Chapter 1

Introduction

1.1 Background

As a significant player in the global market for supplements and pharmaceuticals, Indonesia is currently facing challenges in its pharmaceutical industry. With up to 90% of pharmaceutical active ingredients sourced from other countries, vulnerabilities in the supply chain tend to happen, as seen during the COVID-19 pandemic (Lesmana et al., 2022). Despite having the capability to produce riboflavin locally, there remains a heavy reliance on imports, particularly for its encapsulated form, with evidence from Badan Pusat Statistik in 2024 reported imports of up to 250.000 kg of encapsulated riboflavin in 2023. This situation highlights the need for self-sufficiency in raw material production within the country.

Riboflavin, commonly known as vitamin B2, is a crystalline, orange-yellowish powder that is thermally stable, water-soluble, and essential for various biological pathways that are responsible for producing energy (Bampidis et al., 2021; Olfat et al., 2022; Wallig et al., 2023). Despite its importance, riboflavin is known to be unstable under certain conditions. When exposed to visible or UV light, riboflavin undergoes redox reactions that generate reactive oxygen species like hydrogen radicals and hydrogen peroxide in the presence of oxygen (Choe et al., 2005). Meanwhile under blue light, in particular, induces the degradation of flavin derivatives, producing lumichrome and lumiflavin as the main photoproducts (Insińska-Rak et al., 2023).

Typically, end products that contained riboflavin are stored in dark environments and packaged in protective materials, such as amber or brown bottles, to shield them from fluorescent light and sunlight (Hrubša et al., 2022). However, industries still prefer using encapsulated riboflavin due to several manufacturing and formulation advantages. According to Shekhar et al. (2010), microencapsulation offers several mechanical advantages in pharmaceutical manufacturing. It improves the flow properties of tacky or oily substances, enabling their direct compression into tablets. For instance, non-flowable mixtures of niacin, riboflavin, and thiamine hydrochloride phosphate can be encapsulated and processed into tablets more efficiently. Microencapsulation also reduces the hygroscopicity of core materials, minimizing moisture-related issues, and allows for the separation of incompatible substances, making it especially useful in multivitamin formulations where riboflavin must coexist with other sensitive components..

This study will implement the spray-drying process as a method of encapsulation, which is highly suitable for industries in Indonesia due to its scalability and low operational costs (Djaafar et al., 2018). This process occurs within seconds, enabling the encapsulation of molecules, including heat-sensitive materials, without significant thermal degradation due to brief heat exposure (Kumar et al., 2020). The result of this method would yield a microencapsulated vitamin that protects it from environmental factors such as enhanced oxidative, thermal, and light stability (Cheng et al., 2023).

In the realm of microencapsulation, various substances are recognized for their ability to trap, coat, or encapsulate solids, liquids, or gases, with each material giving different properties that can be optimized for specific applications (Wandrey et al., 2010). In this study, maltodextrin and gelatin will be used as the encapsulating material of riboflavin. Encapsulation products made with different wall materials can show distinct physicochemical characteristics. While many natural polymers have been used, microcapsules with a single coating layer often face limitations such as low encapsulation efficiency, poor stability, and limited solubility (Zhao et al., 2022). In contrast, combining different wall materials can help improve these properties. Maltodextrin offers high water solubility, low viscosity, and excellent drying properties, while gelatin provides strong film-forming ability, emulsification, and structural stability (Kosasih et al., 2023). Their combination creates a synergistic effect that enhances encapsulation efficiency, protects the core material, and improves the physical properties of the resulting microcapsules (Alrosan et al., 2025). Therefore, this study aims to investigate the effect of different maltodextrin-gelatin ratios as wall materials on the encapsulation efficiency of spray-dried riboflavin.

1.2 Objective

1. To compare the encapsulation efficiency of spray-dried riboflavin using maltodextrin, gelatin, and their combination as wall materials.
2. To assess the influence of each encapsulating material on particle size, moisture content, powder flowability, and compressibility.

1.3 Hypothesis

1. The combination of maltodextrin and gelatin as wall materials will result in higher encapsulation efficiency of spray-dried riboflavin compared to using maltodextrin or gelatin alone.
2. The combination of maltodextrin and gelatin will provide superior powder properties (particle size, moisture content, powder flowability, and compressibility) compared to either material alone.