

Optimasi Fermentasi Okara dan Karakterisasi Fisikokimia serta Teknofungsional Ekstrak Protein Tempe Gembus

INTISARI

Okara, residu tidak larut yang dihasilkan selama produksi tahu dan susu kedelai, mengandung protein dan serat dalam jumlah yang tinggi. Namun, pemanfaatannya masih terbatas karena kadar air yang tinggi dan kerusakan cepat selama penyimpanan. Fermentasi dengan *Rhizopus oligosporus* merupakan langkah tepat untuk memodifikasi protein okara melalui hidrolisis enzimatis sehingga dapat meningkatkan kualitas fungsionalnya. Dalam penelitian ini, kondisi fermentasi okara dioptimasi secara sistematis dengan tujuan meningkatkan derajat hidrolisis (DH) dan aktivitas antioksidan sebagai indikator utama sifat teknofungsional. Metode Response Surface Methodology (RSM) digunakan untuk mengevaluasi pengaruh kombinasi konsentrasi starter (0,1–0,9%), suhu fermentasi (25–45°C), dan waktu fermentasi (24–72 jam). Kondisi optimum, yaitu konsentrasi starter 0,55%, suhu 32,27°C, dan waktu fermentasi 51,6 jam, menghasilkan nilai prediksi DH dan aktivitas antioksidan tertinggi. Ekstrak protein yang diperoleh pada kondisi tersebut menunjukkan peningkatan signifikan pada nilai DH, aktivitas antioksidan, *foaming capacity* dan *emulsifying activity index* dibandingkan dengan ekstrak protein okara. Meskipun fermentasi menyebabkan penurunan kadar protein akibat aktivitas proteolitik dan pemanfaatan nitrogen oleh mikroba, kualitas fungsional ekstrak protein meningkat secara nyata. Analisis asam amino menunjukkan peningkatan total asam amino, khususnya fraksi asam amino hidrofobik, sedangkan analisis FTIR mengindikasikan adanya perubahan struktur molekuler protein setelah proses fermentasi. Hasil penelitian menunjukkan bahwa fermentasi okara pada kondisi optimum secara efektif dapat meningkatkan sifat fungsional dan bioaktifnya, sehingga berpotensi dimanfaatkan sebagai sumber protein berkelanjutan dalam pengembangan pangan fungsional.

Kata Kunci: Okara, Tempe Gembus, *Response Surface Methodology*, Derajat Hidrolisis, Aktivitas Antioksidan, Teknofungsional

Optimization of Okara Fermentation and Characterization of The Physicochemical and Technofunctional Properties of Tempe Gembus Protein Extract

ABSTRACT

Okara, an insoluble residu produced during the production of tofu and soy milk, contains relatively high level of protein and dietary fiber. However, its use is limited, primarily due to its high water content and rapid deterioration during storage. Fungal fermentation using *Rhizopus oligosporus* has been recognized as a promising approach to modify okara proteins through enzymatic hydrolysis, thereby improving their functional quality. In this study, fermentation conditions of okara for producing *tempe gembus* were systematically optimized with the aim of increasing the degree of hydrolysis (DH) and antioxidant activity, as key indicators of techno-functional properties. The Response Surface Methodology (RSM) was applied to evaluate the effect of the combination of starter concentration (0.1–0.9%), fermentation temperature (25–45°C), and fermentation time (24–72 h). The optimum conditions, namely a starter concentration of 0.55%, a temperature of 32.27°C, and a fermentation time of 51.6 h, produced the highest predicted values of DH and antioxidant activity. Protein extract obtained under these conditions showed a significant increase in DH, antioxidant activity, foaming capacity and emulsifying activity index compared to the unfermented okara protein extract, with an approximately 2.5 fold increase in DH and more than 3 fold increase in antioxidant activity. Although fermentation resulted in a reduction of total protein content due to proteolytic activity and microbial nitrogen utilization, the functional quality of the protein extract was markedly improved. Amino acid analysis showed an increase in total amino acids, especially hydrophobic residues. While FTIR analysis indicated changes in the molecular structure of protein after the fermentation process. The results of this study indicate that controlled fermentation of okara effectively improves its functional and bioactive properties, indicating that could be used as a sustainable protein in developing functional food.

Keywords: Okara, *Tempe Gembus*, Response Surface Methodology, Degree of Hydrolysis, Antioxidant Activity, Techno-functional properties