

ABSTRAK

Prevalensi diabetes di Indonesia dan global terus meningkat tiap tahun. Selain faktor pola makan yang tidak seimbang, seperti diet tinggi karbohidrat dan tinggi lemak, stres oksidatif juga menjadi pemicu kondisi gangguan metabolik ini. Beras ketan hitam secara alami mengandung senyawa fenolik yang memiliki aktivitas antioksidan tinggi, melindungi sel β -pankreas dari kerusakan oksidatif sehingga memperbaiki resiko diabetes. Selain itu, senyawa fenolik memiliki peran antidiabetik lain, yaitu menghambat aktivitas enzim α -glukosidase dan enzim DPP-IV. Adanya fermentasi pada tape ketan hitam diduga dapat meningkatkan ketersediaan senyawa fenolik yang larut, menjadikannya lebih mudah diakses oleh tubuh dan memberikan efek antidiabetik yang lebih baik. Penelitian ini bertujuan untuk mengevaluasi potensi antidiabetik senyawa fenolik pada tape ketan hitam. Penelitian ini terbagi menjadi tiga tahap. Tahap pertama diawali dengan pembuatan tape ketan hitam menggunakan ragi tape merk NKL. Beberapa parameter uji meliputi analisis sensoris, kadar gula reduksi, kadar etanol, senyawa fenolik total, flavonoid total, aktivitas antioksidan, komposisi dan konsentrasi senyawa fenolik individu menggunakan UHPLC dan aktivitas β -glukosidase. Tahap kedua adalah penelitian *in vitro* tentang bioaksesibilitas senyawa fenolik melalui sistem pencernaan dan bioavailabilitasnya menggunakan kantung usus terbalik. Tahap ketiga melibatkan penelitian *in vitro* dan *in vivo* tentang potensi antidiabetik tape ketan hitam.

Hasil penelitian menunjukkan adanya fermentasi pada pembuatan tape ketan hitam dapat meningkatkan kandungan senyawa fenolik baik fenolik bebas (dari 4,65 menjadi 6,94 mg GAE g⁻¹ berat kering awal) maupun fenolik terlarut (dari 8,27 menjadi 8,95 mg GAE g⁻¹ berat kering awal). Peningkatan konsentrasi senyawa fenolik individu terjadi setelah fermentasi, yaitu asam kafeat (24,32%), asam vanilat (10,03%), dan asam ferulat (5,63%); sementara asam sinapic dan asam 2,4,6-trihidroksibenzoat mulai terdeteksi setelah 24 jam fermentasi. Aktivitas antioksidan fraksi fenolik bebas dan fenolik terlarut meningkat dengan penurunan nilai IC₅₀ masing-masing sebesar 35,24% dan 60,02% setelah fermentasi. Nilai bioaksesibilitas senyawa fenolik sampel sebelum fermentasi sebesar 19,89%, sementara nilai bioaksesibilitas senyawa fenolik pada sampel setelah fermentasi 72 jam meningkat menjadi 27,31% pada fase pencernaan gastrointestinal. Nilai bioavailabilitas senyawa fenolik pada segmen duodenum 27-28%, pada segmen jejunum 32-37% dan pada segmen ileum 17-18%. Pada pengujian potensi antidiabetik, ekstrak etanol tape ketan hitam fermentasi 72 jam menunjukkan potensi antidiabetik yang lebih baik dibandingkan beras ketan hitam tanpa fermentasi, ditunjukkan dengan penghambatan enzim α -glukosidase dan DPP-IV yang lebih baik (IC₅₀ masing-masing sebesar 6,27 mg/mL dan IC₅₀ 9,14 mg/mL), juga memberikan efek hipoglikemik yang lebih baik melalui penurunan glukosa darah, kadar MDA, peningkatan sekresi insulin dan perbaikan jumlah sel β pulau *langerhans* pada tikus percobaan yang diinduksi STZ-NA.

Kata kunci: antidiabetik, senyawa fenolik, tape ketan hitam, *in vitro*, *in vivo*

ABSTRACT

The prevalence of diabetes in Indonesia and globally continues to increase each year. In addition to imbalanced dietary factors such as high carbohydrate and high-fat diets, oxidative stress also acts as a trigger for this metabolic disorder. Black glutinous rice naturally contains phenolic compounds with high antioxidant activity, protecting pancreatic β -cells from oxidative damage and thus improving the risk of diabetes. Furthermore, phenolic compounds play another role in anti-diabetic activity by inhibiting the activities of α -glucosidase and DPP-IV enzymes. The fermentation process involved in black glutinous rice tape is believed to enhance the availability of soluble phenolic compounds, making them more easily accessible to the body and providing a more maximal anti-diabetic effect. This study aims to evaluate the anti-diabetic potential of phenolic compounds in black glutinous rice tape. The study is divided into three stages. The first stage begins with the production of black glutinous rice tape using NKL *ragi tape*. Several test parameters include sensory analysis, reducing sugar content, ethanol content, total phenolic compounds, total flavonoids, antioxidant activity, composition and concentration of individual phenolic compounds using UHPLC, and β -glucosidase activity. The second stage is an *in vitro* study on the bioaccessibility of phenolic compounds through the digestive system and their bioavailability using everted gut sac model. The third stage involves both *in vitro* and *in vivo* research on the antidiabetic potential of black glutinous rice tape.

The results of the study indicate that the fermentation process of yeast tape on black glutinous rice can increase the content of phenolic compounds, both free phenolics (from 4.65 to 6.94 mg GAE g⁻¹ initial dry weight) and conjugated-free phenolics (from 8.27 to 8.95 mg GAE g⁻¹ initial dry weight). The concentration of individual phenolic compounds increased after fermentation, namely, caffeic acid (24.32%), vanillic acid (10.03%), and ferulic acid (5.63%); while sinapic acid and 2,4,6-trihydroxybenzoic acid began to be detected after 24 hours of fermentation. The antioxidant activity of both free and conjugated-free phenolic fractions increased with a decrease in their respective IC₅₀ values by 35.24% and 60.02% after fermentation. The bioaccessibility value of phenolic compounds in the sample before fermentation was 19.89%, while the bioaccessibility value of phenolic compounds in the sample after 72 hours of fermentation increased to 27.31% during the gastrointestinal digestion phase. The bioavailability values of phenolic compounds in the duodenum segment were 27-28%, in the jejunum segment were 32-37%, and in the ileum segment were 17-18%. In the antidiabetic evaluation, ethanol extract from black glutinous rice tape fermented for 72 hours showed better antidiabetic potential compared to unfermented black glutinous rice, as demonstrated by better inhibition of α -glucosidase and DPP-IV enzymes (with IC₅₀ values of 6.27 mg/mL and 9.14 mg/mL, respectively), as well as better hypoglycemic effects through reductions in blood glucose levels, MDA levels, increased insulin secretion, and improvement in the number of β -cells in the langerhans islets in STZ-NA-induced experimental rats.

Keywords: anti-diabetic, phenolic compounds, black glutinous rice tape, *in vitro*, *in vivo*