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Practical Usage of *Caesalpinia sappan* L. As a Natural Dye to a Silk Fabric

Suk-Yul Jung
Molecular Diagnosis Research Institute, Department of Biomedical Laboratory Science,
Namseoul University, 31020 Chungnam, Republic of Korea

Abstract: *Caesalpinia sappan* L. widely distributed in South China and Middle East Asia can be applied as a natural dye. Natural dye covers all the dyes derived from natural resources such as plants insects and animals. To change original colors produced from untreated with other chemicals, mordants have been used. This study analyzed the staining of *C. sappan* L. to silk fabric and color changes by chemical mordants. Each mordant was applied to the silk fabric and pH was maintained with 6 as the natural dye was extracted by boiling water. Color by the dye of dried *C. sappan* L. showed yellowish brown without any mordant. Except for aluminum potassium sulfate and sodium tartrate plus citric acid, silk fabric was mainly dyed in dark color by other mordants. Iron (II) sulfate-mordant induced gray and black to the silk fabric. Interestingly, copper acetate, aluminum potassium sulfate and potassium dichromate-mordants did not completely differ in color but they induced darkness and red color. Our study would be useful to comparatively analyze the staining changes by *C. sappan* L. dye. Further, study will be processed to evaluate them as a biological usage and other applications of natural staining.

Key words: *Caesalpinia sappan* L., natural staining, silk fabric, mordant, color change, biological usage

INTRODUCTION

Caesalpinia sappan L. is a plant of Leguminosae family, commonly known as Brazil or Sappan wood and *C. sappan* L. is widely distributed in South China and Middle East Asia and its dried heartwood has been used as ingredient of food or beverages (Nirmal *et al*., 2015; Toegel *et al*., 2012). Brazilin is the major compound naturally occurring in the *C. sappan* L. heartwood and is used as a red dye for histological staining (Bae *et al*., 2005; Nirmal *et al*., 2015). Brazilin is a biologically active compound but the major limitation of the use of this pure naturally derived compound is its high cost of production, due to the many steps and time involved for purification (Nirmal and Panichayupakaranant, 2014). The Brazilin was isolated from *C. sappan* by centrifugal partition chromatography and was revealed to upregulate intracellular reactive oxygen species (Uddin *et al*., 2015). Moreover, because *C. sappan* L. contains a lot of pigments, it would be able to be applied for natural staining and other chemical usages.

The term, natural dye, covers all the dyes derived from natural resources such as plants insects and animals (Sharma and Grover, 2001). To change original colors produced from untreated with other chemicals, mordants have been used, e.g., copper acetate, aluminum potassium sulfate, sodium tartrate plus citric acid, iron (II) sulfate and potassium dichromate (Jung and Park, 2014; Park and Jung, 2014). For example, copper acetate and potassium dichromate induced the differences of lightness and darkness in the natural staining with dried skins of Vitis coignetiae Pulliat (Jung, 2108a, b). Therefore, it implied that mordants could produce unexpected colors.

In this study, using various mordants above, color changes to fabric silk by *C. sappan* L. were compared with the dye of its original dried materials.

MATERIALS AND METHODS

Preparation of dried *C. sappan* L. and extraction of dye: *C. sappan* L. was purchased from a traditional market and washed three times with Distilled Water (DW). The 700 g of the dried materials was completely dried on air for the next extraction of dye. The protocol was followed by the previously published methods and was modified (Jung, 2018a, b). Briefly, about 600 g of the skins was dissolved into 10 L of distilled water by boiling with strong flame. The pH 6 was continuously maintained and boiling to completely extract the natural dye was performed for 60 min. The boiled mixture was maintained with 100°C. When vapor was come up, the solution was boiled with medium flame for 50 min. When the skins were sufficiently wet in the water, they were filtered to obtain the pure dye.

Application of a natural *C. sappan* L. dye to silk fiber: Our research targeted the staining of silk, using the dried kins of *C. sappan* L. and changes of silk colors using a variety of mordants. Each mordant was applied to the silk fabric and pH was maintained with 6 as the natural dye was extracted by boiling water. Mordants of copper acetate, aluminum potassium sulfate, sodium tartrate plus citric acid, iron (II) sulfate or potassium dichromate were pre-mordanted with the fabric silk as shown in Table 1 and then the dye was added. After the dyeing was finished, the silk fabric was washed with water and dried without squeezing.

Table 1: Treatment of mordants to silk fabric

Mordants	Volume of mordants (g)	Volume of distilled water (mL)	Treatment time (min)
Copper acetate	10	600	15
Aluminum potassium sulfate	10	600	15
Sodium tartrate plus citric acid	30+90	600	15
Iron (II) sulfate	10	600	5
Potassium dichromate	15	600	15

RESULTS AND DISCUSSION

Staining of silk fabric by a dried *C. sappan* L. and applications of mordants: Dried *C. sappan* L. was prepared in Fig. 1 which showed light red. Some showed colors mixed with red and brownish color.

Color by the dye of dried C. *sappan* L. showed yellowish brown without any mordant (Fig. 2). The color changes due to the treatment of the mordants varied greatly. Mordants have been used to set dyes on fabrics or tissues by forming a coordination complex with the dye which then attaches to the fabric or tissues (Jung, 2018a, b; Kadolph, 2012). They may change original colors or intensifying stains in fabrics.

Except for aluminum potassium sulfate and sodium tartrate plus citric acid, silk fabric was mainly dyed in dark color by other mordants. Iron (II) sulfate-mordant induced gray and black to the silk fabric. This was probably due to the iron content of the mordant which seemed to have a

Fig. 1: Dried and ready-to-use *C. sappan* L. dye

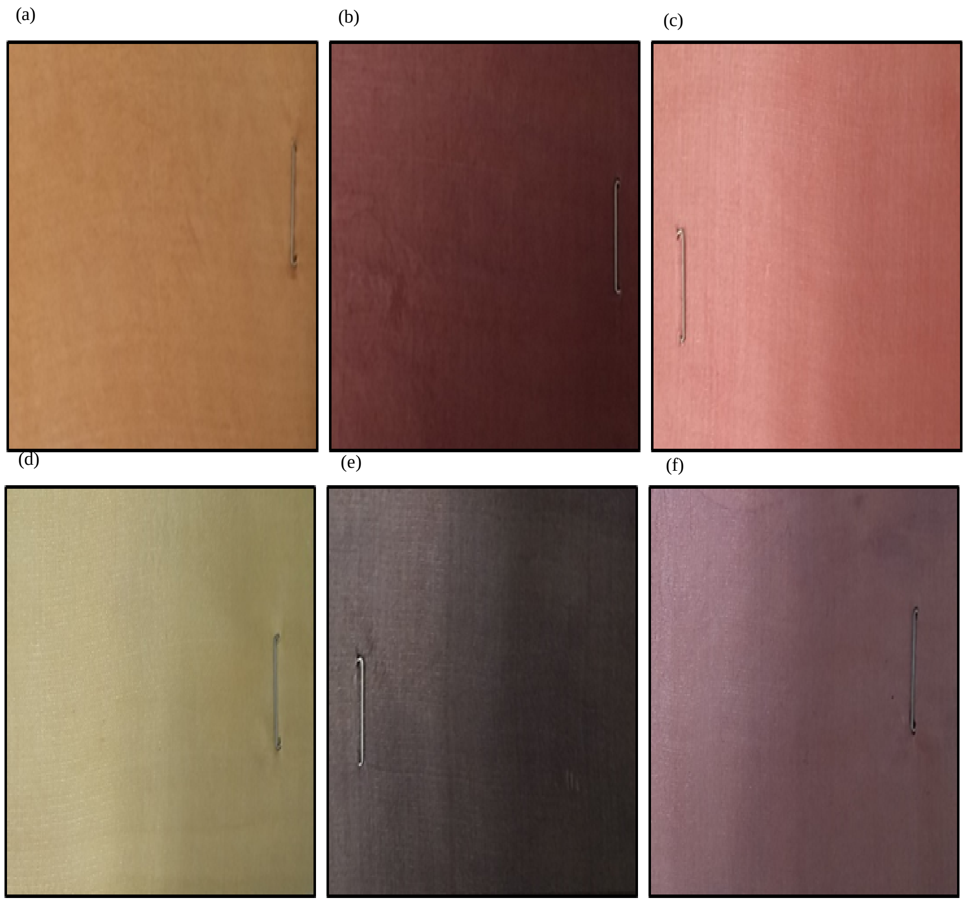

Fig. 2: Staining patterns of *C. sappan* L. dye and color changes by mordants; a) None; b) Copper acetate; c) Aluminum potassium sulfate; d) Sodium tartrate plus citric acid; e) Iron (II) sulfate and f) Potassium dichormate

very dark color. Interestingly, copper acetate, aluminum potassium sulfate and potassium dichromate-mordants did not completely differ in color but they induced darkness and red color.

CONCLUSION

Natural dyeing is closely related to our lives. This is related to the purpose of staining fibers such as silk fabric and the purpose of destroying dyeing and thus, the development of the natural dyeing industry is currently ongoing. The degree of darkness of the color depends on the concentration of the natural dye material used. However, the mordants have been required to produce interesting colors. This fact does not necessarily mean the desired color but it does represent an important means by which a new color is derived by the mordant. In this study, five different chemical mordants were used but may be harmful for human health. Of course, the mordants were pre-mixed with *C. sappan* L. dye and were completely, soaked and dried in silk, so, there would be no risk of allergies due to skin contact. Therefore, natural or bio-mordants are being increasingly important. It was reported that chlorophyll-a as biomordant would be one of the bio-mordants (Guesmi *et al*., 2013). An increase in the color strength values were shown with increasing the concentration of biomordant. The application of the bio-mordant will be one of interests in the staining of silk fabric.

Our study showed that due to the composition of iron in mordants, silk fabric seemed to be darker. On the other hand, copper acetate, aluminum potassium sulfate and potassium dichromate-mordants induced different colors, e.g., red, dark purple as compared with the staining by *C. sappan* L. dye without any mordant.

RECOMMENDATION

Our study would be useful to comparatively analyze the staining changes by *C. sappan* L. dye.

Further, study will be processed to evaluate them as a biological usage and other applications of natural staining.

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