Chapter 1

Introduction

1.1 Background

Obesity is a chronic disease with multiple contributing factors that involve intricate interactions of genetic, molecular, environmental, and behavioral elements (Młynarska et al., 2025). It has become one of the most prevalent global public health issues of the 21st century. In 2022, over 1 billion individuals globally suffered from obesity (body mass index ≥30), approximately one in eight adults, with around 43% of adults categorized as overweight or obese (Ahmed & Mohammed, 2025). Persistent obesity is associated with an increased risk of metabolic dysfunction, including insulin resistance, type 2 diabetes mellitus, and multiple cancer types (Nunn et al., 2022).

Despite its multifactorial nature, the development of obesity is mainly driven by excessive adipose tissue expansion at the cellular level. This expansion occurs via two mechanisms: hyperplasia, which involves the proliferation and differentiation of adipose precursor cells, and hypertrophy, characterized by an increase in adipocyte size (Kesharwani & Brown, 2024). The number of adipocytes in a particular fat depot is predominantly determined early in childhood and tends to remain stable during maturity (Horwitz & Birk, 2023). At the cellular level, adipose tissue expansion is governed by a process named adipogenesis**,** where precursor cells develop and commit to lipid storage and energy homeostasis (Ye et al., 2023).

Adipogenesis is regulated by multiple factors, including nutritional status, cellular signaling pathways, cytoskeletal proteins, and endocrine hormones such as growth hormone, insulin-like growth factor 1, insulin, steroid hormones, and cytokines. At the molecular level, adipocyte differentiation is controlled by a transcriptional cascade involving members of the CCAAT/enhancer-binding protein (C/EBP) family and peroxisome proliferator-activated receptor gamma (PPARγ) (Moseti et al., 2016; Richard et al., 2020). During the early stage of adipogenesis, C/EBPβ and C/EBPδ are induced

following hormonal stimulation and subsequently activate the expression of C/EBPα and PPARγ. These transcription factors function as key regulators that promote adipocyte maturation and lipid accumulation through the activation of genes involved in lipid metabolism. The coordinated activity of these transcription factors ultimately results in the terminal differentiation of preadipocytes into mature adipocytes characterized by the synthesis and accumulation of intracellular lipid droplets (Jiang et al., 2019; Kim et al., 2024).

Amorphophallus muelleri (*porang* or *iles kuning*) is a tuberous plant widely found in Indonesia and is known for its high glucomannan content. Porang, as a source of glucomannan, may provide plenty of benefits as a functional food component (Yanuriati et al., 2017). Glucomannans consist of mannose and glucose, along with certain acetylated residues. The mannose to glucose ratio, degree of acetylation, and molecular weight may vary based on the source of glucomannan (Gurusmatika et al., 2017). Natural polysaccharides like Glucomannan have attracted significant study interest owing to their extensive biological functions (Li et al., 2024). Polysaccharides have emerged as promising anti-obesity agents due to their diverse pharmacological pathways and desirable safety profiles. Preclinical studies have shown that plant-derived polysaccharides have anti-obesity effects through many pathways, including the modulation of lipid and energy metabolism, reduction of inflammation, regulation of gut microbiota, and influence on mitochondrial function (Wang et al., 2025).

The fibroblast cell line, 3T3-L1 cells, is widely utilized *in vitro* for investigating adipocyte development and biology, owing to established techniques for stimulating fibroblasts to differentiate into adipocytes that synthesize and store triglycerides (Odeniyi et al., 2024). Before evaluating the biological activity of a test compound, it is essential to determine its cytotoxicity to ensure that any observed effects on adipogenesis are not attributable to reduced cell viability (Aslantürk, 2018). Cell viability assays therefore provide an important basis for selecting non-cytotoxic treatment concentrations for subsequent adipogenic studies.

Although glucomannan from the closely related species, *Amorphophallus konjac* glucomannan, has been widely studied, research on porang-derived glucomannan is still limited, especially concerning its effects on adipocyte differentiation and lipid accumulation (Widjanarko et al., 2024). In addition, the biological activity of porang glucomannan is influenced by its extraction efficiency and chemical characteristics. Therefore, accurate characterization of the extracted glucomannan is essential prior to biological evaluation. The 3,5-dinitrosalicylic acid (DNS) assay is a widely used colorimetric method for estimating glucomannan content by quantifying reducing sugars released following hydrolysis, enabling comparison of extraction efficiency under different extraction conditions (Deshavath et al., 2020). Furthermore, Fourier Transform Infrared (FTIR) spectroscopy is commonly employed to identify the characteristic functional groups and confirm the structural features of glucomannan based on its absorption bands (Gong et al., 2024). Due to its growing economic significance and potential as a functional food component, it is beneficial to assess the biological activity of porang glucomannan (Riptanti et al., 2022).

1.2 Objective

This study aims to evaluate the biological effects of glucomannan extracted from porang (*Amorphophallus muelleri*) by investigating its cytotoxic effect on 3T3-L1 preadipocytes, determining its ability to suppress lipid accumulation during adipocyte differentiation, characterizing, and quantifying the extracted glucomannan to support the interpretation of its observed biological activities.

1.3 Research Question

1. Does glucomannan extracted from porang (*Amorphophallus muelleri*) exhibit characteristic functional groups consistent with glucomannan as identified by Fourier Transform Infrared

Spectroscopy (FTIR) spectroscopy and contain a measurable glucomannan content as determined by the 3,5-dinitrosalicylic acid (3,5-DNS) colorimetric assay?

2. Does porang (*Amorphophallus muelleri*) glucomannan extract affect cell viability and lipid accumulation during adipogenic differentiation of 3T3-L1 preadipocytes?

1.4 Hypothesis

$H0_1$: The extracted polysaccharide from porang (*Amorphophallus muelleri*) does not exhibit FTIR spectral features characteristic of glucomannan nor contain a measurable glucomannan content as determined by the 3,5-DNS colorimetric assay.

$H1_1$: The extracted polysaccharide from porang (*Amorphophallus muelleri*) exhibits FTIR spectral features characteristic of glucomannan and contains a measurable glucomannan content as determined by the 3,5-DNS colorimetric assay.

$H0_2$: Porang (*Amorphophallus muelleri*) glucomannan extract exhibits cytotoxic effect on 3T3-L1 preadipocytes and does not significantly reduce lipid accumulation during adipogenic differentiation.

$H1_2$:Porang (*Amorphophallus muelleri*) glucomannan extract does not exert a cytotoxic effect on 3T3-L1 preadipocytes and significantly reduces lipid accumulation during adipogenic differentiation.