CHAPTER 1
INTRODUCTION

1.1 Motivation and Problem Statement

Colour is perceived as quality indicator and is one of the most determining attributes to sell a product. Dyed fabrics have been produced in all cultures dated back centuries ago. Dyed textile material from Egypt could be dated to 3200 BC, in India dyed textiles were dated at 2000 BC but the durability of this product is limited (Saxena & Raja, 2014). Before the emerging of synthetic colourant, various plants served as sources for colourants such as indigo plant, madder, turmeric and so forth (Saxena & Raja, 2014). The development of synthetic colourant at the beginning of twentieth century create more producible techniques of application and distinctively lowering the cost of dyed fabrics.

In textile industry, synthetic colourant has been used commercially as it is cheaper, more vibrant and has high stability. However, discharge of coloured effluent to the rivers poses major aesthetic and ecological threat to environment specifically the aquatic ecosystems, thus attracting environment-conscious consumers towards the use of natural colourant (Mittal et al., 2007). The textile industry is also regarded as one of the greatest generators of liquid effluent as this industry uses high amount of water in dying process (Ulson de Souza et al., 2008). There is also growing consciousness about biological and organic value of eco-friendly products attracting interest of consumers towards the use of natural colourant in textile industry (Rajendran & Selvi, 2014). To counter these concerns, natural colourant has been preferred in recent years, leaving synthetic colourants behind, due to realization that it is way safer and eco-friendly (Kumar & Sinha, 2004).

Natural betacyanin has attracted great attention over the past years (Cai et al., 2006). Often times, dragon fruit peel is regarded as waste and an ecological burden to society to dispose them (Bhatnagar et al., 2015) but it is suggested to have abundant amount of betalain forming enzyme as the flesh had, since it is found that the betacyanin pattern is similar with the flesh (Stintzing et al., 2002). Since the discovery, betacyanin
content in *Hylocereus polyrhizus* or red-fleshed dragon fruit peel has been the new focus for the next source of red natural colourant. The peel of the fruit exhibit high content the pigment with high stability at neutral pH (Naderi et al., 2010). However, due to their natural properties, betacyanin pigment cannot adheres well in certain types of yarns.

Three types of yarns which are polyester cotton, rayon, and rayon coolmax are selected to study the affinity of betacyanin pigment from *Hylocereus polyrhizus* to these fabric yarns. Freundlich and Langmuir adsorption isotherm models were introduced to determine which yarns has the highest feasibility of using natural colourant from *Hylocereus polyrhizus* peel.

Currently, there is no recent study of adsorption of betacyanin from dragon fruit on fabric yarns. *Hylocereus* is rich in mucilaginous substances (Naderi et al., 2010), restricting colour yield as well as adsorption on fabric yarns. Other downside is the lower stability of the betacyanin pigment restricting the application of colour on certain yarns.

### 1.2 Objective

Based on the study background and problem statements described in the previous section, the objectives are to study the affinity of betacyanin pigments to three types of yarns, to describe the adsorption process using Freundlich and Langmuir isotherm models, as well as to study the wash fastness of yarns in desorption process.

### 1.3 Scope of This Research

The following scopes have been identified in order to achieve the objectives:

- Betacyanin pigment was extracted from *Hylocereus polyrhizus*, a red-fleshed dragon fruit by using water extraction at 100°C.
- Different types of yarns namely polyester cotton, rayon, and rayon coolmax provided by Pusat Tenun Pahang were experimented.
- The adsorption equilibrium time was determined by studying the liquid samples for 120 minutes at 15 minutes interval.
- Different dilution factors 0.50, 0.60, 0.70, 0.80, and 0.90 of dragon fruit extract were used.
- Freundlich and Langmuir isotherm models were studied to determine which isotherm models agree well with experimental data.
- Root mean square and chi square test were employed to analyse error in data.
- Desorption process was carried out by soaking dyed yarns in tap water.

1.4 **Organisation of This Thesis**

The structure of the thesis is outlined as follow:

Chapter 2 provides literature overview about adsorption process, the raw materials as well as the equipment used throughout the research. The raw materials include dragon fruits specifically *Hylocereus polyrhizus*, a red-purple pulp fruits that is claimed to have higher betacyanin pigments that its other-coloured counterparts. Other than that are three types of yarns, namely polyester cotton, rayon, and rayon coolmax which all of three are provided by Pusat Tenun Pahang. A few of the equipment used are UV-VIS Spectrophotometer, Fourier Transform Infrared Spectroscopy (FTIR), and Scanning Electron Microscope (SEM). Freundlich and Langmuir isotherms will also be discussed in this chapter explaining its application in adsorption of betacyanin pigments on yarns.

Chapter 3 gives a review of the approach applied for adsorption of betacyanin on three different yarns. First, natural dye was extracted from dragon fruit by using water extraction. Three types of yarns that were used in this experiment were washed with domestic detergent and sodium carbonate. Then they were subjected further to three types of mordanting process, namely pre-mordanting, meta-mordanting and post-mordanting where they are soaked in 25% of aluminium potassium sulphate solution before, during and after dyeing process. Equilibrium time was conducted to determine the time required for the adsorption to reach equilibrium for 120 minutes at 15 minutes interval. Next, different dye concentration solutions were prepared and each yarn was soaked into the solutions. The process of adsorption of three different yarns were then analysed using UV-Vis Spectrophotometer and Freundlich and Langmuir isotherm models were introduced to the data and compared. Error analysis such as root mean square error