Chapter 1

Introduction

This introduction chapter presents the background of the study, which include the environmental concerns regarding soy whey generated from the tofu industry and its potential to be further utilized through fermentation with *Aspergillus oryzae.* Furthermore, this chapter also highlight the objective of this study and its hypothesis

1.1 Background

Tofu is a salt or acid coagulated water based gel, containing soy lipids and protein entrapped within its gel network. It is rich in protein, essential minerals and polyunsaturated fatty acids (Ali et al., 2021). The average tofu consumption in Indonesia reached 0.148 kg per capita per week, which is the third highest protein source consumed, just behind chicken eggs and fish meat (Badan Pusat Statistik Indonesia, 2024). According to Mahendra et al. (2024), Indonesia had approximately 84,000 business units that could produce more than 2.56 million tons, with an annual production capacity of 20 million cubic meters. Indonesia's tofu industry largely relies on conventional processing methods, which generate a large amount of waste that is not really fully utilized yet. Tofu waste is considered as an environmental pollutant, with a high Biochemical Oxygen Demand (BOD) level of 6000-8000 mg/L and Chemical Oxygen Demand (COD) of 7.500-14.000 mg/L. The high COD level still indicates the presence of high concentration of organic compounds such as protein, fat, sugar and phenolic compounds which may be further utilized (Melinda & Majdi, 2025).

Previous studies have demonstrated the potential of soy bean whey to be further utilized as a fermentation substrate. Li et al. (2025) reported that the incorporation of soybean whey into sauerkraut fermentation enhanced the activity of lactic acid bacteria, resulting in increased organic acid production and improved sensory properties. In addition to improving fermentation performance and product quality, the utilization of soy whey as a fermentation substrate is

particularly attractive due to its naturally occurring bioactive compounds. Soy whey is a rich source of polyphenols, particularly isoflavones, which are present as glucosides (daidzin: 14.30 mg/g; genistin: 27.61 mg/g) and aglycones (daidzein and genistein: 1.15 mg/g) (Xiao et al., 2015).

Fermentation through microorganisms has been known to enhance the antioxidant properties of legumes by facilitating the release of isoflavone from plant matrix or by transforming glycosides into its derivative aglycones that have better bioactivity (Yin et al., 2022). It is suggested that the fermentation of soy whey with *Aspergillus oryzae* may improve its phenolic content and antioxidant activity. The efficiency of fermentation is influenced by the carbon-to-nitrogen ratio. According to Nachon Raethong et al. (2025), the C/N optimal ratio for *Aspergillus oryzae* lies between 5:1 and 8:1. Glucose is usually added to fermentation as a carbon source due to its high catabolic priority and efficiency. Furthermore, glucose provides readily available energy required for cellular respiration and metabolic activity (Ma et al., 2024). Enhanced metabolic activity of *Aspergillus oryzae*, could lead to the production of enzymes such as β-glucosidases and protease (Sun et al., 2024). Enzymes such as β-glucosidases facilitate the hydrolysis of glycosidic bonds in glycoside, converting phenolic glycosides into their more bioactive aglycones form (Yin et al., 2022). Therefore, an increase in glucose concentration may inccrease metabolic activity and enzyme production, potentially enhancing the release and transformation of bound phenolic compounds during fermentation. However, increased glucose availability may disrupt metabolic pathways and impact the formation of secondary metabolites, therefore glucose management is critical for optimal phenolic compound release (Wang et al., 2024). The aim of this experiment is to investigate the effect of different glucose supplementation concentrations on the phenolic compounds and antioxidant activity of fermented soy whey (FSH) using *Aspergillus oryzae*. By evaluating parameters including pH, total soluble solids (°Brix), viscosity, total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activity, this study aims to determine the optimal glucose concentration that supports microbial activity and enhances the functional properties of soy whey.

1.2 Objective

The objective of this study is to evaluate the effect of glucose supplementation (0%, 1%, 3%, 5%) on the pH, total soluble solids (°Brix), viscosity, total phenolic content (TPC), total flavonoid content (TFC) and antioxidant activity of fermented soy whey by-products using *Aspergillus oryzae*.

1.3 Hypothesis

H_0 **(Null Hypothesis):** Variation in glucose concentrations (0%, 1%, 3%, and 5%) during *Aspergillus oryzae* fermentation of soy whey by-products does not significantly affect the pH, total soluble solids (°Brix), viscosity properties, total phenolic content, total flavonoid content and antioxidant activity of fermented soy whey

H_1 **(Alternative hypothesis):** Variation in glucose concentrations (0%, 1%, 3%, and 5%) during *Aspergillus oryzae* fermentation of soy whey by-products significantly affect the pH, total soluble solids (°Brix), viscosity, total phenolic content, total flavonoid content and antioxidant activity of fermented soy whey.