Chapter 1

Introduction

1.1 Background

Doughnuts are fried bakery products that are widely known for their unique ring-shaped appearance. This product has been commonly distributed throughout the global food market due to its high consumer acceptance, attractive sensory characteristics, and convenience, as doughnuts are categorized as ready-to-eat (RTE) snacks and bakery items in the confectionary market (Elechi, 2022). Study conducted by Halim et al. (2023), among some participants who consumed fast foods 2-3 times per month, doughnuts were noted as their preferred category (64.6%). This trend aligned with the rapid growth in Indonesia's bakery industry. Where bread consumption increased from US$0.8 per capita in 2005 to US$3.6 in 2014, in conjunction with the nationwide growth of doughnut franchises (Ringga, 2017).

Conventionally, doughnuts are prepared using a deep frying process at high temperatures ranging from 120 to 200℃ (Chew & Loh, 2025; Manjunatha et al., 2012). The exposure of high-temperature oil causes rapid moisture evaporation from the food matrix that creates empty pores. Oil then migrates to fill the void, particularly during the cooling process due to pressure drops that cause a vacuum effect. This process can increase the final product's fat content up to 50% of its total weight (Li et al., 2022; Wang et al., 2021). The excessive oil absorption not only lowers the sensory quality by increasing the mouthfeel greasiness, but also raises the calories and trans-fat content (Dangal et al., 2024; Xie et al., 2022).

To mitigate the excessive oil, hydrocolloids have been widely explored as fat-reduction agents in fried foods products. When introduced to the food matrix, the hydrocolloids form a viscous or gel-like system by encapsulating the moisture inside the molecular network (Pirsa & Hafezi, 2023). However, the efficacy of hydrocolloids is heavily dependent on their physical structure and thermal behavior.

Some gums like xanthan, guar, and alginate might produce overly thick or viscous coatings, which generate undesirable gummy-rubbery crusts, reduce crispiness, and thus reduce consumer acceptability (Kurek et al., 2017). Among various hydrocolloids, cellulose-based types–specifically Microcrystalline Cellulose (MCC) and Sodium Carboxymethyl Cellulose (CMC) have shown promising advantages due to their contrasting yet complementary properties(Gaurav et al., 2023; Gibis et al., 2015).

MCC and CMC could reduce oil absorption through their possible complementary mechanisms. MCC is an insoluble cellulose-based polymer that forms a semi-rigid, reversible gel network that physically limits capillaries pathways thus limiting oil infiltration (Zhang et al., 2023). Meanwhile, CMC is a water-soluble, anionic cellulose derivative that enhances dough's water-binding capacity and creates a hydrated surface barrier, raising interfacial tension at the oil-water interface to decrease oil wettability (Xu et al., 2025). Despite the well-established pathways, most previous studies have only examined MCC or CMC independently, leaving for further exploration on their synergistic effects. Both-action systems that limit oil uptake and preserve product quality may be created by combining MCC's physical capillary-blocking impact with CMC's hydration-mediated barrier. The synergistic effects of an MCC–CMC blend on oil absorption and sensory qualities of fried yeast-leavened doughnuts are the focus of this investigation.

1.2 Objective

The objective of this study is to assess the impact of varying concentrations of microcrystalline cellulose and carboxymethyl cellulose (MCC–CMC) blends on the reduction of oil absorption, along with their effects on the physical properties and sensory attributes of yeast-leavened fried doughnuts.

1.3 Hypothesis

Null Hypothesis (H_0): The addition of the MCC–CMC blend does not provide a significant effect on physicochemical properties including oil absorption, moisture content, frying loss, texture profile, color, or consumer acceptability (liking and perceived greasiness) of yeast-leavened doughnuts.

Alternative Hypothesis (H_1): The incorporation of the MCC–CMC blend provides a significant effect on physicochemical properties including oil absorption, moisture content, frying loss, texture profile, color, and consumer acceptability (preference and perceived greasiness) of yeast-leavened doughnuts.