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# Evaluation of Natural Pigment Extracted from Dragon Fruit *(Hylocereus Polyrhizus)* Peels

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## ABSTRACT

*Dragon fruit (Hylocereus polyrhizus), which comes from the family of Cactaceae, is one of the tropical fruits in Malaysia. The peels of red dragon fruit consist of a high content of betacyanin pigment, which responsible for the red-violet colour even though the peel always regarded as a waste. This study aims to evaluate the natural pigment extract from dragon fruits peels using water as a solvent in the extraction method. The colour pigment content was determined based on the absorbance and characterised using Ultraviolet-visible (UV-Vis) at 535 nm and Fourier Transform Infrared (FTIR) spectrometer, respectively. Several extraction parameters were studied and optimised to obtain the optimum condition of the extraction process, including extraction time, extraction temperature, pH, and pigment extract stability towards the light. Results analysis from the pigment extract showed that the optimum conditions were achieved at 4 hours, 25 °C and pH 5 for extraction time, temperature, and pH, respectively. However, the sample pigment extract shows decreased in total betacyanin content over time as it exposed to light but still stable compared to control. In conclusion, the natural pigment extracted from dragon fruit peels using water as a solvent in the extraction method has a high potential to be used as a natural colourant. Moreover, the use of natural resources extracted from peels could be successfully employed as an effective, eco-friendly alternative cleaner and provide a new opportunity to replace the synthetic colourant.*

***Keywords***: *dragon fruit, natural colourant, betalain, betacyanin*

## INTRODUCTION

Colours play an essential role as a food colouring in the food industry as well as in our daily lives, especially in the quality perception of food [1]. The purpose of colour was added is to make the food more attractive, increase the loss of colour during processing, boost the standard, and also influence the consumers to buy the products [2]. Food colouring can be categorised into four classifications, which are natural colours, synthetic colours, nature-identical colours, and inorganic colours [3,4,5]. The safety of synthetic colourants has previously been questioned, leading to a reduction in the number of permitted colourants. Green FCF, tartrazine, and sunset yellow were reported to stimulate allergic reactions, including exacerbation of asthma in sensitive individuals [5].

Natural food colourant is gaining popularity, especially in the food and beverage sectors, due to the strong request for more natural products by health-conscious consumers. One of the pigments has been used in food such as jams, and ice cream colouring is betacyanin, which is responsible for the red colour [6]. Betacyanin pigment can be found in fruits and vegetables such as black currant, beetroot, purple cabbage, blueberries, and dragon fruit. Dragon fruit is rich in betalains, which has a similar array of colour pigments found in beetroot [7]. Betalains can be divided into two types, which are red-purple betacyanins and yellow-orange betaxanthins. Betacyanin is ideal for colouring low-acid foodstuffs such as dairy products as it equivalent to synthetic colourants and preserves their colour over a wide range of pH varying from 3 to 7 [8]. Betacyanin also differs from anthocyanin because it exhibited brighter red colour than the red radish [9]. In this study, the natural pigment was extracted from dragon fruit peels, and the optimisation on extraction time, temperature, pH, and pigment extract stability towards light were determined.

## MATERIALS AND METHOD

### Materials and sample preparation

This study used dragon fruits obtained from the local market in Pasir Gudang, Johor, and chemicals such as hydrochloric acid and sodium hydroxide were used in this study. The peels were washed using distilled water and then dried in the hot air oven at 40 °C until it attains a constant weight. The peels were ground into a powder and were stored inside an amber Schott bottle and wrapped with a layer of aluminum foil to prevent any contact with the light.

### Extraction of natural pigment

Several extraction parameters were studied and optimised to obtain the optimum condition of the extraction process. The parameters evaluated were extraction time (1, 2, 3, 4, 5 and 6 h), extraction temperature (25, 50, 70, 90 and 100 °C), pH (2, 5, 7, 9 and 12) and pigment extract stability towards light (0, 1, 2, 3 and 4 days). For each parameter, 3 grams of powdered dragon fruit peel was added to 30 mL of distilled water before the optimisation study. Distilled water was used as a solvent during the extraction process as the betacyanin pigment is hydrophilic and more soluble in water. To optimize the extraction time, the solution was extracted at a constant extraction temperature of 25 °C and pH 2. The absorbance of aliquots was then measured, and the extraction process was repeated using the optimum extraction time for the next parameter analysis. The solvent pH was altered by using an appropriate addition of 0.1 M of HCl or 0.1 M NaOH. Knick 765 pH meter was used to measure the pH solution.

For the study on the pigment colour stability, 3 grams of powdered dragon fruit peel was added to 30 mL of distilled water at optimum extraction time, temperature, and pH. Control were used as the extraction was done by adding 3 grams of powdered dragon fruit peel into 30 mL of distilled water for 1 hr at room temperature. Both aliquots were exposed to light for 8 h each day. The absorbance of both aliquots were measured for four days, and observation on colour changes were recorded. The extracts were also characterised using Perkin Elmer Spectrum 100 Fourier Transform Infrared Spectroscopy (FTIR) in the range of 400 – 4000 $cm^{-1}$.

### Determination of natural pigment content

The absorbance of each extract solution was measured at 535 nm against distilled water as blank using PG Instruments T80+ Ultraviolet-Visible Spectrophotometer (UV-Vis). The natural pigment (betacyanin) extract concentration was determined using Beer's Lambert law formula [7]:

$$\text{Betacyanin content (mg/L)} = \frac{A \times MW}{(\varepsilon \times b)} \times DF \times 1000$$

Where:

A = absorbance (λ max)

MW = molecular weight of betacyanin, 550 g $mol^{-1}$

DF = dilution factor

ε = molar extinction coefficients, 60,000 L $mol^{-1}$ $cm^{-1}$ in water

b = path length of cuvette, 1 cm

## RESULTS AND DISCUSSION

### Stability of natural pigment extraction

The optimum extraction time of natural pigment was four hours, which yield 37.64 mg $L^{-1}$. As the extraction time increasing, the total betacyanin content is also increasing, as shown in Figure 1. The total betacyanin content showed a drastic increase of up to four hours. The microwave-assisted extraction process of betalain also found that betalain content increased with increasing extraction time [10]. An increase in time and longer contact time favoured the extraction to have more mass transfer. It can be seen that the graph line is still increasing even at six hours extraction. Unfortunately, the final equilibrium between solvent and sample would achieve after a certain duration, and it showed that excessive extraction time would be inessential [11]. Besides, prolonged extraction time is an uneconomical and time consuming from the industrialisation point of view [12].

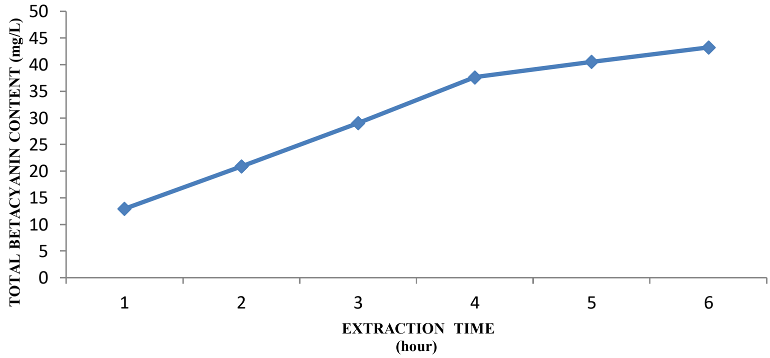


**Figure 1: Relationship between Total Betacyanin Content and Extraction Time**

Figure 2 shows the effect of temperature in the extraction of betacyanin from dragon fruit peels. The line graph showed a constant trend at 25 to 50 °C before it decreased as the extraction temperature increased. The total betacyanin content was highest at both extraction temperature, 25, and 50°C with a yield of 31.02 mg $L^{-1}$. However, 25 °C was selected as the optimum extraction temperature as it was uneconomical to increase the extraction time [12]. The total betacyanin content will also decrease as well as the pigment colour. In this study, it was observed that the red colour of betacyanin changed to light brown at 100 °C of extraction time. This is due to the increase in the betacyanin degradation rates as the temperature of extraction increased [9]. Moreover, the application of betacyanin pigment in the food industry, such as the production of ice cream, does not require a high thermal treatment in the extraction of betacyanin [13].

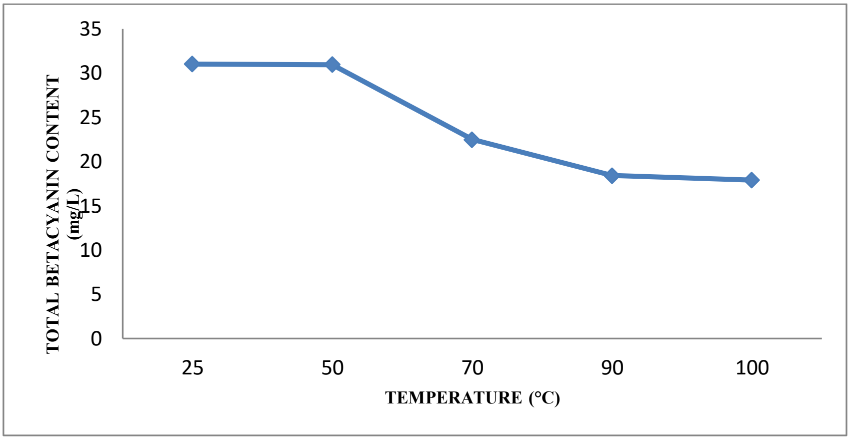


**Figure 2: Relationship between Total Betacyanin Content and Heating Temperature**

The optimum pH for extraction of the pigment was at pH 5, with the highest total betacyanin content obtained at 35.73 mg $L^{-1}$ as shown in Figure 3. The result obtained was supported by the previously studied as the highest yield of betacyanin content was also obtained at pH 5 [14] since the red-fleshed dragon fruit has an original pH 5 [15]. A broad pH which ranged from 3 to 6 is relatively stable for betacyanin [9]. The pigment colour of betacyanin is unstable under the alkaline condition as the concentration decreased above pH 6 due to the degradation of betalain [15,16].

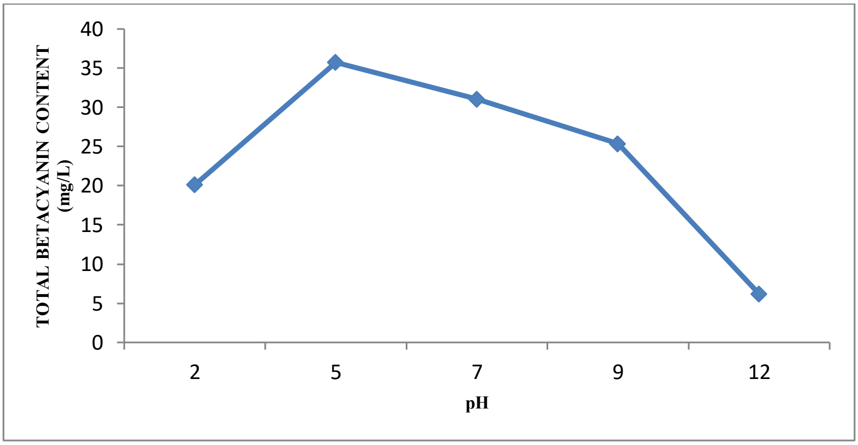


**Figure 3: Relationship between Total Betacyanin Content and PH**

The stability of pigment extract towards the light was determined for four days. Figure 4 shows the total betacyanin content of sample extract and control, which has been monitored over eight hours per day. The line graph shows that the total betacyanin content decreased over time. Results show highest during the extraction day as it yields at 35.97 mg $L^{-1}$ and 27.78 mg $L^{-1}$ for sample extract and control, respectively. On day 4, the betacyanin content of sample and control slightly decreased to 23.23 mg $L^{-1}$ and 22.99 mg $L^{-1}$, respectively. Eventhough both betacyanin content for sample and control decreased, the total betacyanin of the sample is higher than the control. Betacyanin is light-sensitive, and the presence of light absorption in the visible light and ultra-violet range will make the betacyanin to degrade [7]. The presence of light will affect the electron of double bonds in betacyanin molecules to be in the excited stage and cause the higher degradation of betacyanin [2].

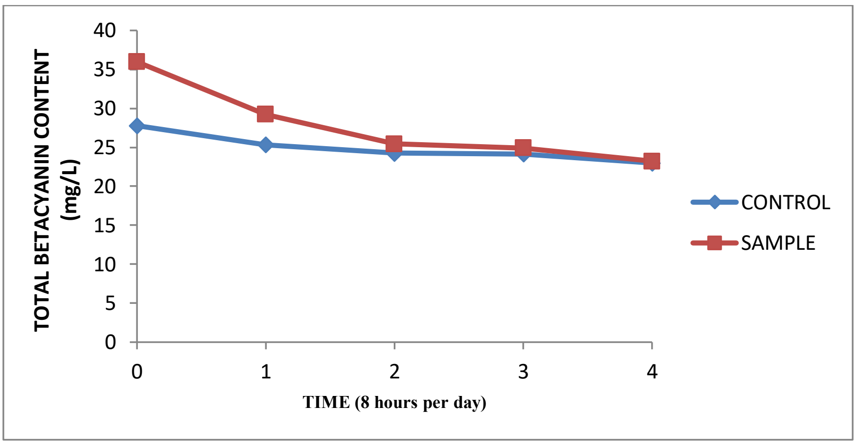


**Figure 4: Relationship Between Total Betacyanin Content Kept in Four Days of Light Exposure**

## Characterisation of natural pigment of dragon fruit peels

The Fourier transform infrared (FTIR) spectral analysis was done to identify the major functional groups present in the extracted pigment, as shown in Figure 5. It showed the broad and medium band at 3376.51 $cm^{-1}$ suggest (O-H) bond in stretching vibration mode represents the hydroxyl group and band at 2932.53 $cm^{-1}$ indicates (C-H) in stretching mode in betacyanin. Previous studies also stated that the broad peak at 3400 cm-1 corresponds to the O-H stretch in dragon fruit dye [17]. The ring stretches absorptions occur at 1631.27, and 1411.23 cm-1 indicates (C=C) bond. The peak at 1308.44 cm-1 represented the (C-O) bond of the carboxylic acid with medium intensity. The presence of the alcohol group (C-O) was confirmed by the wavenumber 1100.00 and 1076.21 cm-1 [18].

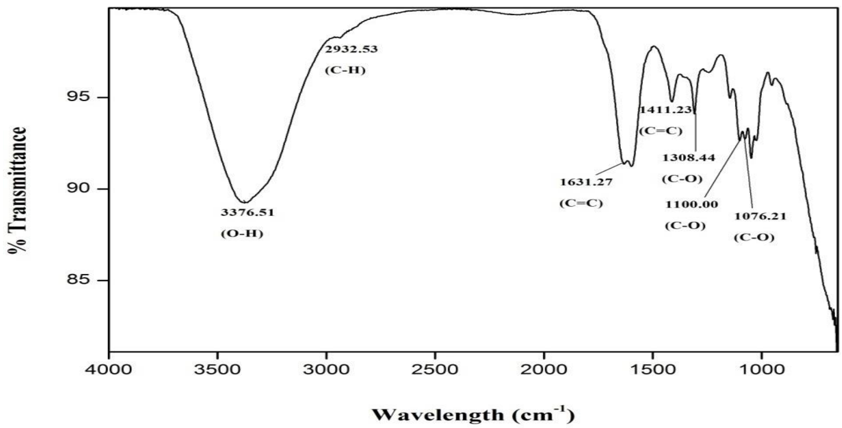


**Figure 5: FTIR Analyses**

## CONCLUSION

The extraction of natural pigment from dragon fruit peels has a high potential to be used as a natural colourant over the synthetic colourant. From this study, sample extract yields optimum betacyanin content at extraction conditions of four hours, 25 °C and pH 5 for the extraction time, extraction temperature, and pH, respectively. The evaluation of extraction temperature and pH showed the betacyanin pigment was more stable at low temperatures and in acidic conditions. Degradation is associated with the colour fading or browning. The stability of the pigment extract towards the light showed gradual deterioration over time, but further study with strictly controlled conditions needs to be done to understand the stability of pigment extract.

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