Comparative Analysis of Colorfastness of Extracted Pigment from Kangkong (*Ipomoea aquatica*) with Varied Alcohol Solutions

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Abstract: Inorganic pigments are the most preferred pigments to be produced due to their greater resistance to fade, efficiency in the application, and how it is overall easier and faster to produce. However, natural water is polluted, and close vegetation is damaged because of the affected water channels that have been damaged due to improper disposal by the manufacturing industry. This paper reviews a comparative analysis of the colorfastness of extracted pigment from kangkong with varied alcohol solutions. A total of 7 varying ethyl alcohol solutions with concentrations ranging from 10% to 70% were obtained using the dilution equation. Kangkong leaves were then utilized for the extraction of chlorophyll due to its high leaf yield rate. The Brightness levels and Saturation levels had an inverse and direct correlation to the alcohol concentration, respectively. This suggests that a greater alcohol concentration is more effective and efficient in the extraction of chlorophyll because the samples had a better expression of colors. After observing the color value before and after administering the colorfastness test, the alcohol concentration in the extraction of chlorophyll has an inverse relationship with the colorfastness of the pigment on textile material.

Key Words: kangkong; ethyl alcohol; colorfastness; chlorophyll; pigment

1. INTRODUCTION

Pigment has been used since 2600 BC and has grown in relevance to society over time (Whittle, S., 2016). However, it is relatively unappreciated by the masses. It has both a functional and aesthetic significance in its application to textile materials. In the coming years, its market size is expected to grow in value, with it having reached 33.2 billion US dollars back in 2019 (Grand View Research, 2020). With the rapid increase in value for pigment, the methods employed to achieve this feat are questioned.

There are two types of pigments that are used for application on textile materials: organic and inorganic pigments. The latter being the most preferred to be produced. This is due to the inorganic pigment's greater resistance to fade, efficiency in the application, and how it is overall easier and faster to produce. However, the production method that is used for inorganic pigments is destructive to the environment. Inorganic pigments are produced by using inorganic metallic compounds, that if used in high amounts, will cause a negative effect on the environment it is exposed to.

Due to a majority of the manufacturing industry using inorganic pigments as colorants for their products, natural water is polluted and close vegetation is damaged because of the affected water channels (Impact of dyes, 2016). The reason behind this damage is due to inorganic pigments being composed of chemicals, that if disposed of improperly, may cause a negative impact on the aforementioned water channels (Koel Colours Private Limited, 2018). Despite this, the cost-effectiveness of inorganic pigments has allowed the pigments to be continually produced, thus increasing water pollution in the environment. As such, it is necessary to provide grounds for manufacturers to transition to utilizing organic pigments, as well as using an alternative environment-friendly production method.

For this study, the researchers have opted to see if the variation of alcohol concentrations in the use of ethyl alcohol in the extraction of chlorophyll from Kangkong leaves will result in the change of color fastness when applied to cotton textile material.

2. METHODOLOGY

The methodology of this study has a total of 5 phases wherein phase 1 is the preparation of alcohol concentrations by dilution, phase 2 is the extraction of chlorophyll using the diluted alcohol concentrations, phase 3 is where the pigment is applied to the textile, phase 4 is the colorfastness test, and finally, in phase 5, the color value is then digitally identified.

2.1 Materials and Equipment

The following materials were used by the researchers for this study: cotton textile materials, kangkong leaves, and 70% ethyl alcohol. As for the equipment, a medium-sized pot was used for the extraction process of the chlorophyll.

2.2 Preparation of Alcohol Concentrations

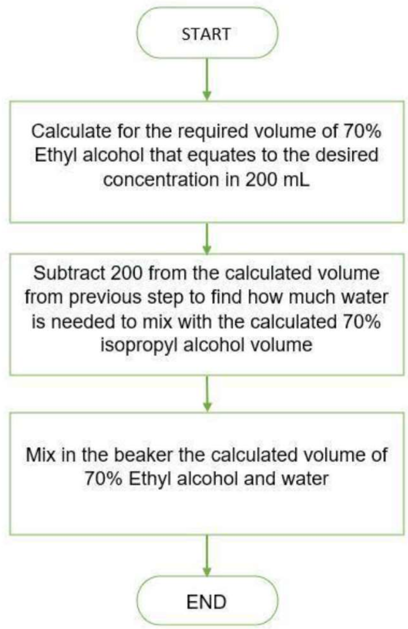

Fig. 1. Preparation of alcohol concentration by dilution

Due to ethyl alcohol being solely commercially sold in 70% alcohol concentrations, a method for diluting the alcohol from 70% is necessary to obtain varying concentrations for the study. Using the dilution equation, which is (C1)(V1) = (C2)(V2), we calculate the volume of the starting solution, which is represented by V1. Initial concentration is represented by C1, while C2 represents the desired concentration and V2 for the total final volume. After dilution, a total of 7 solutions of varying ethyl alcohol concentrations should be obtained.

2.3 Extraction of Chlorophyll

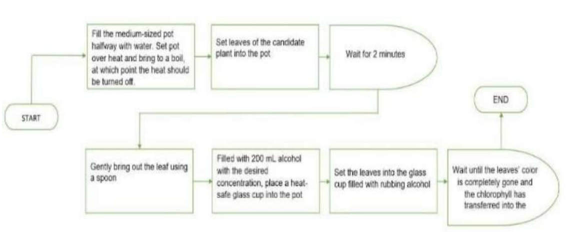

Fig. 2. Extraction of chlorophyll with varying alcohol concentrations

The process of extracting the chlorophyll from the kangkong leaves is straightforward. It simply involves submerging the leaf into boiling water to weaken it and allow the chlorophyll to more easily transfer into the solvent, ethyl alcohol. For 6 min, the leaf sits within the boiling water, which is the time found after performing preliminary tests to determine the steps that needed to be adjusted to properly extract the chlorophyll. The weakened leaf is allowed to rest, submerged in the bowl of 200 milliliters (mL) ethyl alcohol for 1 h. Once extracted, the chlorophyll-alcohol solution is immediately used in the next phase.

2.4 Application of Chlorophyll to Textile

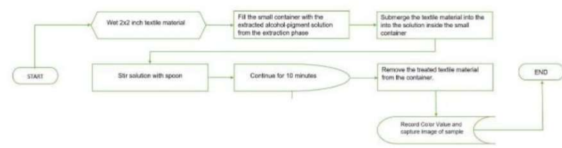

Fig. 3. Application of chlorophyll onto textile material

The extracted chlorophyll is used to dye a 2 in x 2 in textile material made of cotton. The bucket method or sink method was used to apply the chlorophyll. The method is simply submerging the textile into the chlorophyll-alcohol solution for 10 min while it is stirred to ensure an equal distribution of color across the sample. The samples were then dried while concealed from sun exposure to prevent them from being affected by lightfastness, which is different from colorfastness. Once dried, the images of the samples were captured with the homemade photo studio. More details on the studio will be provided in a later section.

2.5 Colorfastness Test

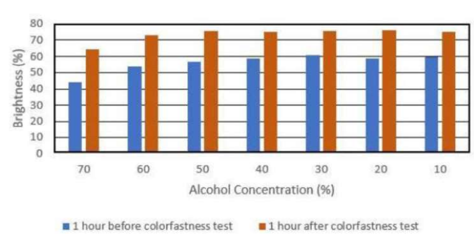

Fig. 5. Comparison of average brightness levels of the samples before and after the colorfastness test.

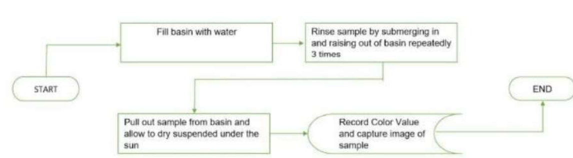

Fig. 4. Colorfastness test method

Once the samples have been collected, it is then subjected to the colorfastness test. The test involves replicating the stress typical clothing undergoes while laundering to observe if the color will fade after experiencing the stress. The test is based on the colorfastness test procedures published by the Southeast University (Shishir, M. M. H., 2014). After preliminary testing, it was necessary to decrease the stress since the color fade is too extreme to make a comparative analysis between the samples. The samples were submerged into room temperature water repeatedly for 3 times and then dried in the same drying conditions mentioned in the previous phase.

2.6 Digital Identification of Color Value

A digital application was used to digitally identify them using the images captured using the home studio to identify the color value of the samples. The application used is adobe photoshop was able to provide a detailed analysis of the coloration of the sample using the captured images such as the hue, saturation, and brightness. These are necessary components to assess the change in coloration of the sample before and after the colorfastness test since the loss of color due to color fade is attributed to the loss of saturation in a color (What is Color Fading and Can It Be Prevented, 2017).

3. RESULTS AND DISCUSSION

A total of 7 varying ethyl alcohol solutions with concentrations ranging from 10% to 70% were obtained. It was observed that a noticeable change in color had occurred in the solutions. Due to how in each solution, the percentage of the ethyl alcohol used was decreased, resulting in the dilution of color in the decreasing concentrations. As for the cotton textile materials, each piece had been submerged in a corresponding ethyl alcohol solution for over 12 hours to best see the coloration of the chlorophyll. As for the drying process, it was opted that the cotton textile was to be dried under a period of 10 minutes with no exposure to sunlight

The brightness levels, which correspond to the color value of a sample, were found for each sample before and after the colorfastness test seen. The average levels across the three trials were found and graphed in figure 5. The Saturation levels were also taken into account because this also represents an important component in the expression of color. Like the brightness levels, the average saturation levels across all three trails for each alcohol concentration was found. This can be viewed in figure 6. The Brightness levels had an inverse correlation with the alcohol concentration, while the Saturation levels had a direct correlation with the alcohol concentration based on the graphs of the average levels of brightness and saturation. These relationships imply that a greater alcohol concentration is more effective and efficient in extraction chlorophyll because the samples had a better expression of colors. This is consistent with the fact that alcohol is capable of weakening the cell walls of plant cells to allow for the contents of the cell to be released (Center, B. S, 2015). It is because of this function of alcohol that chlorophyll can easily be extracted with solutions of greater alcohol concentrations.

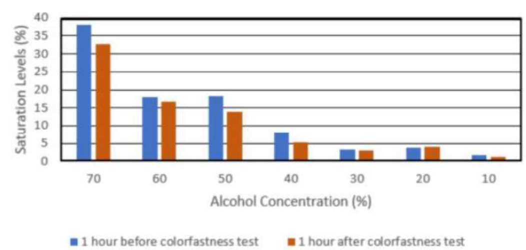

Fig. 6. Comparison of average saturation levels of the samples before and after the colorfastness test.

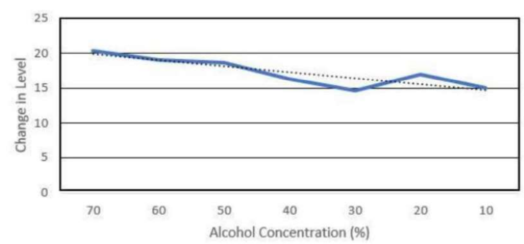

Fig. 7. Difference of Average Brightness levels before and after the colorfastness test.

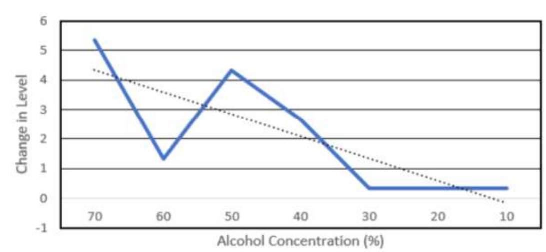

Fig. 8. Difference of Average Saturation levels before and after the colorfastness test.

There is a clear effect from the colorfastness test; however, what is important is how drastic the change is in each level after administering the test after comparing the levels of the samples before and after the colorfastness test. It can be observed from figures 7 and 8 that as the concentration of the alcohol decreased, there is a noticeable loss of change in levels. The difference implies that there is an inverse relationship between alcohol concentration and colorfastness because there is a decrease in the difference between the average brightness and saturation levels before and after the test, albeit minimal.

4. CONCLUSIONS

After observing the color value before and after administering the colorfastness test, alcohol concentration in the extraction of chlorophyll has an inverse relationship with the colorfastness of the pigment on textile material. Additionally, it also has an inverse relationship with brightness levels and a direct relationship with saturation levels. If the priority is to provide a higher quality color application on textile material, then the use of a high alcohol concentration when extracting chlorophyll is preferred; however, if colorfastness is prioritized, finding an alcohol level that balances the color expression while maintaining a minimal loss of color is necessary.

5. ACKNOWLEDGMENTS

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