Chapter 1

Introduction

This chapter discusses the background, research gap, objective, and scope of the research, with a focus on the utilization of *Aspergillus oryzae*-derived mycoprotein and the significance of different drying methods in determining its quality for meat analogue applications.

1.1 Background

The global market for meat analogues is growing rapidly, with an expected annual growth rate of 7.9% from 2019 to 2024 and a projected increase in market size from US$ 4.6 billion in 2018 to approximately US$ 85 billion by 2030 (Imran & Liyan, 2023; Riyanto et al., 2022). This expansion is driven by increasing public awareness of health concerns, the environmental impacts of conventional meat production, and broader sustainability issues, which all promote a shift toward more sustainable, health-conscious food choices (Ismail et al., 2020). As a result, the demand for alternative protein sources, such as meat analogues that deliver desirable sensory attributes while minimizing environmental impact, continues to increase.

Among these alternatives, fungal-derived biomass, or mycoprotein, has gained attention as a promising raw material for meat analogue development. Mycoprotein derived from filamentous fungi such as *Aspergillus oryzae* is known to have a high protein content and a fibrous structure that contributes to meat-like texture and chewiness, making it suitable for meat analogue applications (Montebello et al., 2025). *A. oryzae* shows high adaptability and can generate protein-rich biomass, achieving higher protein yields than several other fungal strains, including *Fusarium venenatum*, under certain substrate conditions (Pratama et al., 2025). It can also utilize soy by-products from tofu production as a low-cost, sustainable substrate and has a long history of safe use in food fermentation. These characteristics highlight its potential as a sustainable and functional protein source, as demonstrated by its successful use in fungal burger patties and mycoprotein-based burgers (Gamarra-Castillo et al., 2022; Rousta et al., 2021)

However, mycoprotein from A. oryzae is typically obtained in a wet or semi-wet form after fermentation, resulting in high moisture content and limited storage stability (Majumder et al., 2023). In this form, the biomass is susceptible to microbial spoilage, depends on cold-chain handling, and is difficult to transport and use as a standardized ingredient, limiting its wider application in meat analogue products where shelf-stable and functionally consistent ingredients are preferred. Therefore, drying is important to reduce moisture and improve storage stability (Bai et al., 2023). Since drying is a heat and mass transfer process, it can alter the microstructure and hydration properties of protein-rich fungal materials, which affects the functional properties for food applications, such as water holding capacity, water and oil absorption, and texture development.

Different drying methods work through different mechanisms and produce different structural and functional outcomes. Oven drying removes water through convective heating and may promote protein denaturation, aggregation, and structural collapse, whereas freeze drying removes water by sublimation, often preserving structural integrity and creating porous matrices with altered crystallinity (Brishti et al., 2020; Yang et al., 2020). These contrasting mechanisms are expected to influence how dried mycoprotein interacts with water and oil, such as porous structures provide greater surface area and capillaries that facilitate liquid absorption and retention, while denser, collapsed structures limit liquid penetration and reduce hydration capacity, ultimately affecting the texture and juiciness of meat analogue products.

Although research on mycoprotein-based meat analogues is expanding, most studies have focused on species such as *F. venenatum*, emphasizing product formulation, nutritional composition, microbial stability, sensory attributes, and substitution performance (Devanthi et al., 2024; Gamarra-Castillo et al., 2022; Santhapur et al., 2024). In these studies, physicochemical, nutritional, and mechanical properties are typically evaluated at the product level, while initial processing steps, including drying, are treated as fixed or secondary variables. In contrast, studies on dried minced meat have shown that drying methods can strongly affect rehydration behavior, microstructure, and texture, highlighting the importance of post-processing conditions for final product quality (Aksoy et al., 2019). However, systematic investigations comparing different post-fermentation drying methods and conditions for *A. oryzae*-derived mycoprotein remain limited, and there is no comprehensive linkage between drying conditions and hydration, microstructure, and texture in meat analogue applications.

Therefore, selecting appropriate drying methods is critical to optimize the functionality of *A. oryzae* mycoprotein as a meat analogue ingredient. The aim of this study is to evaluate the effects of oven drying and freeze drying on the hydration and microstructural properties of *Aspergillus oryzae*-derived mycoprotein, and to assess the textural properties, color, and cooking yield of the rehydrated mycoprotein when applied in a beef meatball model system.

1.2 Objective

This research project aims to:

1. To evaluate the hydration and microstructural properties of wet, oven-dried, and freeze-dried mycoprotein.
2. To assess the texture properties, color, and cooking yield of beef meatball model systems formulated with wet, oven-dried, and freeze-dried mycoprotein.

1.3 Hypothesis

H_0a: There are no significant differences in the hydration properties and microstructure among wet, oven-dried, and freeze dried mycoprotein samples.

H_1a: There are significant differences in the hydration properties and microstructure among wet, oven-dried, and freeze-dried mycoprotein samples.

H_0b: There are no significant differences in texture properties, color, and cooking yield among beef meatball model systems formulated with wet, oven-dried, and freeze-dried mycoprotein.

H_1b: There are significant differences in texture properties, color, and cooking yield among beef meatball model systems formulated with wet, oven-dried, and freeze-dried mycoprotein.