Proximate Composition and Glycaemic Index of Cookies from Corn Flour Mixed Black Soybean

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Abstract. The metabolic characteristics of type 2 diabetes subject are abnormally high concentration of glucose in blood. They need low glycaemic index food to control their bloods glucose. Meals from cereal and bean have important protein, vegetable oils, dietary fibre, and low starch to controlling it. The purpose of this research was to analyzed the proximate composition and glycaemic index of cookies from corn flour and black soybean flour. Proximate composition determined by AOAC methods. The glycaemic index data was measured from nine normal subject (± 23 years) that selected from agricultural student in Garut University. About 50 g glucose was consumed by subjects. Capillary blood samples were taken by glucometer in the fasting state and then at 15, 30, 45, 60, 90, and 120 minutes from the start consumption of glucose. After a week, subjects were consumed of cookies sample equivalent with 50 g glucose. Samples were analyzed for blood glucose concentration and incremental areas under blood glucose curves were calculated. The glycaemic index of cookies was calculated as the incremental area under curve (iAUC) of the cookies expressed as a percentage of the individual’s average incremental area under curve (iAUC) of the glucose. The results showed that the cooky contained moisture (3.79±0.07\%), ash (1.07±0.03%), lipid (29.97±0.28\%), protein (6.03±0.06\%), crude fiber (3.13±0.38\%), and carbohydrate (59.15±0.31\%). The cookies have 40.00±17.95 glycaemic index and it was classified as low glycaemic food (less than 55). Furthermore, consuming the cookies could be control the blood glucose of subjects. 

Keyword: Black Soybean, Cookies, Corn Flour, Glycaemic Index

1. Introduction
Diet is the major modifiable risk factor for degenerative disease subject like type 2 diabetes mellitus. This subject have abnormal concentration glucose in their blood because of insulin resistance or abnormally insulin secretion from beta cell pancreatic. Food glycaemic index is relevant in managing diabetes mellitus.

The glycaemic index illustrated the raise of blood glucose after subject consuming particular foods and compared to glucose as a standard. Glycemic index response was dependent to type and content of carbohydrate in foods, digestion, and absorption of monosaccharides in our body. Low glycaemic index foods have high dietary fiber. It’s diet can minimize of postprandial insulin secretion. The insoluble
fiber might play a role in controlling blood glucose level subjects. It might increasing digesta viscosity after meals [1].

Starch is maize mainly content (72-73%), it has 25-30% amylose and 70-75% amylopectin. Waxy maize is rich of amylopectin content (100%) and it has 1-3% monosaccharides [2]. The boiled and roasting maize have 21 and 39 glycaemic index respectively. The boiled maize should be prefered choice meals for diabetec subjects [3]. Corn has 28.66-41.37 glycaemic index value [4]. Maize meal stiff porridge have 16 glycaemic load (medium glycaemic load) [5].

Soybean contains complex carbohydrates and dietary fiber that contribute to low glycaemic index. Soybean has 35% protein content and complete amino acid content just than another legumes [6]. Black soybean has been used widely as a nutritionally rich food in Indonesia. Consume of dietary fiber rich tofu have been effective in inflammatory reducting [7] and malondialdehyde level reducting [8]. Okara bread, okara steam bread, and okara noodle have 49±8, 54±2, 52±14 glycaemic index. Diet with okara product have hypoglycaemic effect because of its dietary fiber containt [9].

Corn and black soybean are Indonesian local food as a carbohydrate source that could be alternative main food. Diabetic subject need some glycaemic index meals everyday. Therefore, the present study was designed to analyze the proximate composition and glycaemic index of cookies from corn flour and black soybean flour.

2. Methods

2.1. Cookies preparation

Cookies was made from wheat flour, corn flour, black soybean flour, and added with addition substances [10]. Percentage ratio of this cookies (wheat flour : corn flour : black soybean flour) devide in four formulation, i.e: cooky control/R (100:0:0), cooky A (70:25:5), cooky B (60:35:5), and cooky C (50:45:5). Cookies formulation shown on Table 1. The addition substance (butter, sugar, salt, and baking powder) mixed until homogen cream was formed (about 5 minutes). And then, eggs, wheat flour, corn flour, and blacksoybean flour was added and mixed. After that, this dough added with strawbery slurry and mixed equally. Dough was forming about 1 cm thickness and it weight about 7-8 grams. Cookies oven-baked at 160 °C temperatures about 60-80 minutes.

| R       | A       | B      | C      |
|---------|---------|--------|--------|
| Wheat flour (g) | 130    | 91     | 78     | 65     |
| Corn flour (g)  | 0      | 32.5   | 45.5   | 58.5   |
| Black soybean flour (g) | 0      | 6.5    | 6.5    | 6.5    |
| Powdered sugar (g) | 50     | 50     | 50     | 50     |
| Butter (g)      | 80     | 80     | 80     | 80     |
| Eggs (g)        | 25     | 25     | 25     | 25     |
| Strawberry slurry (g) | 10     | 10     | 10     | 10     |
| Natrium bicarbonat (g) | 1.5  | 1.5    | 1.5    | 1.5    |
| Salt (g)        | 0.5    | 0.5    | 0.5    | 0.5    |

2.2. Proximate and crude fiber analysis

The proximate [11] and crude fiber [12] analysis refers to Association of Official Analytical Chemists methods. The available carbohydrate content for each sample calculated by difference using the FAO/WHO procedure [13].

2.3. Statistical analysis

Data were analyzed using SPSS Statistic shoftware (22.0). Differences in means values were tested by analysis of variance. Significance levels were obtained with Duncan’s test at P<0.05.

2.4. Glycaemic index test [5,14]

2.4.1. Product preparation
The best cookies from proximate and sensory analysis [10] has a carbohydrate composition, and than it counted equivalent with 50 grams glucose.

2.4.2. Subject selection
This research has an ethical clearance approval by Research Ethics Committee of Chatolic Atma Jaya University, Jakarta, in number: 0680/III/LPPM-PM.10.05/06/2018, and all subject signed an informed consent document. The first step was screening to looked for normal subject at Agricultural Department of Garut University. Subject were selected based on having age 20-30 years old. All subject may have normal body mass index (18.5-24.9), they may have bloods pressure about <120/<80 (SIS/DIA) and fasting blood glucose ≤100 mg/dl. Exclusion criteria included the smoked subject, uncontrolled hypertension, and pregnant. The number of subject for this study were nine followers.

2.4.3. Glycaemic index test
On the day before a test, subject were not to eat or drink after 22:00 h until to 08:00 next day, or during 10 hours. In first day, subject consumed 50 grams glucose dissolved in to 250 mL water within 15 minutes. A further 250 mL water were given during the subsequent 2 hours. Blood glucose was measured by glucometer (Accu-check performa) before drinking (0 mins) and at 15, 30, 45, 60, 90, and 120 minutes intervals after the test water were given. Subject were encourage to keep minimum their physical activity during the testing. After a week, subject consumed some cookies (sample) that equivalent with 50 grams glucose. In this case, measuring of blood glucose was same with reference (glucose standard).

2.4.4 Determination of glycaemic index value
Blood glucose curves were constructed from blood glucose values from each subject at 0-120 minutes for the reference test and meals test. The curve was a relationship of the time (X axis) and blood glucose level (Y axis). The incremental area under curve (iAUC) were calculated geometrically using the trapezoid rule and ignoring the area beneath of baseline. Sample glycaemic index was calculated from the formula:

\[ \text{Glycaemic Index} = \frac{\text{iAUC (test food)}}{\text{iAUC (reference food)}} \times 100 \]

3. Results and Discussion

3.1. Proximate and crude fiber composition
The proximate and crude fiber composition of cookies from corn mixed blacksoybean flour shown in Table 2 and Table 3. Corn and black soybean flour could be reduced of wheat flour usage in this meal. They increasing of protein, lipids, ash, and dietary fiber content in cookies.

| Cookies | Moisture content (%) | Ash content (%) | Lipids content (%) | Protein content (%) | Available carbohydrate (%) |
|---------|----------------------|-----------------|--------------------|---------------------|---------------------------|
| R       | 4.07±0.16c           | 0.66±0.13a      | 27.59±0.56a        | 5.36±0.09b          | 62.33±0.33c               |
| A       | 3.08±0.00a           | 1.23±0.01b      | 30.29±0.01b        | 6.37±0.35c          | 59.04±0.36b               |
| B       | 3.79±0.07b           | 1.07±0.03b      | 29.97±0.28b        | 6.03±0.06b          | 59.15±0.31b               |
| C       | 5.05±0.19d           | 1.10±0.01c      | 29.86±0.58b        | 5.97±0.65ab         | 58.02±0.34a               |

Notes: Data on the same column with different letter superscripts are significantly different (p < 0.05) as assessed by Duncan’s test at P<0.05

The water is binding substances in cookies dough respectively. Increment corn and black soybean flour absorb a lot of water and increased the moisture content significantly (p<0.05). Protein content
was increased significantly after addition of corn and black soybean flour (p<0.05). While, lipids content was not increased significantly. Food minerals depend on ash content from it. Corn and black soybean flour addition in cookies could be reduced wheat flour usage. Corn and black soybean flour addition could be increasing cookies mineral content not significantly (Table 2). Available carbohydrate is a complex carbohydrate that contains dietary fiber. Carbohydrate complex could be controlled of blood glucose for diabetic subject.

Table 3. Crude fiber composition of cookies from corn flour mixed black soybean

| Cookies | Crude fiber content (%) |
|---------|-------------------------|
| R       | 1.59±0.01^a             |
| A       | 1.78±0.48^a             |
| B       | 3.13±0.38^b             |
| C       | 2.06±0.33^a             |

Notes: Data on the same column with different letter superscripts are significantly different (p<0.05) as assessed by Duncan’s test at P<0.05.

Wheat flour had just 0.3% crude fiber [15]. Corn flour addition could be decreased the starch content, because of it increasing crude fiber content. Low glycemic index food has low starch. Cooky B was higher crude fiber just than another cookies. Addition of corn and black soybean flour could be increased crude fiber content. This fiber could be controlled blood glucose of diabetic subject. It have 6.03±0.08% protein content that beneficial for cells improvement. Dietary fiber can be increased the indigestible carbohydrate portion in small and large intestinal and reduce the rate of carbohydrate absorption. Dietary fibers delay the glucose absorption in intestine [16]. The blood glucose level after consuming of okara food were lower than control food. Okara is by product of tofu from soybean [16].

3.2. Subject characteristic
The general characteristics of nine subjects we used shows in Table 4.

Table 4. The general characteristic of subject

| Characteristics          | Numeric |
|--------------------------|---------|
| Total subject            | 9       |
| Age (years)              | 23      |
| Height (m)               | 1.61    |
| Weight (kg)              | 55.25   |
| Body Mass Index (kg/m²)  | 21.28   |
| Fasting blood glucose (mg/dL) | 87.86 |

This volunteers consist of six men and three women. The age means of subject was 23 years old. The means body mass index was 21.28 (kg/m²), and they had 87.86 mg/dL means of fasting blood glucose. Normal body mass index is 18.5-25 kg/m². Normal fasting blood glucose is ≤126 mg/dL. Volunteers were the normal subject for this test.

3.3. Glycaemic index cookies from corn flour mixed black soybean
The glycaemic index is relevant in both preventing and managing diabetes mellitus. Diets with high glycemic index or low dietary fiber content are linked with more than twice risk of diabetes when compared to diets with low glycemic index [17]. Cooky B is the best cookies from proximate and fiber composition (Table 1 and Table 2) and sensoric value [10]. The value of glycaemic index level shown in Table 4. Based on the Table 4, this cooky have low glycemic index value, that was 40 (lower than 55).

Means of nine subject blood glucose during consume this cookies is shown on Figure 1. Based on Figure 1, the blood glucose level means cookies consumption was lower than glucose consumption. Low glycemic index diets have been shown to decreased fasting and postprandial blood glucose responses.
Protein concentrate from maize could be used to food supplementation [18]. Consuming of boiled corn could be beneficial for diabetic subject that controlled their blood glucose concentration. It cause of dietary fiber present in maize [3]. Steam maize has medium glycaemic index [19]. Black soybean contain 39% protein [20]. Protein, dietary fiber, isoflavones, and anthocyanin availability in black soybean tofu had reduced of fasting blood glucose for diabetic subjects [7]. Water soluble polysaccharide could be reduced of insulin resistance and oxidative stress on mice endoplasmic reticulum [21]. Cookies made from corn and black soybean flour could be controlling the blood glucose of diabetic subject, so it could be prefer to choice meals for diabetic subject.

| Subject | Glycaemic index | Means | Standard Deviation |
|---------|----------------|-------|-------------------|
| 1       | 44             | 40    | 17.95             |
| 2       | 37             |       |                   |
| 3       | 62             |       |                   |
| 4       | 30             |       |                   |
| 5       | 24             |       |                   |
| 6       | 41             |       |                   |
| 7       | 65             |       |                   |
| 8       | 51             |       |                   |
| 9       | 9              |       |                   |

Figure 1. Means of subject blood glucose during consume of cookies from corn mixed black soybean flour. Red line was subject blood glucose level after consumed the glucose. Blue line was subject blood glucose level after consumed the cookies.

Protein, essentials fatty acid, dietary fiber, and lechitine from black soybean reduced of blood glucose [7]. Soybean contains of phytochemical compounds such as anthocyanins and procyanidins. Dietary black soybean seed coat extract reduced blood glucose levels and enhances insulin sensitivity in type 2 diabetic mice [22]. High dietary fiber food disposed to increasing feses density and reducing transit times in colon. Dietary fiber could be controlling of glucose and lipid metabolism [23].

4. Conclusions
Corn and black soybean flour addition in cookies could be reduced wheat flour usage. Cooky B (60% wheat flour; 35% corn flour; and 5% black soybean flour) was the best cookies from proximate and sensory analysis and had taking glycaemic index test. Cookies from corn mixed black soybean flour contained moisture (3.79±0.09%), ash (1.07±0.04%), lipid (29.97±0.40%), protein (6.03±0.08%), crude fiber (3.13±0.54%), and available carbohydrate (59.15±0.44%). It has 40.00±17.95 glycaemic index and classified as low glycaemic food (less than 55).
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