CHAPTER I

INTRODUCTION

1.1 Research Background

Presently, the fashion industry is a widely prevalent and trendy sector among the general population. Nevertheless, it also generates a substantial quantity of pollutants, including synthetic chemical dyes emitted during the process of coloring batik cloth (Kharisma Subagyo, 2021). The rise of contemporary batik fashion trends affects the growth of consumer demand over time, both domestically and internationally. Numerous batik manufacturers select to utilize synthetic dyes, as their expedient implementation, user-friendly, and cost-effectiveness (Kartikasari & Yasmi Teni, 2016). In addition, Evy Ernawati & Rostika Noviyanti (2021) reported that the textile sector contributes around 60% of the dye market. About 10−15% of synthetic dyes are wasted during the production process. In addition, the textile sector continues to face significant issues related to the substandard quality of synthetic dye waste and its impact on water conditions.

Synthetic dyes are a category of colors produced using organic chemicals, with the majority containing intricate aromatic compounds in their composition (Firdaus Mohamad Yusop et al., 2022). Synthetic dyes are the preferred choice for coloring cotton because they cling strongly to this fabric, making them more popular than other dyes (Mohamad Yusop, Tamar Jaya, et al., 2023). Remazol Brilliant Blue R (RBBR) exemplifies a synthetic dye that is categorized as a reactive dye. It originates from anthraquinone, exhibiting water solubility and the capacity to form negative ions. The attraction of negative ions to the positive regions of water molecules complicate their separation (Mohamad Yusop, Nasehir Khan, et al., 2023). The presence of RBBR in the environment can obstruct sunlight from reaching water bodies, which in turn disrupts the growth of hydrophytic flora, lowers dissolved oxygen levels, and reduces populations of aquatic fauna. Furthermore, its aromatic properties are associated with negative outcomes, particularly carcinogenic effects and mutations (Berradi et al., 2019; Elwakeel et al., 2021).

Dye wastewater treatment options are currently categorized into physical techniques, for instance, adsorption and membrane processes. The chemical methods, including oxidation, electrocoagulation, ozonation, solvent extraction, and photocatalysis (Bukhari et al., 2022; Yousefi et al., 2021). Additionally, biological methods utilize various species of bacteria, algae, and fungi for the treatment process (Mohamad Yusop, Nasehir Khan, et al., 2023). Some of the several methods for removing dyes discussed in the literature, the adsorption technique is distinguished as a cost-effective, eco-friendly, versatile, straightforward, user-friendly approach, and environmentally benign (Marya Mistar et al., 2023).

Adsorption is a widely utilized technique for reducing dye contamination. Furthermore, adsorption denotes the process whereby molecules or ions adhere to the surface of a material called an adsorbent (Nure et al., 2023). The capacity to differentiate various adsorptions on activated carbon is often employed because to its high efficiency, straightforward design, and economical for chemical compounds (G. A. A. Al-Hazmi et al., 2024; Oko et al., 2022). Activated carbon is a highly porous substance comprising 85−95% carbon content, generated by hightemperature heating (Madani et al., 2023). The requirements for activated carbon continue to grow, driven by its well-developed pore structure, remarkable specific surface area, and optimal pore size distribution. Its high adsorption capacity, varied surface chemistry, and notable surface reactivity, due to the presence of numerous functional groups, make it a preferred adsorbent for various chemical species (Mudhoo et al., 2019).

Several research have studied the manufacture of activated carbon for pollutant removal, using locally accessible plant materials and by-products (Nure et al., 2023). Rice husks, corn cobs, sugar cane pulp, and coconut fiber are some of the most common raw materials used to produce activated carbon (S. Fatimah & Astuti, 2023; Putranto et al., 2022; Somyanonthanakun et al., 2023; Zhang et al., 2023). Currently, activated carbon is predominantly sourced from plantations, agricultural products, mining activities, and wood or wood waste (Arsad et al., 2010).

Activated carbon can be derived from the discarded stems of the marigold (*Tagetes erecta*) (Sahara et al., 2017). The marigold is mostly prized for its blooms and leaves, which serve a variety of purposes including prayer, beautification, and medicinal. On the other side, marigold growing generates a large amount of agricultural waste after harvest. Until now, the stems of the marigold plant have not been fully utilized. Usually, marigold plant waste is burned, but continual burning causes air pollution (Sahara et al., 2017; Susrama & Yuliadhi, 2020). The stems of the marigold can serve as a key component in activated carbon production due to their significant carbohydrate content, including cellulose, hemicellulose (25-27%), and lignin (33-36%), which demonstrate strong adsorption properties (Made Siaka et al., 2017).

Research on the use of marigold stem waste as activated carbon is limited, as demonstrated by several existing studies. In a study conducted by Sahara et al. (2018) The adsorption process utilized marigold stem waste to decolorize Rhodamine B, activated by H_3PO_4. Previous research utilized activated carbon derived from marigold stem waste for the adsorption of Pb^{2+} and Cu^{2+} metal ions. This study involves the activation of activated carbon derived from Marigold (*Tagetes erecta*) utilizing sulfuric acid (H_2SO_4).

The characterization of activated carbon aligns with the technical standards outlined in SNI 06-3730-1995 for activated carbon. The procedure necessitates dried and carbonized marigold stems. Following carbonization, the stems must undergo activation with 70% H_2SO_4, incorporating proximate analysis, functional group analysis, and morphological analysis. Additionally, to evaluate efficiency, experiments were performed to investigate the impacts of varying contact time (30, 60, 90, 120, and 150 minutes), pH levels (1, 3, 5, 7, and 9), and concentrations (60, 80, 100, 120, and 140 mg/L) on the adsorption of RBBR dye. This research aims to mitigate pollution from synthetic dye effluents in aquatic environments and convert plant waste into high-quality products.

1.2 Problem Identification

Based on the research background provided earlier, the problem can be stated as follows.

1. What are the characteristics of activated carbon from Marigold (*Tagetes erecta*) stem waste?
2. What is the optimum adsorption condition of Remazol Brilliant Blue R dye that utilizes activated carbon from Marigold (*Tagetes erecta*) stem waste?
3. What is the adsorption isotherm model of Remazol Brilliant Blue R dye that utilizes activated carbon from Marigold (*Tagetes erecta*) stem waste?

1.3 Research Purposes

The aims of this research arise from the problem identification, as follows.

1. To analyze and compare the characteristics of activated carbon from the Marigold (*Tagetes erecta*) stem waste with the standard quality of activated carbon by (SNI) 06-3730-1995.
2. The objective is to determine the optimum condition of activated carbon from Marigold (*Tagetes erecta*) stem waste.
3. To examine the adsorption isotherm model of Remazol Brilliant Blue R dye that utilizes activated carbon from Marigold (*Tagetes erecta*) stem waste.

1.4 Research Significance

The subsequent significance of this research is significant.

1. This study proposes employing waste from the stems of the Marigold (*Tagetes erecta*) as a new method for separating dye waste, by converting it into activated carbon as an adsorbent.
2. Aids in the reduction of dye waste and waste from Marigold (*Tagetes erecta*) after they have been harvested.
3. As a substitute approach for managing the waste of Marigold (*Tagetes erecta*) that has no practical or commercial value.