan can be used as a binder, thickener and emulsifier. The advantages of porang tubers are that they are water soluble and high in fiber and have a high molecular weight. Carbohydrate content that is high in fiber is good for consumption by diabetes mellitus sufferers because it can improve the blood lipid profile and reduce blood sugar [12].

METHOD

Analog rice formulation

Mocaf, cornstarch flour, and GMS (glycerol monostearate) were mixed with some water. Then the dough is added by different concentrations of konjac flour which is 2%, 3%, 4%, and 5%. After homogen, the dough was preheated at 80-90 C for 5 minutes before it was cut using extrude. Then the dough will become like rice as it is dried using a cabinet dryer at 60 C for 5 hours.

Glycemic index test

The materials used in this study are rats, rice paddy, and analog rice with konjac flour. A total of 36 scissors will be used in the research, pre climatized for a week for environmental adjustment, health control and weight. They were divided into six groups, with each group consisting of six scissors. Group I during the treatment was given only control rice, group II was given analog rice 0%, group III analog rice 2%, group IV was given analog rice 3%, group V was given analog rice 4%, and group IV was given 5%. These ingredients were given orally 1 time. Before the administration of these ingredients all scratches were conditioned on a fast of 1 night or 8-10 hours. The tail vein blood was taken in the 0th, 30th, 60th, 90th, and 120th minutes after the material was administered. The glycemic index (IG) is calculated by comparing the Area Under the Curve (AUC) of blood glucose scored after sampling with the standard AUC of glucose, then multiplied by the figure 100. The calculation of the AUC follows the formula of the trapezium formed at the bottom of the curve between the time (minutes) and the glucose level (mg/dl).

Dietary fiber analysis

The fat-free sample was weighed at 1 g then put into an Erlenmeyer flask and 200 mL of 1.25% H2SO4 was added, and heated in a magnetic stirrer at 100ºC for 30 minutes while stirring. Next, filter it with filter paper then wash it with hot water until it is neutral (tested with litmus paper). The residue was transferred into an Erlenmayer, then 200 mL of 1.25% NaOH solution was added and heated again at 100ºC for 30 minutes while stirring. The solution is cooled and then filtered using constant filter paper of known weight. The residue is washed using 15 mL of 96% ethanol, followed by washing with hot water until neutral (test with litmus paper). The residue in the filter paper is then oven to 100ºC until the weight is constant, then weighed. Next, the weighing data is calculated.

RESULT AND DISCUSSION

Glycemic Index of Analog Rice

Glycemic index testing is a method used to group food consumption by carbohydrate content based on its effect on postprandial blood glucose levels [13]. Rice is one of the foods that is categorized as having value with a high glycemic index. However, not all types of rice have a high glycemic index, this also depends on the rice variety and other factors (especially the chemical compounds) [14, 15]. The glycemic index value can also be interpreted as the incremental area under the blood glucose response curve to 50g of food carbohydrates. A total of 50 g of reference food was taken from the same subject within a certain time period [16]. Shozib *et al*, stated that the glycemic index value is a numerical classification based on in vivo testing which functions to measure blood sugar levels relative to the consumption of food, drinks, nutraceutical products, medicines and other consumable ingredients [17].

Table 1. Rat blood glucose levels per 30 minutes

Sample	blood glucose 0 minutes (mg/dl)	blood glucose 30 minutes (mg/dl)	blood glucose 60 minutes (mg/dl)	blood glucose 90 minutes (mg/dl)	blood glucose 120 minutes (mg/dl)
White rice IR 64	67.49	129.69	146.60	142.61	130.16
Konjac Flour 0%	68.70	105.26	142.29	107.47	99.47
Konjac Flour 2%	67.63	91.52	115.41	105.74	98.55
Konjac Flour 3%	67.72	94.60	100.35	99.30	93.78
Konjac Flour 4%	67.50	88.77	109.56	98.15	86.50
Konjac Flour 5%	65.83	84.71	104.54	93.31	80.53

Glucose is a key energy source of living organisms. Blood glucose is the main sugar found in human and animal blood. It is the body's primary source of energi [18]. A blood glucose test is a test that mainly screens for diabetes by measuring the level of glucose (sugar) in the blood. Blood glucose is measured in mmol/L (millimoles per liter) or mg/dl (milligrams per deciliter). Blood glucose

monitoring facilitates the identification of patterns in blood glucose (sugar) changes resulting from dietary modifications, physical activity, medicine, and pathological processes like diabetes mellitus [19]. Table 1 showed the value of blood glucose of rats from 0 minutes to 120 minutes. Rat consumed white rice IR 64 had blood glucose 67.49 mg/dl - 130.16 mg/dl. Rat consumed analog rice with 0% konjac flour had blood glucose 68.70 mg/dl - 99.47 mg/dl. Rat consumed analog rice with 2% konjac flour had blood glucose 67.63 mg/dl - 98.55 mg/dl. Rat consumed analog rice with 3% konjac flour had blood glucose 67.72 mg/dl - 93.78 mg/dl. Rat consumed analog rice with 4% konjac flour had blood glucose 67.72 mg/dl - 86.50 mg/dl. Rat consumed analog rice with 4% konjac flour had blood glucose 65.83 mg/dl - 80.53 mg/dl. As the data showed, the higher concentration of konjac flour in rice analog affected the lower level of blood glucose in 120 minutes. The higher level of blood glucose in 120 minutes is affected by white rice IR 64, while the lower level of blood glucose in 120 minutes is affected by analog rice with 5% of konjac flour. According to Khan et al., normal blood glucose is between 90 to 99 mg/dl (5.0 to 5.5 mmol/L). The analog rice still affects a normal level of blood glucose compared to the white rice IR 64 [20].

The glucose response shown by a person who consumed peppermint rice or analog rice with konjac flour is shown in table 1. Glucose responses are the serum glucose levels after consuming the test ingredient. In table 1 the glucose response after consumption of peppermint rice is higher compared to analog rice. On the analog rice consumption the higher the konjac flour added the lower the blood glucose levels. Blood glucose levels increased from 67.49 mg/dl in 0 minutes to 142 mg/dL in 90 minutes. Different effects were shown on consumption of 5% konjac flour analogous rice, not too high increases from 0 minutes of 65.83 mg/ dl to 93 mg/ dL in the 90 minutes after consumption.

In patients with certain diseases it is recommended to consume complex and high-fiber carbohydrates because they will be more slowly degraded by digestion so control blood glucose levels. Complex carbohydrates or polysaccharides are abundant in bulbs and cereals. The basic ingredients for making the analog rice are mocaf, corn flour and porridge flour containing starch or polycarbons of the type Water-soluble polycarbonates (PLA) and high fiber. Consumption of PLA can reduce the efficiency of carbohydrate absorption which affects the decrease in the insulin response which causes impaired function of the pancreas so that it can improve its function in producing insulin [21]. Modified cassava flour in this analog rice contains high carbohydrates (87.3%) mostly consisting of polysaccharides [22]. The nutrient content of corn is polycarbonate 72-73% with amylose: amylopectin 25-30%: 70-75%.

Table 2. Glycemic index of analog rice

Sample	I	II	III	GI
White rice IR 64	83.38	86.72	84.34	84.34
Konjac Flour 0%	89.24	88.27	89.73	89.08
Konjac Flour 2%	44.14	42.14	44.14	43.47
Konjac Flour 3%	37.64	37.16	30.97	35.26
Konjac Flour 4%	26.19	25.22	25.71	25.71
Konjac Flour 5%	20.37	19.89	19.40	19.89

The glycemic index value categories are divided into high, medium and low. Products with a low glycemic index range less than 56, medium when the value ranges from 56-69 and high when the value is above 69 [23]. As Table 2 showed, white rice IR 64, analog rice with 0% konjac flour, analog rice with 2% konjac flour, analog rice with 3% konjac flour, analog rice with 4% konjac flour, analog rice with 5% konjac flour had 84.34, 89.08, 43.47, 32.26, 25.71, and 19.89 of glycemic index,

respectively. Rice analog added by 2%, 3%, 4%, and 5% of konjac flour has a normal glycemic index while white rice IR 64 and rice analog with no adding konjac flour have high glycemic index. According to Jenkins et al., the glycemic index differences can be caused by differences in food ingredients, food processing methods, amylose levels, amylopectin levels, fat levels, protein levels and fiber levels of a food product [24] . Food processing can cause food glycemic index values to increase because through processing, the structures of food macromolecules become more easily digested and absorbed which might increase blood glucose levels rapidly. The level of gelatinization also affects the glycemic index value because the process of starch gelatinization causes starch granules to expand. The expanding granules and free starch molecules are very easily digested by enzymes in the intestines. This rapid enzyme reaction will cause blood glucose levels to rise. White rice IR 64 has a higher glycemic index supposedly due to the starch being more gelatinized than the analogous rice.

Dietary Fiber of Analog Rice

Amorphophallus contains high glucomannan which includes water-soluble fibers. Water-solute fibers are known to have effects on calorie intake, lipid metabolism, and glucose homeostasis [25]. Table 3 shows the results of the analysis of food fiber on analog rice. The highest food fibre has analog rice with 5% konjac flour is 20.38%. The higher the addition of cognac flour in analog rice indicates the higher the value of the fiber produced. The higher the value of fiber will affect the glycemic value of the index, because the fiber cannot be directly digested by the digestive system so it will not increase blood sugar levels [26].

Table 3. Dietary fiber rice analogues

Sample	I	II	III	Dietary FIber (%)
Konjac Flour 2%	10.34	10.83	10.5	10.56
Konjac Flour 3%	13.38	14.00	14.34	13.91
Konjac Flour 4%	15.32	14.96	14.01	14.76
Konjac Flour 5%	20.61	20.33	20.21	20.38

CONCLUSION

In this study it was concluded that the values of blood sugar, glycemic index and food fiber influenced by analogous rice with added konjac flour 2%, 3%, 4%, and 5% had differences. The higher the concentration of konjac flour, the lower the value of the blood sugar produced. So the glycemic index values on analog rice with supplemented konjac flour 2%, 3%%, 4% and 5% were 43.47, 35.26, 25.71, and 19.89, respectively. These values can be categorized as normal GI values, so it can be inferred that the consumption of analogue rice with additional konjac flour does not increase virgin sugar rapidly.

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