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# Effect of sago consumption on NCDs clinical sign among who consuming sago in Kepulauan Meranti District, Riau Province, Indonesia

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## Abstract

**Objectives:** The objective of this study was to identify the effect of sago consumption on NCDs clinical sign among consuming sago in Kepulauan Meranti District, Riau Province.

**Design:** A cross-sectional study with selected purposively

**Setting:** The study was carried out in Kepulauan Meranti District, Riau Province, Indonesia

**Subjects:** One hundred and eighty-one subjects consuming sago.

**Outcome measures:** A questionnaire; Socio-demographic, lifestyle, family history of DM, and direct measurement; anthropometry, random capillary blood glucose (RCBG), cholesterol, systolic and diastolic blood pressure (SBP&DBP), and waist circumference (WC).

**Results:** The majority of subjects rarely and often consuming sago had RCBG categorized as RCBG <140 mm/dL (91.2%) with 65.2% normal body mass index (BMI). Socio-demographic, lifestyle (smoking and physical activity), family history of DM and clinical signs (cholesterol, SBP, DBP, and WC)were not significantly different for subjects in the RCBG<140 mm/dL group between those rare and often consuming sago. However, in the RCBG 140-200 mm/dL group, education level, family income, family history of DM, DBP and cholesterol significantly differed. There was a significant correlation between sago consumption with cholesterol and WC.

**Conclusions:** Consuming sago may have the potential as an alternative food to prevent the NCDs.

**Keywords:** Non-communicable diseases, prevention, risk factor, sago

## Introduction

Non-communicable diseases, (NCDs), are the leading cause of mortality worldwide with 41 million deaths each year, equivalent to 71% of all deaths globally. Each year, 15 million people die from an NCD between the ages of 30 and 69 years; over 85% of these "premature" deaths occur in low- and middle-income countries. Cardiovascular diseases account for most NCD deaths, or 17.9 million people annually, followed by cancers (9.0 million), respiratory diseases (3.9million), and diabetes mellitus or DM (1.6 million). A combination of genetic, physiological, lifestyle and environmental factors can cause these diseases. Some risk factors include unhealthy diets, lack of physical activity, smoking and secondhand smoke, and excessive use of alcohol [37].

DM is one of NCDs Individuals experiencing RCBG 140-200 mm/dL (5-10%) can be at risk of developing DM which is a heterogeneous metabolic disorder characterized by long-term impairment of insulin secretion and damage [36,23]. RCBG 140-200 mm/dL is a condition in which the blood glucose level is higher than RCBG <140 mm/dL but lower than the threshold of diabetes mellitus [31,36]. The prevalence of DM in the world continues to increase, and Indonesia is at sixth [16]. According to the data of the Indonesian Basic Health Research [20], the prevalence of DM under 15 doubled (2.1%).

The prevalence of DM in Riau Province was 1.0%, while it was 0.6% in Kepulauan Meranti District [20]. Type 2 diabetes mellitus (T2DM)is the most common form observed in adults. Two major groups of factors influence it, being unchangeable factors such as gender, age, the genetic history of DM, and changeable factors as smoking, alcohol, physical activity, obesity, hypertension, cholesterol, and sedentary [9,33,4,16].

Decreasing the sensitivity of target tissues to the metabolic effects of insulin, known as insulin resistance in tissues, is one of the causes of T2DM. Obesity is one of the many risk factors that cause T2DM which can be measured through WC and BMI. The prevention of T2DM can be carried out by controlling the risk factors [20,4]. Some studies showed that traditional food could be an alternative to preventing RCBG 140-200 mm/dL from becoming T2DM by reducing hyperglycemia, insulin resistance, and obesity [30].

Sago is a traditional source of carbohydrates, besides rice, widely available in Indonesia (5.2 million hectares or ± 50% of the sago area in the world). It is spread in several provinces including Riau Province with Kepulauan Meranti District as a sago producer [6]. Sago is still consumed by most people even though it is not considered as a staple food. It has several advantages over other sources of carbohydrates. Sago has a low glycemic index (GI) around 27. It also contains resistant starch, high starch and amylose, and antioxidant. These nutrients play a role in maintaining RCBG <140 mm/dL blood glucose by increasing the number of beta cells producing insulin, reducing hypoglycemic and improving lipid metabolism [11;33,21,35]. However, rice, as the main source of carbohydrate in Asia, has a relatively higher GI (64-93) and several studies have shown that it could increase the risk of T2DM [10,28]. On the other hand, low GI food may be useful in ameliorating hyperglycemia and glucose-over load associated with diabetic conditions [17].

Studies have shown that consuming sago was good for health in that it reduced blood glucose, LDL cholesterol, and triglycerides level. Thus, it could reduce the risk of T2DM, and heart disease [36,11,2]. Although Kepulauan Meranti District is a sago-producing region, T2DM incidence is still observed in the area. Therefore, researchers were interested to identify the effect of sago consumption on NCDs clinical sign among the sago-based agricultural community in Kepulauan Meranti District, Riau Province.

## Materials & Methods

### Study Setting and Subjects

This study used a cross-sectional design and was carried out from June to September 2017 in Kepulauan Meranti District, Riau Province. The research protocol was approved by the Research Ethics Commission involving Human Subjects of Bogor Agricultural University: 031/IT3. KEPMSM-IPB/SK/2017.The study involved 181 subjects living in several villages, namely Sungai Tohor, Tanjung Sari, Nipah Sendanu, Batin Suir and Lalang Tanjung. The subjects were selected purposively. The inclusion criteria were 1) the age of the subject, 35-80 years, 2) not hospitalized, and 3) not suffering from serious illness or chronic drug consumption. The subjects were divided into 2 groups; 1) a group consuming sago<140 g/day, and 2) a group consuming sago ≥140 g/day.

### Data Collection Procedure

The interviewer used questionnaires to collect data on the characteristics of the subjects (age, sex, education level, occupation, and family income). Anthropometry measurement was used to describe the BMI which consisted of weight and height using the SECA brand weighed (capacity of 100 kg, accuracy of 0.1 kg) and microtome stature meter (the accuracy of 0.1 cm). The BMI was calculated through the formula of weight (kg) divided by height (m) squared. The measurements of WC were conducted using a tape measure (0.1 cm accuracy). The measurement of RCBG and cholesterol was done using Easy Touch Model: GCU Made In Taiwan with glucose strips and cholesterol. Sphygmomanometer was used to determine SBP and DBP.

The family history of DM was obtained from questionnaires. Physical activity was recorded based on physical activity forms or daily activities in minutes monitored in 24-hour activities. All values were expressed in metabolic multiples of BMR called metabolic rate (MR). The results of the calculation of the metabolic rate were categorized according to the assessment of physical activity levels. It was classified into high (MR>2.09), moderate (MR<1.76-2.09) and mild (MR<1.76). Smoking exposure was obtained from a questionnaire.

### Measurement of Dietary intake

The amount of sago (consumed by the subjects) was determined by the SQ-FFQ questionnaire from 71 food items and analyzed using the Indonesia food table composition in 2013. The amount of sago was summed in 1 week based on meal frequency and divided by seven to get the daily consumption. This study surveyed the information about the meals, foods, and items consumed for 24 h before the survey and explained that it was a survey on the intake, which would reflect the subjects' dietary life level in ordinary times, recorded from food recall 24 h. To assess the subjects' sago consumption, this study examined the levels of intake of several kinds of sago product like sago noddle, bihun sago, lempeng sago (sago plus grated coconut in the shape of a plate eaten with fried anchovy), sempolet (sago pulp with added shrimp, snails, squid or shellfish and fern vegetables), sago rendang (small granule sago eaten with bananas), gobak (such as sago plates but not shaped plates), sago mutiara (sago in the form of granules cooked with added sugar and coconut milk), kapurun (sago pulp eaten with fish curry), sesagon (sago in grains with coconut grated), and sago lemak (sago in the form of granules made with the addition of coconut milk).

## Statistical Analysis

The analysis was conducted using SPSS 18.0 (IBS SPSS Statistics, Armonk, NY, USA). The data on food intake were processed using Nutrisurvey software. Data for the descriptive statistics of the variables were expressed as mean ± standard deviation (SD). Bivariate analysis using an independent t-test to compare the two groups and a Pearson correlation to find out the relationship among the factors with RCBG 140-200 mm/dL. A p-value <0.05 and ≤0.01 was considered significant. Grouping of subjects based on the research by Hariyanto et al.,[11] which states that sago consumption 140gr / day could reduce blood glucose, cholesterol and triglyceride levels in diabetic patients.

## Results

### Characteristics of the Subjects

The results showed that subjects consuming sago ≥ 140 g/day (55.25%) were more than those consuming<140g/day (44.75%). Subject consuming ≥ 140 g/day sago were mostly female with age ≥ 50 years (56%), and male (44%). Most of the subjects had low education in both groups, i.e., <140 g/day (81.5%) or ≥140 g/day (91%), respectively. Most of the subjects had low income in both groups, consuming sago <140 g/day (86.4%) and ≥140 g/day (94%).

As shown in Table 2,the means BMI(23.67 ± 5.09) in both groups consuming sago <140 g/day and ≥140 g/day were categorized as RCBG <140 mm/dL (65.2%). These results were supported by data in Table 1, i.e., the mean physical activity that was heavy(66.9%). Generally, subjects were active or passive smokers(83.4%) in both groups without a family history of DM (92.3%).

The present study showed that the highest frequency of sago consumption was (1x/day,> 1x/day) 39.22% with the number of sago consumption of 173.73 ± 88.27 /g/day. A percentage (71.16%) of the subjects had consumed sago for more than ten years. The obtained measurements of RCBG from subjects were categorized as RCBG <140 mm/dL compared to those of RCBG 140-200 mm/dL subjects consuming sago <140 grams/day (40.88%) and ≥140 grams/day (52.28%), as presented in Figure 1.

### Subjects Condition of RCBG 140-200 mm/dL

The results showed that the mean RCBG subject was 102.28 ± 27.76 mm/dL, which was still within the range of the normal category (91.2%), while RCBG 140-200 mm/dL was 8.8%. The factors for incidence of RCBG 140-200 mm/dL were the variables in this study; BMI, SBP, DBP, cholesterol, and WC commonly categorized as normal (Table 2).

There was no significant difference in RCBG 140-200 mm/dL subjects between groups consuming sago <140 g/day and≥140 g/day in all variables. Educational levels, family income/month and family history of DM for RCBG <140 mm/dL subjects were significantly different among the groups (Table 3).

The clinical sign showed no significant difference for RCBG 140-200 mm/dL subjects between group consuming sago <140 gr/day and≥ 140 gr/day for variables such as BMI, SBP, DBP, cholesterol, and WC. DBP and cholesterol in RCBG <140 mm/dL subject significantly differed between the groups (Table 4).

Table 5 illustrated Pearson'sx2 with p-value among factors. This assumed that those correlation among factors were highly significant with a p-value less than 0.01(<1%) and significant if a p-value less than 0,05 (<5%). There were highly significant correlation between SBP, DBP and cholesterol (p=0.000, x2=59.8 and p=0.001, x2=24.2) and among WC with BMI (p=0.000, x2=75.6). There were also significant correlation between sago consumption, cholesterol, and WC (p=0.026, x2-16.5 and p=0.019, x2=17.5); and between RCBG and SBP (p=0.013. x2=18.4).

## Discussion

The present study suggested that the effect of sago consumption could be seen from the measurement of RCBG in the two groups. Some studies showed that gender, age, and level of education were significant factors associated with the incidence of RCBG 140-200 mm/dL [15,5], while occupation and family income levels were not significantly associated with the incidence of RCBG 140-200 mm/dL [29,15].

Education determines a person's knowledge of the food pattern [33]. However, in general, high income and good work will lead to a person consuming high-fat and high-carbohydrate food, as well as a lack of consumption of food fiber which can cause a risk of RCBG 140-200 mm/dL [25]. Some studies suggested that a family history of DM was significantly associated with the incidence of T2DM [18].

An association between WC and BMI was found in the present study. Other studies have also demonstrated that obesity was a risk factor for RCBG 140-200 mm/dL [34,14]. Obesity can be seen from BMI which is usually associated with blood glucose levels in patients with T2DM and can be reduced by low GI and high fiber food consumption [19] Sago is

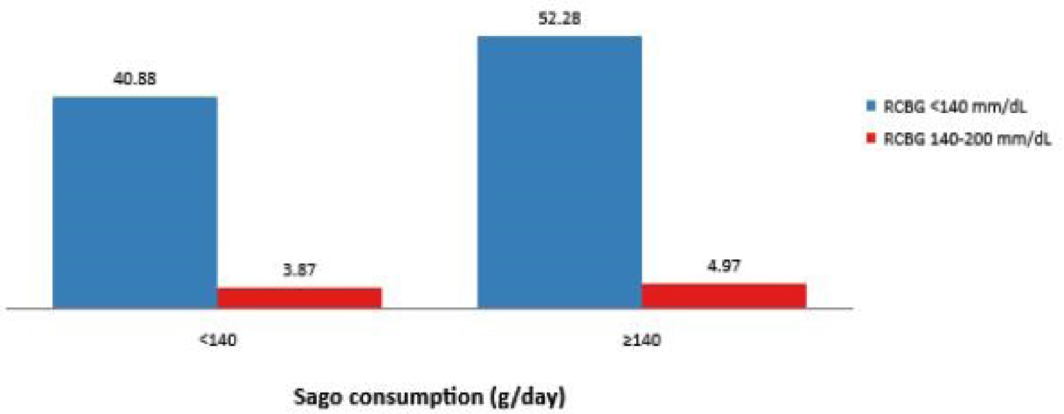


Figure 1. Random capillary blood glucose are based on the amount of sago consumption

| Characteristic | Group consuming sago | |
|---|---|---|
| | Rarely (n=81)<br>n (%) | Often (n=100)<br>n (%) |
| Gender | | |
| Man | 26(32.1) | 36(36) |
| Women | 55(64.9) | 64(64) |
| Age | | |
| <50 year | 41(50.6) | 44(44) |
| ≥50 year | 40(49.4) | 56(56) |
| Educational level | | |
| Low education | 66(81.5) | 91(91) |
| High education | 15(18.5) | 9(9) |
| Occupation | | |
| Not occupation | 23(28.4) | 29(29) |
| Occupation | 58(71.6) | 71(71) |
| Family Income/month | | |
| Low | 70(86.4) | 94(94) |
| High | 11(13.6) | 6(6) |
| Physical activity | | |
| High | 55(67.9) | 66(66) |
| Moderat | 26(32.1) | 34(34) |
| Smoking | | |
| Yes | 67(82.7) | 84(84) |
| No | 14(17.3) | 16(16) |
| Family History of DM | | |
| Yes | 9(11.1) | 5(5) |
| No | 72(88.9) | 95(95) |

Table 1. Characteristics of subjects from the group that consumes sago <140 g/day and ≥ 140 g/day

| Variable | Groups consuming sago | | Mean±SD |
|---|---|---|---|
| | Rarely(n=81) | Often(n=100) | |
| | n (%) | n (%) | |
| RCBG | | | 102.28 ± 27.76 |
| <140 mg/dL | 74(91.4) | 91(91) | |
| 140-200 mg/dL | 7(8.6) | 9(9) | |
| BMI | | | 23.67±5.09 |
| 18.5 - 24.9 kg/m2 | 49(60.5) | 69(69) | |
| 25–27.0 kg/m2 | 32(39.5) | 31(31) | |
| SBP | | | 132.04±25.52 |
| Normal (<130 mm/Hg) | 42(51.9) | 52(52) | |
| Hypertension (≥130 mm/Hg) | 39(48.1) | 48(48) | |
| DBP | | | 82.39±14.26 |
| Normal (<80 mm/Hg) | 42(51.9) | 64(64) | |
| Hypertension (≥80 mm/Hg). | 39(48.1) | 36(36) | |
| Choolesterol | | | 171.03±66.28 |
| Normal (≤200 mg / dL) | 55(67.9) | 77(77) | |
| High (≥200 mg dL). | 26(32.1) | 23(23) | |
| WC | | | 85.21±12.08 |
| Normal: Men (<90 cm) & Women (<80 cm) | 57(70.4) | 70(70) | |
| High risk: Men (≥90 cm) & Women (≥80 cm). | 24(29.6) | 30(30) | |

Table 2. Distribution of subjects' clinical sign

RCBG, random capillary blood glucose; BMI, body mass index, SBP, systolic blood pressure; DBP, diastolic blood pressure; Cholesterol; WC, waist circumferences

| | RCBG <140 mm/dL (n=16) | RCBG 140-200 mm/dL (n=165) | | | | |
|---|---|---|---|---|---|---|
| | Rarely | Often | p-value | Rarely | Often | p-value |
| Gender | | | 0.257 | | | 0.659 |
| Man | 2(28.6)2) | 5(55.6) | | 24(32.4) | 31(34.1) | |
| Women | 5(71.4) | 4(44.4) | | 50(67.6) | 60(65.9) | |
| Age | | | 0.158 | | | 0.510 |
| <50 year | 4(57.1) | 2(22.2) | | 37(50) | 42(46.2) | |
| ≥50 year | 3(42.9) | 7(77.8) | | 37(50) | 49(53.8) | |
| Educational level | | | 0.727 | | | 0.000 |
| Low | 6(85.7) | 8(88.9) | | 60(81.1) | 83(91.2) | |
| High | 1(14.3) | 1(11.1) | | 14(18. | 8(8.8) | |
| Occupation | | | 0.705 | | | 0.957 |
| No occupation | 2(28.6) | 3(33.3) | | 21(28.4) | 26(28.6) | |
| Occupation | 5(71.4) | 6(66.7) | | 53(71.6) | 65(71.4) | |
| Family Income/ month | | | - | | | 0.000 |
| Low | 7(100) | 9(100) | | 63(85.1) | 84(93.4) | |
| High | 0(0) | 0(0) | | 11(14.9) | 6(6.6) | |
| Physical activity | | | 0.158 | | | 0.268 |
| High | 4(57.1) | 7(77.8) | | 51(68.9) | 59(64.8) | |
| Moderat | 3(42.9) | 2(22.2) | | 23(31.1) | 32(35.2) | |
| Smoking | | | 0.727 | | | 0.715 |
| Yes | 6(85.7) | 8(88.9) | | 61(82.4) | 76(83.5) | |
| No | 1(14.3) | 1(11.1) | | 13(17.6) | 15(16.5) | |
| Family History | | | - | | | 0.002 |
| Yes | 7(100) | 9(100) | | 65(87.8) | 86(94.5) | |
| No | 0(0) | 0(0) | | 9(12.2) | 5(5.5) | |

Table 3. Subjects' demographic characteristics according to sago consumption
All estimates were weighted and calculated taking the complex study design into account.
P-value was obtained from a t-test independent, P value < 0.05

| Characteristic | RCBG <140 mm/dL (n=16) | RCBG 140-200 mm/dL (n=165) | | | | |
|---|---|---|---|---|---|---|
| | Rarely | Often | p-value | Rarely | Often | p-value |
| BMI (kg/m2) | | | 0.158 | | | 0.064 |
| Normal | 4(57.1) | 7(77.8) | | 45(60.85.1) | 62(68.1) | |
| Overweight | 3(42.9) | 2(22.2) | | 29(39.2) | 29(31.9) | |
| SBP (mmHg) | | | 0.705 | | | 0. 958 |
| Normal | 5(71.4) | 6(66.7) | | 34(45.9) | 42(46.2) | |
| Hypertension | 2(28.6) | 3(33.3) | | 40(54.1) | 49(53.8) | |
| DBP (mmHg) | | | 0.705 | | | 0.033 |
| Normal | 5(71.4) | 3(33.3) | | 34(45.9) | 33(36.3) | |
| Hypertension | 2(28.6) | 6(66.7) | | 40(54.1) | 58(63.7) | |
| Cholesterol (mm/Hg) | | | 0.258 | | | 0.025 |
| Normal | 3(42.9) | 2(22.2) | | 23(31.1) | 21(23.1) | |
| High | 4(57.1) | 7(77.8) | | 51(69.9) | 76(76.9) | |
| WC (cm) | | | 0.257 | | | 0.747 |
| Normal | 2(28.6) | 4(44.4) | | 22(29.7) | 26(28.6) | |
| High risk | 5(71.4) | 5(55.6) | | 52(70.3) | 65(71..4) | |

Table 4. Subjects' clinical signs according to sago consumption
All estimates were weighted and calculated taking the complex study design into account.
BMI, Body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; WC, waist circumferences.
P-value was obtained from a t-test independent, P value < 0.05

| Sago consumption | | | | | | |
|---|---|---|---|---|---|---|
| x2 | 12.6 | -8.6 | -13.4 | -16.5 | 17.5 | 9.1 |
| P | 0.092 | 0.25 | 0.071 | 0.026 | 0.019 | 0.221 |
| RCBG | | | | | | |
| x2 | | 18.4 | -5.4 | 0.9 | 9.8 | -112 |
| P | | 0.013 | 0.472 | 0. 906 | 0.188 | 0.875 |
| SBP | | | | | | |
| x2 | | | 59.8 | 24.2 | 8.1 | -2.7 |
| P | | | 0.000 | 0.001 | 0.279 | 0.715 |
| DBP | | | | | | |
| x2 | | | | 8.3 | 11.1 | 9.3 |
| P | | | | 0.266 | 0.136 | 0.211 |
| Cholesterol | | | | | | |
| x2 | | | | | 1.5 | -11.8 |
| P | | | | | 0.845 | 0.113 |
| WC | | | | | | |
| x2 | | | | | | 75.6 |
| P | | | | | | 0.000 |

Table 5 Correlation among significant factors among subjects consuming sago
All estimates were weighted and calculated taking the complex study design into account.
RCBG, random capillary blood glucose; BMI, Body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; WC, waist circumferences.
P-value was obtained from a Pearson correlation test, P-value < 0.05

a low GI food. This mechanism occurs because the suspension of food (chyme) reaches the small intestine slowly, absorption of glucose in the small intestine becomes slow, and fluctuations in blood glucose levels are also relatively small [1].

Association between sago consumption, cholesterol and WC supported by a study by Amir et al., [2] showed that sago consumption patterns could affect the levels of LDL. Trisnawati et al.,[33] showed that cholesterol levels were significantly associated with the incidence of RCBG 140-200 mm/dL. Some studies suggested that WC was significantly associated with the incidence of T2DM [26-27], causing an increase in FFA, damaging pancreatic β cells that could produce insulin due to lipotoxicity [20]. This mechanism occurs because cholesterol plays a role in pancreatic beta cell dysfunction through an increase in serum cholesterol which increases pancreatic cholesterol and free fatty acids, especially in the case of obesity [13].

In the present study, it was observed that there were associations between RCBG and SBP. Several studies have shown that blood pressure was significantly associated with the incidence of RCBG 140-200 mm/dL which mechanism was related to high sodium intake causing changes in insulin sensitivity and insulin plasma concentration associated with nitric oxide pathways [15,33,22].

The carbohydrate adequacy of the subjects in this study, besides rice, was fulfilled by sago which had high fiber and amylose content, resulting in more resistant starch which became prebiotics for the intestines and facilitated digestion [24]. The high amylose content in sago was due to the presence of α- (1,4) - glycosidic bonds that were not branched with a more crystalline structure and stronger hydrogen bonds, making it difficult to be hydrolyzed by digestive enzymes and resulting in slow digestion. High levels of amylose also slow down the digestion of starch to cause low IG [3]. The high content of sago fiber also affected blood sugar [8]. The subjects in this study had normal energy and carbohydrate intakes (1,848 kcal and 284.5 g, respectively), normal energy and carbohydrate adequacy levels(91.9% and 93.6%, respectively). However, there was a mild deficit in protein intake and level of adequacy (48.3 g and 84.9%, respectively), with even excessive fat intake.

### Limitations and Strengths of the Study

This study had several benefits. Specifically, it was one of the community nutrition studies to find out the effect of sago consumption among people consuming sago for a long time. Despite these benefits, our study had some limitations. It did not measure the fasting blood glucose or postprandial blood glucose and profile lipid of the subjects.

## Conclusion and Recommendation

In conclusion, RCBG subjects were categorized as <140 mm/rather than RCBG 140-200 mm/dL with normal BMI in both groups. There was a significant correlation between sago consumption with cholesterol and WC. The results of this study provided an alternative food to control NCDs signs through planning meal and dietary management with sago product.

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