Chapter 1 : Introduction

This chapter discusses the background, objectives, and hypotheses of the study on the utilization of mycoprotein in tuna-based fish balls. The chapter also outlines the research gap and the need to investigate the effects of different substitution ratios on product quality and acceptability.

1.1. Background

Indonesia's fisheries sector is supported by its geographical characteristics, as 70% of Indonesian territory consists of marine areas, which increases fish production and consumption (Saragih, 2022). This contributes to the steady and consistent increase in fish consumption in Indonesia, growing from 54.56 kg/capita (2020) to reaching 58.91 kg/capita (2024) (Ridwan, 2025). Fish is widely consumed due to their high protein content, essential fatty acids such as omega-3, vitamins, and minerals (Noreen et al., 2025). To increase product value and improve the sensorial quality, fish is commonly processed into various fish based products such as fish cakes and fish balls (Peh et al., 2024). In addition, according to Statistics Indonesia (2021), 88.13% of fish consumption in Indonesia comes from processed fish products such as nuggets and fish balls. Yellowtail fusilier (Caesio cuning) is a white fleshed fish that is commonly used in fish ball production due to their high lipid and myofibrillar protein content, including actin and myosin, which provides a strong gel forming ability and under thermal processing results in the desirable elastic and bouncy texture characteristics of fish balls (Mabuchi et al., 2018). In addition, white fleshed fish typically contains lower concentrations of myoglobin, which upon thermal processing results in a pale beige or white colored flesh (Furuta et al., 2022). The growing demand for processed fish products has increased the demand for raw materials while simultaneously raising the concerns over long-term resource availability due to excessive exploitation of fish stocks (Bogard et al., 2017). There has been a focus towards the development of formulation strategies that explores the utilization of alternative raw materials such as plant based proteins (Yao et al., 2024). Fungi have been commonly utilized into the food system, either consumed directly or used as biological agents in fermentation processes and it could serve as a good plant based alternative.

Mycoprotein is a fungal derived protein produced through aerobic fermentation, and is one of the promising alternative proteins due to its meat like characteristics, high amount of protein and dietary fiber, with relatively low total and saturated fat levels (Ahmad et al., 2022; Derbyshire, 2022). High mycoprotein consumption has also been associated with improved dietary fiber intake and lower glycaemic index in overweight and obese individuals. Recent studies on mycoprotein incorporation into processed products have mainly explored beef based products such as patties and sausages, as well as poultry based products such as chicken nuggets. This application is largely driven by sustainability concerns associated with livestock production, due to their high greenhouse gas emissions as well as extensive land and usage (Khan et al., 2023). Additionally, mycoprotein exhibits fibrous structure that strongly resembles the muscle fibers of beef and chicken (Santhapur et al., 2024). In contrast, its application in fish based products remains limited. Fish contains different muscle structure compared to beef and chicken, which causes mycoprotein to often be perceived as less suitable with fish based formulation. Studies that investigate mycoprotein incorporation into processed fish products remain uncommon despite the high nutritional benefit potential offered by mycoprotein incorporation. Partial protein substitution using mycoprotein in fish balls can enhance their fiber content as well as protein content (Derbyshire & Delange, 2021). However, the substitution can alter the sensorial properties of fish balls, such as texture and color.

While the bouncy and elastic characteristics and pale white color are preferable in conventional fish ball formulations (Tampubolon et al., 2025), it limits the suitability for fish ball formulation studies involving alternative protein incorporation such as mycoprotein as mycoprotein exhibits a darker color and contains high protein content, which upon thermal processing, resulted in a firmer texture due to protein denaturation. In contrast, dark fleshed fish species such as tuna, contains a higher concentration of myoglobin, which upon thermal processing resulted in a darker flesh (Sánchez-Zapata et al., 2025). In addition, tuna exhibits high protein and low lipid content, which are comparable to mycoprotein, contributing to the firmer texture development upon thermal processing. Tuna provides

more comparable results to evaluate mycoprotein incorporation into fish ball matrix compared to yellowtail based formulation due to the similar properties exhibited by tuna and mycoprotein.

The limited application of mycoprotein in processed fish products has driven the need to explore its applicability despite the structural differences. This study aims to evaluate the incorporation of mycoprotein into tuna based fish balls formulated with a wide range of mycoprotein substitution ratios to provide a thorough understanding of the effects of mycoprotein incorporation on the physicochemical and sensory properties fish balls

1.2. Objective

The main objectives of this research are to determine the effect of different mycoprotein substitution ratios on the sensory properties of fish balls using descriptive scaling method, evaluate the preference levels through a ranking test, and to evaluate the effects of different mycoprotein substitution ratios on the physicochemical properties of fish balls

1.3. Hypothesis

There were two hypotheses that were tested in this research :

- $H0_a$: different ratios of mycoprotein substitution does not significantly affect the intensity of sensory properties and preference levels of fish balls
- $H1_a$: different ratios of mycoprotein substitution significantly affect the intensity of sensory properties and preference levels of fish meat balls
- $H0_b$: different ratios of mycoprotein substitution does not significantly affect the physicochemical properties of fish balls
- $H1_b$: different ratios of mycoprotein substitution significantly affect the physicochemical properties of fish balls