

# I. INTRODUCTION

## 1.1. Background

Herbal remedies made from leaves and roots boiled in water, filtered, and can be drunk for a specific time (Syukur, 2022). *Madura kencing manis* herbal remedies from Madura is renowned for its rich use of herbal components believed to have medicinal properties (Pratiwi *et.al.*, 2024). *Madura kencing manis* herbal remedies includes ingredients such as *Piper crocatum* Ruiz & Pav (red betel leaf), *Costus igneus* (insulin plant), *Cinnamomum verum* J.Presl (cinnamon), *Coriandrum sativum* L. (coriander), and *Curcuma xanthorrhiza* Roxb (*temulawak*).

Phytochemicals in *Madura kencing manis* herbal remedies play crucial roles in managing diabetes and oxidative stress. According to Bayati *et al.* (2025) flavonoids possess antioxidant and possesses anti-diabetic effects by enhancing insulin sensitivity and lowering blood sugar levels. Gallego *et al.* (2025) explain that polyphenols regulate blood sugar by inhibiting carbohydrate-digesting enzymes. Tannins exhibit anti-diabetic effects by inhibiting enzymes involved in carbohydrate digestion, which helps control postprandial blood sugar, as noted by Zhang *et al.* (2021) state that saponins enhance insulin secretion and improve insulin sensitivity, contributing to glycemic control and cardiovascular health.

According to Yang *et al.* (2024) alkaloids help regulate glucose metabolism by inhibiting enzyme es involved in carbohydrate digestion. Lastly,

terpenoids protecting organs from oxidative damage caused by high blood sugar, as described by (Mierza *et al.*, 2023). These components are individually effective, the complete formulation's specific effects remain unproven, and there is no protein identification evidence to verify their direct impact on biological systems. There is no evidence from protein identification studies, such as SDS-PAGE (*Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis*), which could help verify any direct effects of the herbal components on protein expression or modification in relevant biological systems (Bouabdellah *et al.*, 2024).

Common medical treatments include insulin therapy, which involves injecting insulin into the body, or using diabetes medications such as biguanides like metformin. Metformin lowers blood sugar levels but can cause side effects such as nausea and gastrointestinal disturbances (Foretz *et al.*, 2023). Conventional medicines are modern drugs that rely on scientific research conducted by experts, such as researchers or doctors (Mierza *et al.*, 2023).

Observation of structural testicular using scoring data to evaluate histological preparation for percentage damage of tubules and spermatogenesis stage (Thanh *et al.*, 2020). The measurement of structural histology of the testicular is the relative weight of male reproductive organs (testes), index gonadosomonal, and diameter tubulous seminiferous, which can be indicators of reproductive health performance.

Measuring the function of the testis as reproductive performance, such as measuring superoxide dismutase (SOD) levels, provides insight into the

degree of oxidative stress that neutralizes harmful superoxide radicals, which are elevated in diabetic conditions (Wang *et al.*, 2024). Protein analysis using sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) is important to detect changes in protein expression or modifications caused by diabetes, which could impact testicular function for provide molecular insights into how diabetes affects testicular health and whether the herbal treatment can reverse the effect (Jain *et al.*, 2025).

Diabetes is a metabolic disorder marked by high blood sugar levels due to issues with insulin secretion, insulin action, or both. It is the ninth leading cause of death globally, accounting for over 1 million deaths each year. In 2017, around 462 million people worldwide were diagnosed with type 2 diabetes, representing 6.28% of the global population (Saputra *et al.*, 2018). The prevalence of diabetes mellitus continues to rise annually in Indonesia with a population exceeding 200 million. Indonesia ranks among the top seven countries globally for the incidence and prevalence of diabetes mellitus (Soomro & Jabbar, 2024).

Diabetes mellitus (DM) has been increasingly recognized for its negative impact on male fertility (Zhang *et al.*, 2021). Diabetes can lead to erectile dysfunction (ED), which occurs due to neuropathy, endothelial dysfunction, and poor vascular health, all of which impair normal erectile function. A histological examination of diabetic rats revealed thickening of the basal membrane and atrophy of seminiferous tubule cells (Ballester *et al.*, 2020).

Mahmud *et al.* (2020) stated that oxidative stress in diabetes results from an imbalance between the production of reactive oxygen species (ROS) and the body's antioxidant defenses, causing cellular damage. Testicular tissue, being highly vulnerable to oxidative stress, frequently suffers damage under diabetic conditions (Hassanein *et al.*, 2024). This study aims to assess and examine the potential effects of *Madura kencing manis* herbal remedies on the histological structure of the testes and reproductive performance in diabetic white rats (*Rattus norvegicus*).

## **1.2. Problem Formulation**

The problem in this research is how the administration of *Madura kencing manis* herbal remedies affects the testicular structure and function of diabetic white rat (*Rattus norvegicus*).

## **1.3. Research Objectives**

This research aims to evaluate and analyse the potential effects of *Madura kencing manis* herbal remedies on testicular structure and functional reproductive performance in diabetic white rats (*Rattus norvegicus*).

## **1.4. Research Benefits**

The results of this research may provide a foundation for future studies investigating other herbal remedies and their effects on diabetes-related complications, paving the way for new therapeutic developments by using natural ingredients.