Chapter 1

Introduction

1.1 Background

The demand for gluten-free products has been increasing recently by 16% between 2018 and 2022, allowing them to be one of the top ten existing food trends currently (Hassan et al., 2024). Despite the increase in demand for gluten-free products, there is still a limited availability of gluten-free products in Indonesia. For instance, gluten-free products are rarely found due to their dependence on wheat as a raw material for noodles, pasta, and bakery products, reaching up to 10.29 tons of wheat imported per year (Rizqi et al., 2024).

To tackle the challenges, including limited availability and high prices of gluten-free bread, one possible strategy is to combine okara flour with other common gluten-free products such as MOCAF (modified cassava) flour (Aussanasuwannakul et al., 2024). As the fourth largest producer of cassava worldwide, MOCAF flour is widely available in Indonesia and has been studied frequently to hold the potential to substitute wheat flour (Rozi et al., 2023). However, MOCAF flour contains only 1.2% protein and 3.4% fiber per 100g, which suggests okara needs to be added to increase its nutritional content (Pandin et al., 2022). On the other hand, okara is a low-cost ingredient and contains a good amount of nutrition, including protein and fiber, which can improve the overall nutritional content of gluten-free bread (Campderrós, 2017; Čech et al., 2022; Khasanah et al., 2025). Okara contains 56-58% total dietary fiber, contributing up to 14% of fiber in okara-enriched gluten-free bread, as investigated by Pešić et al. (2023). A study by Tridtitanakiat et al. (2023) also mentioned that the amount of proteins contributed by the supplementation of 10% okara flour in gluten-free bread can reach up to a 2.4% increase.

Nevertheless, a major challenge remained in which the physical characteristics, specifically loaf volume and the sensory characteristics of the gluten-free bread, are still inferior. Campderrós

(2017) found that adding okara flour by 5%, 7.5%, and 10% reduced the specific volume of bread to 2.78 cm^3/g, 2.52 cm^3/g, and 2.06 cm^3/g, respectively. Similarly, Zaidiyah et al. (2022) reported that using MOCAF flour instead of wheat flour in the dough can result in a smaller overall volume of bread. As a result, a component capable of mimicking certain rheological properties of gluten, such as hydrocolloids, is necessary to improve bread quality (Culetu et al., 2021).

Hydrocolloids can increase the specific volume and porosity and reduce the hardness of the bread, resulting in an improvement in the characteristics of the bread (Lestari et al., 2019). Nonetheless, the effect of hydrocolloids on the specific volume of gluten-free bread is distinct depending on the type and level of hydrocolloids used as well as the type of formulation used. For instance, Franco et al. (202) demonstrated that the addition of 2% CMC increased the specific volume of gluten-free bread made using rice flour from 0.61 cm^3/g to 2.76 cm/g, whereas combining 1% CMC with 1% xanthan gum can result in a specific volume of 2.43 cm^3/g. However, there are limited studies that have arisen related to the usage of hydrocolloids on gluten-free bread.

In this experiment, two hydrocolloids are used which are carboxymethyll cellulose (CMC) and k-carrageenan. CMC is one of the most promising cellulose derivatives in the food industry due to its availability and abundance of raw materials as well as its low-cost synthesis process. Characterized by its odorless, tasteless, non-caloric, and physiologically inert properties, CMC are often used as hydrocolloids to function as a moisture binder, stabilizer, thickener, and much more in industries such as condensed milk and mayonnaise (Rahman et al., 2021). Other than CMC, k-carrageenan is also used in the food industry specifically as emulsifiers, thickeners, gelling agent and stabilizers. According to Salehi (2019), k-carrageenan has been shown to be able to improve the specific volume and reduce firmness of bakery products. Aside from its ability to improve the physical properties of baked products, k-carrageenan is also relatively cheap hydrocolloids that can result in substantially low-cost large production process (Radosavljević et al., 2022). With both hydrocolloids being promising in the aspect of accessibility, cost and functionality, CMC and k-carrageenan are applied in this research as hydrocolloids to observe its potentiality in terms of improving the physical and sensory characteristics of bakery products specifically gluten-free bread.

Therefore, this study aimed to analyze and compare the effect of different levels (0, 2%, 4%) of hydrocolloids (CMC and k-carrageenan) added to gluten-free bread to improve their physical characteristics and sensorial acceptability. The physical analysis includes crumb texture, crust hardness, crumb color, moisture content, bake loss, and specific volume. For sensory evaluation, a 9-point hedonic scale and Check for All That Apply (CATA) will be used.

1.2 Objective

The objectives of this study are listed in the following:

a. Investigate and compare the effect of different levels and types of hydrocolloids on the physical characteristics and sensorial acceptability of gluten-free bread
b. Determine which level and type of hydrocolloids is suitable to be used as an improver towards the physical characteristics and sensorial acceptability of gluten-free bread

1.3 Hypothesis

The specific hypotheses are listed as follows:

1. H_o: Different type and levels of hydrocolloid added did not significantly affect the physical characteristics and sensorial acceptability of gluten-free bread

   H_1: Different type and of hydrocolloid added significantly affects the physical characteristics and sensorial acceptability of gluten-free bread