

## INTISARI

Tempe merupakan makanan fermentasi kedelai khas Indonesia yang dilaporkan memiliki aktivitas anti-diabetes dan anti-disbiosis. Di Yogyakarta, tempe dibuat melalui proses perendaman kedelai yang ditambah dengan air kecutan yang mengandung bakteri asam laktat untuk menurunkan keasaman kedelai. Teknik ini tidak digunakan pada proses pembuatan tempe di luar negeri dan diduga mempengaruhi aktivitas anti-diabetes serta anti-disbiosis. Tujuan dari penelitian ini adalah untuk mengevaluasi pengaruh sumber kecutan dalam proses pembuatan tempe terhadap profil metabolik dan mikrobiom model hewan coba diabetes. Metode penelitian yang digunakan adalah eksperimen kuasi pada 35 ekor tikus galur Wistar jantan berumur 8 minggu. Induksi diabetes mellitus dilakukan melalui injeksi streptozotisin 65 mg/kg bb dan nikotinamida 230 mg/kg bb. Tikus diabetes dibagi kedalam 6 perlakuan: kontrol negatif serta kelompok tempe (tempe TA, tempe TAL, tempe TK, tempe TG, dan tempe TLP) yang diberikan secara peroral. Darah diambil sebelum (pre-test) dan setelah 30 hari perlakuan (post-test) guna analisis serum glukosa darah, kolesterol total, trigliserida, HDL, dan LDL puasa. Hewan dieutanasia pada akhir perlakuan guna analisis mikrobiom sekum menggunakan 16s rDNA sequencing. Hasil penelitian menunjukkan bahwa Firmicutes, Proteobacteria, Actinobacteria dan Bacteroidetes merupakan bakteri penyusun pada sekum tikus. Suplementasi tempe yang dibuat dari kecutan bakteri asam laktat (tempe TK, TG, dan TLP) secara bermakna ( $p < 0,05$ ) memiliki kelimpahan relatif filum *Firmicutes* dan rasio *Firmicutes/Bacteroidetes* yang tinggi serta *Proteobacteria* yang rendah. Ketiga tempe ini diketahui mampu meningkatkan kelimpahan secara bermakna ( $p < 0,05$ ) bakteri penghasil asam lemak rantai pendek seperti *Oscillospira* dan *Roseburia spp* serta menurunkan bakteri gram negatif penghasil lipopolisakarida (LPS) yaitu *Bacteroides vulgatus*, *Bacteroides fragilis*, *Bacteroides uniformis* dan genus *Burkholderia*. Terdapat perbedaan yang signifikan ( $p < 0,05$ ) pada nilai serum delta glukosa, trigliserida, HDL, LDL puasa serta indeks HOMA-IR, HOMA- $\beta$  post-test. Kadar serum kolesterol puasa, insulin puasa post-test, serta indeks keragaman alfa (Shannon, Simpson, dan Chao1) tidak berbeda signifikan antar kelompok. Suplementasi tempe yang dibuat dengan kecutan bakteri asam laktat memiliki dampak positif dalam memodulasi mikrobiota saluran cerna, memperbaiki profil glikemik, dan profil metabolik model hewan coba diabetes mellitus tipe 2.

**Kata kunci:** Bakteri asam laktat, Diabetes Mellitus, Mikrobiom, Profil Metabolik, Tempe

## ABSTRACT

Tempe is a fermented soy from Indonesia which is reported to have anti-diabetic and anti-dysbiosis activity. In Yogyakarta, tempeh is made through the process of soaking soybeans with sour water (kecutan)-containing lactic acid bacteria to reduce the acidity of soybeans. This technique is not used in the tempe-making process abroad and is thought to affect anti-diabetic and anti-dysbiosis activities of tempeh. The purpose of this study was to evaluate the effect of the source of sourness in the tempeh-making process on the metabolic profile and microbiome of a diabetic animal model. The research method used was quasi-experimental on 35 male Wistar rats aged 8 weeks. Induction of diabetes mellitus was carried out by injection of streptozotocin 65 mg/kg bw and nicotinamide 230 mg/kg bw. Diabetic rats were divided into 6 treatments: negative control and tempeh group (TA tempe, TAL tempe, TK tempe, TG tempe, and TLP tempe) which were given orally. Blood was taken before (pre-test) and after 30 days of treatment (post-test) for analysis of serum blood glucose, insulin, total cholesterol, triglycerides, HDL, and fasting LDL. Animals were euthanized at the end of treatment for cecum microbiome analysis using 16s rDNA sequencing. The results showed that *Firmicutes*, *Proteobacteria*, *Actinobacteria* and *Bacteroidetes* were the constituent bacteria in the cecum of rats. Supplementation of tempeh made with lactic acid bacteria (tempe TK, TG, and TLP) had significantly ( $p < 0.05$ ) higher relative abundance of *Firmicutes* phylum, *Firmicutes/Bacteroidetes* ratio and lower *Proteobacteria*. These three tempeh were known to significantly stimulate the growth of short-chain fatty acid-producing bacteria such as family of *Oscillospirales* and *Roseburia spp.* and to decrease the gram-negative bacteria producing lipopolysaccharide (LPS), namely *Bacteroides vulgatus*, *Bacteroides fragilis*, *Bacteroides uniformis* and the genus *Burkholderia*. There were significant differences ( $p < 0.05$ ) in the serum delta glucose, triglyceride, HDL, fasting LDL and HOMA-IR index, HOMA- $\beta$  post-test. Serum levels of fasting cholesterol, post-test fasting insulin, and alpha diversity indices (Shannon, Simpson, and Chao1) were not significantly different between groups. Supplementation of tempeh made with lactic acid bacteria has a positive impact in modulating the gastrointestinal microbiota, improving the glycemic profile, and the metabolic profile of experimental animal models of type 2 diabetes mellitus.

**Keywords:** Diabetes Mellitus, Lactic Acid Bacteria, Microbiome, Metabolic Profile, Tempe