

## TEPUNG GAYAM (*Inocarpus fagifer* Forst.): INDEKS GLIKEMIK, SIFAT FUNGSIONAL, MODIFIKASI SIKLUS *AUTOCLAVING-COOLING* SERTA SIFAT GIZI *IN VITRO* DAN *IN VIVO*

### INTISARI

**Latar belakang.** Gayam merupakan pangan lokal yang mengandung amilosa yang tinggi dan berpotensi sebagai bahan untuk pembuatan tepung kaya pati resisten. Pati resisten mempunyai manfaat fisiologis dalam menurunkan kadar glukosa dan memperbaiki profil lipid darah. Tepung kaya pati resisten ini sangat diperlukan untuk mencegah penyakit diabetes mellitus dan dislipidemia. Kendala pada proses pengolahan gayam menjadi tepung adalah terjadinya pencoklatan yang disebabkan reaksi oksidasi dari enzim polifenolase. Salah satu cara untuk mencegah terjadinya pencoklatan adalah dengan perlakuan pre-gelatinisasi. Pre-gelatinisasi merupakan proses pemanasan dengan perebusan yang dilanjutkan pengeringan. Cara ini juga dapat meningkatkan pati resisten. Perlakuan lanjutan untuk meningkatkan kadar pati resisten tepung gayam dapat menggunakan modifikasi siklus *autoclaving-cooling* pada tepung yang dipreparasi dengan perlakuan pre-gelatinisasi. Dalam rangka pengembangan pangan lokal, maka gayam perlu dikaji potensinya sebagai pangan lokal yang digunakan untuk bahan tepung termodifikasi kaya pati resisten dikaitkan dengan efek menurunkan kadar glukosa dan memperbaiki profil lipid darah.

**Tujuan.** Tujuan penelitian ini adalah untuk mengidentifikasi karakteristik tepung gayam dengan perlakuan pre-gelatinisasi, menentukan indeks glikemik tepung gayam dengan perlakuan pre-gelatinisasi, mengidentifikasi sifat fungsional tepung gayam yang dimodifikasi siklus *autoclaving-cooling*, mengevaluasi kapasitas penghambatan absorpsi glukosa dan pengikatan asam empedu dari tepung gayam yang dimodifikasi siklus *autoclaving-cooling*, serta mengevaluasi sifat gizi dalam menurunkan kadar glukosa dan memperbaiki profil lipid darah dari tepung gayam yang dimodifikasi siklus *autoclaving-cooling*.

**Metode.** Bahan utama menggunakan gayam yang diperoleh dari Kabupaten Bantul, Daerah Istimewa Yogyakarta. Gayam yang digunakan dipilih berwarna coklat kekuningan, masak di pohon, berumur 3-4 bulan dan berat 75-110 g/biji (ukuran sedang-besar). Penelitian ini meliputi 5 (lima) tahap yaitu: (i) preparasi tepung gayam dengan perlakuan pre-gelatinisasi dengan variasi waktu 15, 30 dan 45 menit, (ii) penentuan indeks glikemik tepung gayam yang dipreparasi dengan pre-gelatinisasi, (iii) modifikasi dan identifikasi sifat fungsional tepung gayam menggunakan modifikasi siklus *autoclaving-cooling* dengan variasi 1-5 siklus, (iv) uji sifat gizi *in vitro* meliputi penghambatan absorpsi glukosa dan kapasitas pengikatan asam empedu, dan (v) uji sifat gizi tepung gayam termodifikasi dalam menurunkan kadar glukosa dan memperbaiki profil lipid *in vivo*. Uji *in vitro* dan *in vivo* menggunakan tiga jenis diit yang terdiri dari diit tepung gayam alami (DGA), diit tepung gayam pre-gelatinisasi 45 menit (DP45) dan diit tepung gayam pre-gelatinisasi 45 menit yang dimodifikasi tiga siklus *autoclaving-cooling*.

(DPAC3). Pada uji *in vivo* disiapkan pakan isokalori untuk tiga kelompok tikus Wistar diabetes yaitu kelompok yang diberikan diet DGA, DP45, dan DPAC3. Tikus Wistar non diabetes dan diabetes yang diberi pakan standar digunakan sebagai kontrol sehat (KS) dan kontrol diabetes (KD).

**Hasil.** Hasil penelitian menunjukkan bahwa perlakuan pre-gelatinisasi dapat meningkatkan indeks putih dan kadar pati resisten tepung gayam. Tepung pre-gelatinisasi selama 45 menit memiliki indeks putih paling tinggi (83,77) dan kadar pati resisten paling tinggi (17,92%). Menggunakan glukosa sebagai pangan standar, indeks glikemik tepung tanpa pre-gelatinisasi/tepung gayam alami, tepung pre-gelatinisasi 15, 30 dan 45 menit secara berturut-turut sebesar 74, 75, 71 dan 57. Modifikasi siklus *autoclaving-cooling* dapat meningkatkan kadar pati resisten serta beberapa sifat fungsional yakni densitas kamba, kapasitas pengikatan air, kapasitas pengikatan minyak, daya pengembangan dan viskositas balik. Tepung gayam termodifikasi 3 siklus *autoclaving-cooling* memiliki kadar pati resisten yang paling tinggi (28,12%). Modifikasi tidak mempengaruhi morfologi granula dan kristalinitas. *Scanning electron microscopy* menunjukkan granula pati memiliki bentuk yang tidak beraturan, permukaan kasar dan heterogen. Analisis *X-ray diffraction* menunjukkan seluruh tepung gayam memiliki kristalinitas tipe C. Penelitian *in vitro* menunjukkan bahwa kapasitas pengikatan asam empedu dan penghambatan absorpsi glukosa lebih signifikan pada DPAC3 dibandingkan diit DGA dan DP45. Pada kelompok perlakuan, setelah 28 hari percobaan, kadar glukosa darah, insulin, HOMA-IR, kolesterol total, kolesterol LDL, trigliserida dan indeks aterogenik mengalami penurunan, sedangkan kolesterol total, HOMA- $\beta$ , GLUT4, HDL serta SCFA mengalami peningkatan. Efek tersebut terlihat lebih signifikan pada kelompok DPAC3 dibanding DGA dan DP45.

#### **Kesimpulan.**

Semakin lama waktu pre-gelatinisasi menghasilkan indeks putih dan kadar pati semakin tinggi. Tepung gayam pre-gelatinisasi 45 menit memiliki indeks glikemik yang lebih rendah dibandingkan tepung gayam alami serta tepung gayam pre-gelatinisasi 15 dan 30 menit. Modifikasi siklus *autoclaving-cooling* meningkatkan kadar pati resisten, densitas kamba, WHC, OHC dan daya pengembangan. Diit DPAC3 memberikan efek menurunkan kadar glukosa dan memperbaiki profil lipid darah yang paling baik dibandingkan diit DGA dan DP45.

**Kata kunci:** tepung gayam, pre-gelatinisasi, indeks glikemik, siklus *autoclaving-cooling*, glukosa darah, profil lipid

## GAYAM (*Inocarpus fagifer* Forst.) FLOUR: GLYCEMIX INDEX, FUNCTIONAL PROPERTIES, AUTOCLAVING-COOLING CYCLES MODIFICATION, AND NUTRITION PROPERTIES IN VITRO AND IN VIVO

### ABSTRACT

**Background.** Gayam is a local food, has high amylose content and is a good potential as a source of flour having high resistant starch content. Resistant starch has a positive impact on health, such as preventing the increase in blood glucose and cholesterol levels significantly. The high resistant starch in flour is needed for prevention of diabetes mellitus and dyslipidemia. A major problem of processing gayam seed into gayam flour is the formation of brown color due to the oxidation reaction of polyphenol groups by enzymes. Pre-gelatinization is method to eliminate polyphenol enzymes activity. Pre-gelatinization is a hydrothermal process that consists of boiling and drying. Gayam flour preparations enriched in resistant starch were obtained from pre-gelatinized gayam flour by consecutive autoclaving-cooling cycles treatments. For development of local food, gayam needs to be assessed for its potential as the high resistant starch flour as a modified flour associated with decreased glucose levels and improved blood lipid profile.

**Objectives.** The objectives of this study was to identify the physical and chemical properties of pre-gelatinized gayam flour, to determine the glycemic index of pre-gelatinized gayam flour, to identify the functional properties of modified gayam flour from different number of autoclaving-cooling cycles, to evaluate the nutritional properties in vitro (inhibition capacity of glucose absorption and binding capacity of bile acids) modified gayam flour, to evaluate the nutritional properties in vivo (hypoglycemic and hypocholesterolemic) modified gayam flour, and to study the mechanism of the effect of decreased blood glucose and improved lipid profil.

**Methods.** Gayam seeds were obtained from Bantul, Yogyakarta, Indonesia, and had the following characteristics: russet color, ripe on tree, age 3-4 months, and weight 75-110 g/seed (medium-big size). This research was conducted in five steps as follows: (1) preparation gayam flour by pre-gelatinization treatment for 15, 30, and 45 minutes, (2) determination of glycemic index of pre-gelatinized gayam flour, (3) modification of gayam flour by autoclaving-cooling 1-5 cycles and identification of functional properties, (4) evaluation the in vitro absorption of glucose and binding of bile acids, and (5) evaluation the in vivo effects in blood glucose and cholesterol levels. In vitro and in vivo steps consisted of three diet i.e (a) native gayam flour diet (DGA), pre-gelatinized gayam flour for 45 minutes diet (DP45), and modified gayam flour by autoclaving-cooling for three cycles diet (DPAC3). In vivo studies was prepared as isocaloric feed for three groups of diabetic Wistar rats i.e DGA, DP45, and DPAC3 diet. Non diabetic and diabetic Wistar rats which were fed with standart feed were used as control (KS) and diabetic group (KD), respectively.

**Results.** The results showed the pre-gelatinization treatment increased the whiteness index and resistant starch content of gayam flour. The pre-gelatinized gayam flour for 45 minutes has highest whiteness index (83.77) and resistant starch content (17.92%). Using glucose as the reference food, the glycemic index values of native gayam flour, pre-gelatinized gayam flour boiled for 15, 30, and 45 min were 74, 75, 61, and 57, respectively. The autoclaving-cooling cycles treatment increased resistant starch content, and several functional properties, i.e bulk density, water holding capacity, oil holding capacity, swelling power and setback viscosity. The modified gayam flour by autoclaving-cooling for three cycles has highest of resistant starch content (28,12%). Modifications did not affect the granule morphology and crystallinity. Scanning electron microscopy showed that the forms of gayam flour granules of were irregular shape, rough surface and heterogen. X-ray diffraction studies showed that all the gayam flour exhibited C-type diffraction pattern. In vitro studies showed that the bile acids capacity and the inhibition glucose absorption were more significant in DPAC3 than DGA and DP45 diet. After 28 days experiments, blood glucose, insuline, HOMA-IR, total cholesterol, LDL cholesterol, trigliseride and atherogenic index were decreased, while HOMA- $\beta$ , GLUT4, HDL cholesterol and SCFA were increased in treatment groups, were more significant in DPAC3 than DGA and DP45 diet.

**Conclusions.** Longer pre-gelatinization times increase the whiteness index and resistant starch content. The glicemic index values of pre-gelatinized gayam flour boiled for 45 minutes had lower than native gayam flour, pre-gelatinized gayam flour boiled for 15 and 30 minutes. Autoclaving-cooling cycles treatments significantly increased the resistant starch content, bulk density, WHC, OHC and swelling power. The effect in hypoglycemic and hypocholesterolemic of DPAC3 diet had highest than DGA diet and DP45 diet.

**Keywords:** gayam flour, pre-gelatinization, glycemic index, autoclaving-cooling cycles, blood glucose, lipid profil