Chapter 1

Introduction

1.1 Background

Brewer's spent yeast (BSY) is a beer brewing byproduct made up of *Saccharomyces* sp. yeasts that are removed during or at the end of the brewing process. Estimation shows that 15 to 18 tons of BSY are disposed of per 10.000 hectoliter of beer production to prevent unwanted accumulation of hydrogen sulfide which causes sulfur off-flavor (Jaeger et al., 2024). The disposal of BSY in bulk can be quite costly for large breweries, as it requires a special treatment plant and cannot be directly discharged as an industrial waste to conventional wastewater treatment streams due to containing high chemical oxygen demand (COD) value of 0.53 kg/hL that can deplete the oxygen content in the water, rendering the water treatment plant ineffective and causing detrimental effects on the environment (Bryant et al., 2021). Consequently, breweries must invest in specialized waste treatment facilities or third party companies for BSY disposal, which increases operational costs. This has led many large-scale producers to seek applications of BSY as a strategy to reduce waste management costs.

An overlooked aspect of BSY is its chemical composition; it consists mostly of inactivated *Saccharomyces* sp. which contains up to 60% of protein, a branched-chain amino acid, and minerals that can be extracted as protein concentrates (Jacob et al., 2018). Yeast protein concentrate (YPC) exhibits higher thermal stability, superior emulsifying capability, and an allergen-free profile, offering better functional properties when compared to other conventional plant-based protein (Cao et al., 2024; Ma et al., 2023). In addition, yeast protein (YP) contains trace minerals and B-vitamins that are beneficial to the human body (Jach et al., 2022). Nevertheless, the application of BSY is quite limited to mostly aquafeed currently due to limited study which utilizes its difficult-to-extract bioactive components (Gokulakrishnan et al., 2023).

Intracellular proteins are entrapped within yeast cell walls composed primarily of mannoproteins and β-1,3-glucans. These highly resistant structures hinder solvent accessibility and reduce the effectiveness of conventional pH-shift protein extraction methods. (Kieliszek, 2025). Consequently, pretreatment steps to break the cell wall prior to extraction are crucial to effectively extract the proteins from BSY. Physical disruption techniques are economical, controllable, and appropriate for industrial application, as they are the most scalable. Sonication and high-pressure homogenization (HPH) are often used to disturb microorganism cells in large quantities (Li et al., 2025; Katsimichas et al., 2024). By introducing HPH, the yeast cell wall is ruptured by shear stress, turbulence, impact, and cavitation caused by HPH forcing cell suspensions through a tiny valve at high pressure (Katsimichas et al., 2024).

Meanwhile, high-frequency sound waves are used in sonication to create cavitation bubbles that violently burst, rupturing the cell wall and releasing intracellular proteins. Both of the aforementioned pretreatments are used in this project with the main intention to induce cell wall lysis therefore a combination of both pretreatments are also adapted to further improve the intracellular protein release from BSY which would maximize yield output and protein content of extracted protein concentrate. Nevertheless different pretreatments would have different degrees of efficiency and effect on YPC composition and functional characteristics. Therefore, the aim of this study is to investigate the effect of different treatments on the yield of protein concentrates obtained from BSY, proximate composition, as well as their functional properties.

1.2 Objective

Investigating the efficacy of various mechanical pretreatments in relation to the protein extraction yield, characterization of functional properties, and proximate composition of protein concentrate derived from BSY.

1.3 Hypothesis

H0 (null Hypotheses):

- BSY that underwent different pretreatments that consists of homogenization, sonication and a combination of both would produce protein concentrates that have closely similar proximate composition and functional properties
- Yeast protein obtained from brewer's spent yeast through homogenization, sonication and a combination of both methods would not have applicable functional characteristics

H1 (alternative hypotheses):

- BSY that underwent different pretreatments that consists of homogenization, sonication and a combination of both would produce protein concentrates with significantly different proximate compositions and functional properties
- Yeast protein obtained from brewer's spent yeast through homogenization, sonication and a combination of both methods would have functional characteristics