Chapter 1

Introduction

1.1 Background

Abrus precatorius, commonly referred to as Saga, is a medicinal vine indigenous to India and tropical Asia, extending its presence to regions like Indonesia. This botanical marvel has ingrained itself in traditional medicine, owing to its diverse pharmacological properties (Garaniya, 2014). Notably, its leaves contain abrusosides, and its roots house glycyrrhizin, a sweet-tasting terpenoid surpassing sugar's sweetness by over 50 times. Saga has gained historical acclaim for its efficacy in treating various ailments, and contemporary research continues to uncover its therapeutic potential. Recent investigations suggest a promising role for Saga in respiratory health, hinting at possible effectiveness against conditions like COVID-19 (Bouchentouf, 2020). A comprehensive understanding of Saga's benefits necessitates a thorough exploration of its triterpenoid biosynthesis pathway. Despite the potential benefits provided by the compounds within the plant, there is however a limited understanding of their synthesis pathway especially for abrusosides. Naturally, however, the concentration of triterpenoids contained within the saga plant is very low.

Triterpenoids are natural compounds that are highly diverse and are commonly found in plants. They are more often stored in a glycosylated form, also known as saponins. Saponins primarily serves as a defense mechanism against pathogenic microbes and herbivores (Mugford, 2012). In addition to its role in plant defence, saponin also offers benefits for human health. Plants from the genera Panax and Glycyrrhiza are known for their medicinal properties. These plants contain saponins, such as ginsenosides and glycyrrhizin, which have pharmacological effects that are advantageous to humans. In the saga plant, glycyrrhizin and abrusosides are the notable triterpenoid saponin which plays a role in its defense system, especially under stressful conditions. Similar to many saponins, these compounds are known for their wide range of therapeutic benefits, including antioxidant, anti-cancer, anti-inflammatory, antifungal, antibacterial, and pain-relieving properties (Qian, 2022). While some aspects of the saga plant's triterpenoid composition are still limitedly studied, it remains a valuable source of high-quality compounds with potential applications in medicine and the development of industrially significant chemical products.

Triterpenoid saponin production is triggered when the plant is under stress. Triterpenoid biosynthesis in plants, including *A. precatorius*, primarily occurs through the mevalonate (MVA) pathway, a vital metabolic route for isoprenoid production. This process begins in the cytoplasm with the conversion of acetyl-CoA into 3-hydroxy-3-methylglutaryl-CoA (HMG-CoA), which is then reduced by HMG-CoA reductase to generate mevalonic acid—an essential regulatory step in triterpenoid synthesis (Noushahi, 2022). Under methyl jasmonate treatment, the expression of key biosynthetic genes such as *squalene synthase (SQS)* and *β-amyrin synthase (bAS)* is upregulated, increasing the metabolic flux toward triterpenoid saponin production (Nguyen, 2019). This response, driven by stress signaling, enhances secondary metabolite accumulation, leading to a higher yield and altered composition of triterpenoid saponins.

Methyl jasmonate functions as a signaling hormone that triggers the synthesis of secondary metabolites and protective chemicals in plants under stress. Methyl jasmonate is a compound derived from jasmonic acid used to induce plant defense mechanisms against pests, pathogens, and environmental stresses. When it is applied to a plant, it triggers the production of secondary metabolites that act as a chemical defense against pests and pathogens (Xia, 2023). Triterpenoid synthesis expression levels have been successfully increased in *Centella asiatica* by methyl jasmonate treatment, as observed in other plants (Nguyen, 2019). Although they are of different families, they share similarities such as that of producing triterpenoid saponins with medical properties. They share similar bioactive compounds, such as flavonoids and polyphenols, and respond to stimulators like methyl jasmonate to enhance secondary metabolites production. The findings of these studies highlight the capability of methyl jasmonate to modulate plant defense mechanisms to enhance the biosynthesis of economically significant secondary metabolites in plants.

Furthermore, the detection technique to quantify the amount of secondary metabolites in the plant is also important in order to determine the success of artificial induction, such as that done using the methyl jasmonate treatment. For triterpenoid saponin quantification, several detection methods are available. A study conducted by Xu et al. (2022) combines both the qualitative Salkowski reaction and quantitative vanillin-perchloric acid chromogenic method to detect the presence of triterpenoid content in *Ganoderma lucidum*. Another study by Mora-Ocación et al. (2022) utilized the Liebermann-Burchard method combined with UV spectroscopy to quantify triterpenoid saponins in quinoa. While the Salkowski, Vanillin-perchloric acid tests, and the Liebermann-Burchard test have all been successfully used for saponin detection, the first two methods are only suitable for specific types of saponins, particularly those containing steroid groups. Meanwhile, the Liebermann-Burchard method also facilitates the detection of triterpenoid saponins in addition to steroids.

1.2. Aim

This study aims to assess the effect of methyl jasmonate treatment at various concentrations on the accumulation of triterpenoid saponins in saga leaves and roots. The methyl jasmonate used was 0.1 mM, 0.3 mM, and 0.5 mM, and the presence of total saponin was measured by utilizing a Leibermann-Burchard semi-quantitative analysis.

1.3. Hypothesis

H_0: No significant difference is observed in the production of triterpenoid saponins in the roots and leaves of saga plant across different concentrations of methyl jasmonate.

H_1: A significant difference is observed in the production of triterpenoid saponins in the roots and leaves of saga plant across different concentrations of methyl jasmonate.