

Natural Dyes from Cannonball Tree and Dragon Fruit: A Sustainable Solution for Textiles

Ms.Mubeena K M¹, Ms.Durga V², Ms.Krishna Priya K³, Ms.Rinsha K K⁴, Ms.Sreyalakshmi T S⁵, Dr.Jesy E J⁶
^{1,2,3,4,5}UG Department of chemistry, Little flower college (Autonomous), Guruvayoor, University of Calicut, India.

⁶Assistant professor, Little flower college (Autonomous), Guruvayoor, University of Calicut, India.

Emails: ansarmubeena909@gmail.com¹, durgavelayathikode@gmail.com²,
krishnapriyakrish003@gmail.com³, mayaan20141@gmail.com⁴, pranavpilakkattiri@gmail.com⁵,
linmaryclare@gmail.com⁶

Abstract

Natural Dyes from Cannonball Tree and Dragon Fruit: A Sustainable Solution for Textiles This study investigates the potential of using natural dyes from the Cannonball tree (*Couroupita guianensis*) and Dragon fruit (*Hylocereus polyrhizus*) as a sustainable and non-toxic alternative to synthetic dyes in the textile industry. Driven by increasing environmental concerns, the research aimed to develop a viable, non-toxic coloring method. Dyes were extracted from dragon fruit peel and the fruits and flowers of the Cannonball tree. A 10% citric acid solution and a four-day maceration period were used for dragon fruit to maximize anthocyanin yield. Thin Layer Chromatography (TLC) identified the key components: the dragon fruit extract showed an R_f value of 0.62 (betacyanin), and the Cannonball tree extract yielded an R_f value of 0.57 (indigo dye). The extracted dyes were applied to cotton fabrics, and their color fastness was evaluated. The results indicated excellent color retention even after multiple washes. The findings conclude that both the Cannonball tree and dragon fruit are promising, eco-friendly sources for natural dyes, offering a sustainable solution to reduce the environmental impact of conventional textile dyeing processes.

Keywords: Natural Dyes, Cannonball Tree, Dragon Fruit, Sustainable Textiles, Color Fastness, Betacyanin, Indigo.

1. Introduction

The global textile industry is increasingly focused on sustainable practices, driving a critical need for environmentally sound alternatives to conventional synthetic colorants. Natural dyes, which are derived from renewable resources like plants, are favored because they are non-toxic and biodegradable, aligning perfectly with the principles of green chemistry. This research specifically investigates the potential of the Cannonball Tree (*Couroupita guianensis*) and Dragon Fruit (*Hylocereus* spp.) to serve as viable sources for sustainable natural dyes that can be applied to cotton fabrics. By using these sources, the project directly addresses the environmental concerns linked to petroleum-based synthetic dyes. The Dragon fruit peel is noted for its rich anthocyanin pigments, while the Cannonball fruit yields valuable indigo dye. This research thus strongly highlights the significant potential of both the Cannonball and Dragon fruit as eco-friendly

alternatives for the textile industry Shown in Figure 1 A) Cannonball Fruit B) Dragon Fruit [1].



Figure 1 A) Cannonball Fruit B) Dragon Fruit

2. Method

2.1. Preparation of Fruit Extract

The process began with the selection of a mature cannonball fruit and dragon fruit. The fruit was quite large, the first step involved breaking open the mature fruit. This action was necessary to allow for the separation of the pulp from the hard outer rind [2].

2.2. Fermentation

The fermentation step began with the mature fruit being broken open. The fruit pulp was ground and then placed into a container with water. This mixture was then allowed to ferment at room temperature for a period of 5 days. This five-day duration was specifically chosen as it was found to be optimal for producing an intense pigment.

2.3. Dye Extraction

Once the 5-day fermentation period was complete, the mixture was ready for dye extraction. The liquid extract containing the dye had to be separated from the solid residues. This separation was achieved by filtering the mixture.

2.4. Characterization

The extracted dye was characterized using Thin Layer Chromatography (TLC). For the cannonball dye, the crude powder was dissolved in chloroform and plotted on the TLC plate. The solvent used for eluting the plate was also chloroform. The analysis revealed an R_f value of 0.57, which was determined to be equal to the R_f value of standard indigo dye. Similarly, the dragon fruit dye, analyzed in a (1:1) ethanol and water eluent, had an R_f value of almost 0.67, confirming the presence of betacyanin [3].

2.5. Application on Cotton Fabric

For application, cotton fabric was scoured, immersed in the dye bath heated for 30 minutes to an hour, and then rinsed. Finally, the color was fixed by soaking the fabric in 1:4 water and vinegar solution before air-drying Shown in Figure 2.



Figure 2 Dyeing Process

3. Results and Discussion

3.1. Results

3.1.1. TLC Of canon ball

- The cannonball fruit extract produced an indigo color.
- TLC was used to characterize the crude dye, which was dissolved in chloroform and plotted on a thin layer chromatographic plate.
- The R_f value was determined to be 0.57, which matches the R_f value of standard indigo dye, confirming the presence of indigo dye.
- The blue pigment produced after the 5-day fermentation period was attributed to the presence of coloring components indigotin and indirubin Shown in Figure 3.
- It was concluded that the cannonball fruit extract contained a high amount of tannins, which contributed to its indigo color [4].

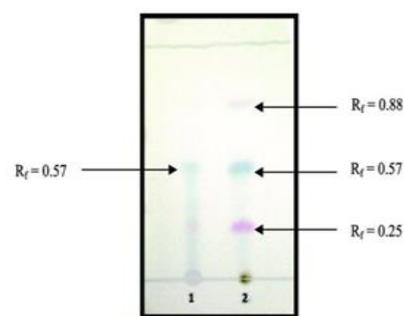


Figure 3 TLC of Cannonball

3.1.2. TLC of Dragon Fruit

- The dragon fruit extract produced a vibrant pink color.
- TLC analysis of the crude powder, dissolved in a 1:1 ethanol and water mixture, indicated the presence of betacyanin.



- The literature review suggests that the Rf value for betacyanin is between 0.5 to 0.7, and in the 1:1 ethanol-water eluent, the dye's Rf value was almost 0.67 [5].
- The vibrant pink color is directly responsible for the high amount of betacyanins present in the extract Shown in Figure 4.

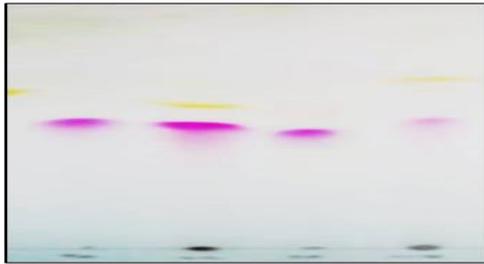


Figure 4 TIC of Dragon Fruit

3.2. Discussion

The extraction successfully yielded two distinct natural dyes: an indigo color from the cannonball fruit and a vibrant pink color from the dragon fruit. The color intensity and shade were shown to be adjustable by varying the ratio of the two extracts.

3.2.1. Cannonball Fruit Dye

The blue pigment extracted from the cannonball fruit was confirmed to be a form of indigo dye. Thin Layer Chromatography (TLC) of the crude powder yielded an Rf value of 0.57, which is equivalent to the standard Rf value for indigo dye. Previous research supported this finding, identifying indigotin and indirubin as the primary coloring components produced after the fermentation of *C. guianensis* fruit pulp. The final conclusion linked the indigo color specifically to a high amount of tannins present in the cannonball fruit extract [6].

3.2.2. Dragon Fruit Dye

The dragon fruit extract's vibrant pink hue was definitively attributed to betacyanin's. TLC analysis further supported this, with the crude dye exhibiting an Rf value of 0.67 in a 1:1 ethanol and water eluent. This value falls within the expected range of 0.5 to 0.7 for betacyanin compounds.

Conclusion

The study successfully confirmed the potential of two natural sources—cannonball (*Couroupita guianensis*) fruit and dragon fruit (*Hylocereus polyrhizus*)—for

dye extraction and application on cotton fabric. The cannonball fruit extract yielded an indigo color due to the high content of tannins, with TLC analysis confirming the presence of indigo dye (Rf 0.57). Conversely, the dragon fruit extract produced a vibrant pink color attributed to a high amount of betacyanins, supported by a TLC Rf value of almost 0.67. The ability to vary color shade by changing the extract ratio highlights the versatility of these dyes. The use of these fruits offers a sustainable and eco-friendly alternative to synthetic dyes. Further research should focus on optimizing the extraction process and significantly improving the colorfastness and durability of the natural dyes. Additionally, the potential applications of these natural dyes should be evaluated across other industries, including food and cosmetics, in addition to textiles. Further research can also explore the potential of other plant-based sources of natural dye.

Acknowledgement

We express our sincere gratitude to Dr. Jesy E. J for her invaluable guidance and supervision throughout the project titled "EXTRACTION OF NATURAL DYE FROM CANNON BALL & DRAGON FRUIT & APPLICATION ON COTTON FABRIC". We also acknowledge the dedicated efforts of our team members: Durga. V, Krishnapriya K, Mubeena K. M, Rinsha K. K, and Sreyalakshmi T. S.

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