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CARISSA CARANDAS FRUIT EXTRACT AS A NATURAL FABRIC DYE

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ABSTRACT - This study aimed to produce a natural fabric dye that can create an intermediate color from cranberry (Carissa carandas) extract. The natural dye was generated by mixing water and fruits, then heated to simmer. To be able to test for the type of fiber which best absorbs the dye, 3 different fabrics were used – Swiss cotton, greige, and silk cocoon fabric. The silk cocoon fabric, found to be most viable for natural dyeing, was used in testing for the effect of the fruit's ripeness to the color it produces. Three different sets of the fruit were used – fully-ripe violet cranberries, ripe red-violet ones, and slightly-ripe red cranberries. It was found out that the produced colors ranged from red-violet to blue-violet. The fabric dyed using the ripe cranberries produced the most highly-intense color among the three (3) sets of tests. It can be concluded that the extract was able to produce a natural fabric dye of intermediate colors. Moreover, the ripeness of the fruit affects the value and intensity of the fabric dye's color. The experiment may later on be improved and tested for the best number of hours it would take soaking the fabric to produce a darker color value.

Keywords: Carissa carandas, cranberry, natural fabric dye, intermediate color

INTRODUCTION

The karanda or karanda cranberry (Carissa carandas) is a climbing shrub or small tree usually reaching 5 meters tall. The numerous and spreading branches form dense masses and are set with sharp thorns, simple or forked, up to 5 cm long, in pairs in the axils of the leaves (Morton, 1987). It is cultivated for its edible fruit, which can be eaten raw, made into jam and jelly, or used for pies. Carissa carandas, a perennial plant, is a hardy shrub that is easily maintained, Pruning of the plant is said to enhance the cultivation of its berries. Harvesting cranberries is not labor intensive. The ripe berries are very rich in anthocyanins. These anthocyanins are responsible for the color of the karanda cranberries. The uses of natural bio-pigments, such as anthocyanins from fruit and food products, are an excellent alternative to synthetic colors (Khuen and Sulaiman, 2008).They are non-toxic and from renewable resources. Little has been known, however, of the karanda cranberry's dyeing capability, especially on fabric. Decorators and fashion houses of today have adopted the color of cranberries synthetically for dresses, lipsticks, walls, and many other things, but they were not the first to appreciate the color. Some early Indians and Asians made use of this fruit as a coloring agent smeared on their skin or clothing.

This study was conducted due to the researcher's interest on the karanda cranberry plant and its significance other than for consumption and medical use – such as its capability of dyeing fabric, the production of an intermediate color, and the strength of the color it produces.

The researcher hypothesizes that the extract from the karanda cranberry would be a good natural fabric dye and may produce a color between red and violet since the fruit generates a liquid concentrate between these colors. The production of a natural fabric dye from the cranberry would greatly help in providing sustainable livelihoods for the agriculturists and make textile industries more competitive by reducing production costs and eliminating the huge expenses of chemical imports.

REVIEW OF RELATED LITERATURE

Karanda Cranberry

The karanda cranberry (Carissa carandas), popularly known as karanda or as the Indian cranberry, is a woody, climbing shrub or small tree with profuse branching and can grow up to a height of 5 meters. The branches have either simple or forked thorns. Its leaves are broadly ovate to oblong and measure between 3 to 7 centimeters long and 1.5 to 4 centimeters wide. Its fruit is broadly ovoid or ellipsoid, 1.5 to 2.5 centimeters long, and turns red-violet when ripe and almost black when over-ripe. There are 2-4 small, flat, brown seeds embedded in the sour pulp of the fruit.

The karanda cranberry is native and common throughout India, Malaysia, and Burma. It is cultivated mainly for its fruit and marketed in villages rather than in large produce stores. It is also often grown in several Asian countries such as Thailand, Cambodia, Vietnam, and in the Philippines. The plant requires full exposure to the sun and grows even on the poorest, driest, and rockiest soils. It is often most fruitful on deep, fertile, well-drained soil; but if the soil is too wet, there will be excessive vegetative growth and lower fruit production (Morton, 1987).

Uses

The berries of the karanda are utilized in jams, tarts, and puddings. They are also sun-dried in several countries to produce dried cranberries famous as a snack or as an additional ingredient in granola bars and cereals. Aside from being a food source, the karanda also has various medicinal uses. The ripe fruit is often used as a source of Vitamin C, with 9-11mg ascorbic acid for every 100mg of the fresh fruit. The leaves are valued as herbal medicine for diarrhea, intermittent fever, and many more. The paste of the pounded roots of the plant serves as fly repellent and is an ingredient in a remedy for itches.

The health benefits derived from the karanda cranberry have long been known and supported by scientific research. However, little is known of its dyeing capability and its ability to “stain” clothes. Indians and Asians of long ago used the berry for some time to color designs on their skin and on the skin of their animals as an early form of tanning. Scientists claim that the berry owes its ability to stain and color surfaces on its anthocyanins. Cranberries are rich in the anthocyanin pigments from the range of red, violet, or blue. They carry an anthocyanin content of roughly 60mg for every 100g fresh weight of the cranberries.

Fruits owe their ability to dye fabrics and threads to the pigment that they contain, such as the large amount of anthocyanins present in the karanda cranberries. Anthocyanins are a very large group of red-blue plant pigments. They occur in all higher plants, mostly in flowers and especially fruits but also in leaves, stems, and roots. In these parts they are found predominantly in outer cell layers. Their amounts are relatively large. The color of anthocyanins depends on the structure, but sometimes also on the acidity of the fruit. Many anthocyanins are red at acidic conditions and turn blue at less acid conditions.

The basic chromophore of anthocyanins is the 7-hydroxyflavylium ion. Naturally-occurring anthocyanins typically have hydroxyl substituents (that provide the thermal stability), are occasionally glycosylated, and the B-ring or the 2-phenyl ring has one or more hydroxyl or methoxy substituents, depending on its color.

Cultivation Practices

The Karanda first fruited in the Philippines in 1915. P.J. Wester described it in 1918 as "one of the best small fruits introduced into the Philippines within recent years."

Propagation is usually by seed because cuttings have never rooted readily. Experimental work in India has shown that cuttings from mature plants may not root at all; 20 percent of hardwood cuttings from trimmed hedges have rooted in November but not when planted earlier. Cuttings from nursery stock gave best results: 10 percent rooted in late September; 20 percent in early October; 30 percent in late October; and 5percent in early November.

The plant grows slowly when young. Once well-established, it grows more vigorously and becomes difficult to control. If kept trimmed to encourage new shoots, it will bloom and fruit profusely. Thus, the quantity of berries produced annually will depend on frequent trimming of the karanda plant.

The karanda may bloom and fruit off and on throughout the year. To use unripe berries, the fruits are harvested from mid-May to mid-July. The main ripening season is August and September. The 5- pointed calyx remains attached to the plant when the fruit is picked, leaving a gummy aperture at the base (Morton, 1987).

As observed from a few plantation of the karanda in Cebu City, Philippines, the fruit ripens 4 weeks after the fruit has fully developed. It is considered the best time to harvest the fruit for dyeing purpose.

The plant may be cultivated commercially on an orchard, given sufficient area and spacing of one meter apart from the other. Preferably, the land should be a big open space with a good amount of sunlight. However, the amount of fruit yield annually is not certain because it is dependent on the fruit bearing capacity and the health and condition of the plant.

Dye

A dye is a soluble color that is applied from a solution called the dye liquor. It penetrates and combines with the fabric, yarn, fiber, or thread being dyed. Dyeing can be defined as the process of applying a comparatively permanent color to a fiber, yarn, thread, or fabric, via immersion in a dye bath (Castle, 2007).

There maybe different methods of fabric dyeing, but the basic principles are common and similar. First, a quantity of dye is made by dissolving the dyestuff in a given quantity of water, usually determined by the amount of fabric. Then, the fabric to be dyed is wetted out. Wetting out helps the fibers to swell and causes the polymers to move apart slightly – providing enhanced consistency and a more even uptake of the dye. The fabric is then immersed in the dye liquor held inside a vessel called the dye bath. Traditionally, water is used since it is the cheapest carrier of the dye. The dye liquor undergoes a process referred to as migration. This is where the dye molecules are attracted and move towards the fabric. The dye oftentimes loses its color as the textile becomes dyed, and this process is known as exhaustion. Dye molecules then go through a process referred to as diffusion. This is the process where the dye molecules move into the amorphous regions of the textile and anchored by a procedure called fixation. Anchoring the dye is assisted by the natural forces and bonds that exist between the polymers of the fiber and the dye, including the use of fabric fixatives such as salt or vinegar.

The advantages and disadvantages of natural fabric dyes over the present-day synthetic dyes are many. They are less toxic than their synthetic counterparts and are obtained from renewable sources. Natural dyes also cause no disposal problems for they are biodegradable and are harmonized with nature. The production of natural fabric dyes may help in providing sustainable livelihoods for the agriculturists and make textile industries more competitive by eliminating the huge expenses of chemical imports.

Natural dyes were used many years ago until the synthetic dyes were discovered in the mid-19th century. They are obtained from various plant, animal, or mineral sources. Plants and lichens yield yellows, oranges, pinks, greens, browns, and black. Yellows may be obtained from saffron (Crocus sativus) and turmeric (Curcuma longa or Curcuma tinctoria). Orange dyes may be produced from dandelion (Sambucus ebulus), and the skin of onions (Allium cepa). Pinks and purples come from berries of the blackberry (Rubus fruticosa) and the strawberry (Fragaria ananassa). Browns and blacks can be obtained by various coffee beans and tea (Wells, 1997).

The colors obtained with vegetable and fruit dyes are often rich, but they can also produce softer shades than those of synthetic dyestuffs. They are not as wash-fast as the synthetic ones, but with the careful use of fixatives, these characteristics can be improved. Salt is sometimes used for regular fruit dyes but vinegar is recommended for acidic fruit dyes.

Fabric

Fabrics are basic necessities of people. They are used in various ways, in different kinds and purposes. Their primary function is to enhance people's interaction with the natural surroundings and the social milieu. They are signifiers of meaning – often providing insights into people's interactions with their environment and other cultures (Respicio, 2003). In their totality, fabrics define the cultural identity of the people as a community and as a nation.

Fabrics are differentiated by its fiber type. Oftentimes, all or part of their name is derived from the fiber of which they are made of. Some common fabric fibers used in the Philippines are: cotton, used in casual clothing; cotton/polyester, as with greige fabric, is utilized for eco bags (reusable shopping bags), aprons, apparel, and the like; silk cocoon, used in formal Philippine wear such as barongs and Filipiniana dresses.

Cotton fibers are flattened, twisted tubes, the walls of which are composed of cellulose fibrils built up in a number of concentric layers. What distinguishes cotton from all other fibers is its spiral structure, which gives it elasticity and greater suitability for spinning. No other natural fiber has this quality and it has never been imitated by synthetic fibers.

Greige fabric is available in cotton-polyester and 100 percent polyester fiber. Synthetic fibers are best blended with natural fibers such as polyester mixed with cotton to produce a fabric with a natural handle and less crease (Sorger and Udale, 2006). The fabric is a light to medium, loom state, woven fabric without any additional finishing. Greige fabric is extremely versatile and has various uses. It is not processed in any additional finishing operations but the fabric may be customized with designs when required.

Another type of fiber is the silk, such as that found in the silk cocoon fabric. Silk is lower in density than cotton, wool, and rayon fibers, and is highly moisture-absorbent, retaining 30 per cent of its weight in water without feeling damp to the touch. It is more heat-resistant than fabrics likewool, for example, and has good dyeing properties. The silk cocoon fabric is a fabric made from protein fibers that are claimed to be good in absorbing natural dye colors.

Color

Color is the visual response to the wavelengths of sunlight recognized as red, blue, green, and so on; having the physical properties of hue, intensity, and value (Bone et al., 2002). Hue designates the name of a color and indicates its placement in the color wheel. Intensity refers to the saturation, strength, or purity of a hue. In this regard, any vibrant color is considered to be of high intensity while any dull color is considered to be of low intensity. Value is the relative lightness or darkness of a color. On a gray scale, the lightest value is white, and the darkest is black. The terms tint, tone, and shade are also used in this context when dealing with paint. A tint refers to white being added to the color. It is called tone when gray is added to the color, and shade when black is added instead (Aspelund, 2010).

Color is an element of design, instantly appreciated by adults and most of all by children. A child, for instance, turns his attention to bright colored toys or objects in fascination as these come in different hues. A window display of brightly colored shirts for summer makes passersby turn his head twice to look at the display. Coloris universally appreciated not only for the variety it showcases but also for its contribution to beauty.

Color is also considered an expressive element because it conveys an immediate emotional reaction. Research has shown that light, bright colors make an individual feel joyful and uplifted; warm colors are generally stimulating; cool colors are calming; while cool, dark, or somber colors are generally depressing (Bone et al., 2002).

Based on the theories of Louis Prang in 1876, a color system was developed. The said system led to the development of the Prang Color Wheel composed of 12 hues The colour wheel is grouped into primary, secondary, and intermediate colors. Red, yellow, and blue are primary colors, so called because they can not be produced by mixing other hues. The secondary colors are violet, orange and green, which are formed when two primary hues are mixed together. Intermediate color is the result of mixing a primary and secondary color. The intermediate colors are blue-violet, red-violet, blue-green, yellow-green, red-orange, and yellow-orange (Bone et al., 2002).

MATERIALS AND METHODS

This study used the qualitative style of research.

The materials used in the experiment are the following:

a. Karanda Cranberries, are the raw materials, were harvested at the researcher's garden where the plant grows.

Figure 1. Karanda cranberries

b. Cooking pot was used in boiling the berries to generate the fruit extract which was used in dyeing.

c. Stove was used to heat the cooking pot bearing the fruit and water mixture.

d. Commercial Cane Vinegar

e. Basins were used for:soaking the fabrics in vinegar; and in holding the fruit extract when the fabrics were dyed.

f. Fabrics - Three kinds of fabric were used in the experiment. Each kind of fabric was made of different types of fiber. The greige fabric that was used was made of a combination of cotton and polyester fibers; the Swiss cotton fabric was made of cotton; and the silk cocoon fabric was made of silk.

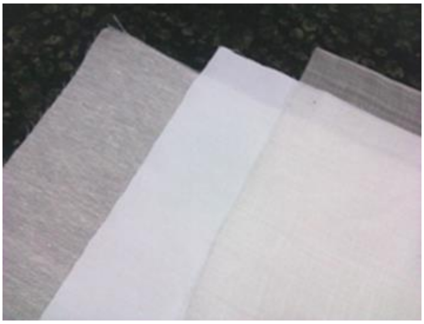

Figure 2. Greige, Swiss cotton, and silk cocoon fabric

g. Strainer - was used in separating the liquid extract from the karanda cranberry fruits.

h. Clothing Iron - was used to flatten the fabrics and iron out any wrinkles they had. This allowed for a better comparison of the fabrics afterwards.

General Procedure:

Extraction

The first process in producing the natural fabric dye is extraction. For three square feet of fabric, 4 cups of the cranberry fruit were used. The cranberries were chopped in half and put inside the cooking pot. For every 2 cups of fruit, 5 cups of water was added (fruit-water ration of 2.5). This means that for the 4 cups of fruit in the cooking pot, 10 cups of water were added to it.

The mixture was heated to boiling. Once the water started to boil, it was left to simmer for 20 minutes – just enough for the fruit to soften. This allowed the fruit to release its pigment into the water where it is immersed. After simmering, the stove was turned off. The mixture was left to cool for 6 hours in the cooking pot.

As soon as the mixture cooled, it was strained to separate the liquid extract from the cranberries. The extract was placed in a clean basin.

Applying the Fixative

Natural dyes, such as those from berries, require a fixative to fix the dye color on to the fibers of the cloth. There are two common fixatives that are found in the household: acetic acid and sodium chloride. Acetic acid is found in vinegar and sodium chloride is in the form of salt. Acetic acid, commonly used in vegetable dyes and acidic fruit dyes, contributes in lowering the pH of the dye bath and helps to extract more dyestuff, enhancing the final color of the dye (Wells, 1997). It works by soaking the fabric in vinegar for a period of time. Salt, on the other hand, is usually used as a fixative for fruit dyes. It works by immersing the fabric in a boiling solution of salt and water. Any of the two fixatives may be used in the cranberry extract dye since the extract comes from a fruit and is acidic. Boiling, however, would damage a fabric made of protein fiber such as the silk cocoon fabric. For this reason, the vinegar was used as a fixative in the dyeing process.

The cloth was soaked in vinegar in a ratio of 1:1. For every square foot of cloth, 1 cup of vinegar was added. For the 3 square feet of cloth – 1 square foot each for greige, Swiss cotton, and silk cocoon fabric – 3 cups of vinegar were used. The fabrics were soaked in vinegar for an hour. After soaking, they were washed in cold water.

Fixing the Dye

The wet fabrics, washed with cold water, were soaked in the cranberry extract. The wetness of the fabric allows for an even distribution of the dye to the cloth. They were soaked for 8 hours.

Then, the fabrics were lifted from the extract and washed with cold water. They were hung outside to dry in the shade. Once the fabrics were dry, they were ironed to remove any wrinkles on the cloth and for easy comparison with the others.

Three different kinds of fabrics were dyed to compare which fiber best absorbed the dye. The fabrics were dyed together for 3 trials. The fabric found to have absorbed best the natural dye from the cranberry extract was used in testing for the relationship between the fruit's ripeness to the color it produces. The first set of cranberries used in dyeing was a group of very ripe ones that were dark violet and almost black in color. The second set of cranberries used in dyeing was a group of berries that were just ripe enough and were partly violet and partly red-violet in color. The third set of cranberries was a group of just slightly ripe ones that was red in color. Each set of cranberries were used in dyeing the same kind of fabric of 3 trials each.

The result of the three degrees of fruit ripeness were observed and analyzed comparatively as to the intensity of color on the fabric.

RESULTS AND DISCUSSION

The karanda cranberry extract was able to stain and dye the 3 different kinds of fabric – Swiss cotton, greige, and silk cocoon. The fabrics were left with colors ranging from red-violet to blue-violet and violet. These colors were similar to that of *Vaccinium macrocarpon* and other related species, such as those utilized in a study by Sengupta and Singh regarding "Natural, *Green* Dyes for the Textile Industry." The value and intensity of the color dyed on to the fabrics using the karanda cranberry were significantly different from each other, by comparing results on the test for the relationship of the ripeness of the fruit. The silk cocoon fabric was dyed with the most intense and vibrant color of the three. The results suggest that the fruit extract works well with the silk cocoon fabric, since it has porous protein fibers with more surface area. This may have contributed to its capability in absorbing the natural dye. Protein fibers are strong, resilient, and very absorbent (Brackmann, 2013).

Figure 3. 1st test with the different kinds of fabric

Figure 4. 2nd test with the different kinds of fabric

Figure 5. 3rd test with the different kinds of fabric

In the test for relationship between the ripeness of the fruit and the color it produces, it was found that the ripe and red-violet berries produced the most striking shade of red-violet on the dyed fabric. The slightly-ripe red berries and the over-ripe violet ones both produced a blue-violet shade. These colors were similar to that of *Vaccinium macrocarpon* and other related species.

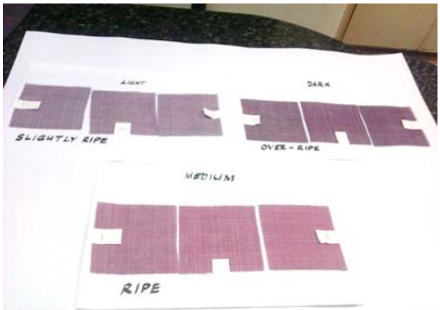

Figure 6. Results from the test for the fruit's ripeness in relation to the color it produces

Anthocyanins play a role in the colors of ripening fruit. The color of anthocyanin pigments range from red, purple, or blue, depending on their pH. As the pH changes from low to high, the pigment color also changes from red to purple to blue, respectively. The effects of pH stress, however, sometimes vary by the type of fruit and the structure of anthocyanins present. The *Carissa carandas* contains 3 anthocyanins or bio-pigments, namely pelargonidin-3-O-glucoside, cyanidin-3-O-rhamnoside, and cyanidin-3-O-glucoside. The vibrant red-violet color produced in the experiment may have been a result of the high level of these pigments present when the karanda cranberries were ripe enough. In a study conducted by Khuen and Sulaiman in the School of Biological Sciences of Universiti Sains Malaysia, the highest percentages of pelargonidin-3-O-glucoside were detected at the ripening stage. The content of cyanidin-3-O-glucoside and cyanidin-3-O-rhamnoside increased during the ripening and development. However, the content was reduced in the over ripening of the fruit.

After three washes of the dyed fabrics, they turned into a lighter shade of the original hue. This suggests that the natural dye is not that colorfast, but still was able to retain a good amount of color on the dyed fabric. Natural dyes employed with acid, according to Koester and Simpson, have varying moderate to good colorfastness after washing (Koester & Simpson, 1995).

Figure 7: The dyed silk cocoon fabric after one wash, two washes, and three washes, respectively, showing a gradual change to a lighter shade and lesser intensity compared to the original color

SUMMARY

The primary objective of this study was to analyze the potential of the karanda cranberry extract as a natural fabric dye. Specifically, it aimed to determine the type of fiber which best absorbed the dye; test the relationship between the fruit's ripeness to the kind of color it produced on the fabric; assess the differences in value and intensity of the color it produced; as well as examine and analyze the colorfastness of the natural dye.

This study on the production of a natural fabric dye from the cranberry extract was conducted from 15 February to 1 April 2014 at the researcher's home in Cabancalan, Mandaue City, Cebu, Philippines.

The research materials included: Karanda cranberries, cooking pot, stove, commercial cane vinegar, 2 separate basins (for the cranberry extract and tthe vinegar fixative), 3 types of fabric (Silk cocoon, Greige, and Swiss cotton), strainer, and clothing iron.

The general procedure in producing the natural fabric dye includes extraction, application of the fixative, and fixing the dye.

It was found that the silk cocoon fabric absorbs the natural fabric dye well, owing to the properties of its protein fibers. The same fabric produced the most vibrant red-violet color with the ripe cranberries.

CONCLUSION

The natural fabric dye was able to color several kinds of fabric with the silk cocoon displaying the best in absorbing the dye. The same fabric produced the most vibrant color using the red-viole ripe cranberries. However, the natural dye proved to be less colorfast than that of the synthetic dye, providing a lighter shade and lesser intensity compared to the original color after three washes. The dye had been able to produce several colors, mainly red-violet and blue-violet. It can be concluded, therefore, that the karanda cranberry extract can produce a natural fabric dye and create intermediate colors on a fabric. Commercialization is indeed possible since cranberry can be grown in plantations.

RECOMMENDATIONS

Should other researchers wish to improve and develop this project, consider these points: the study was simply limited to a specified number of minutes in simmering, based on common procedure on other dye production from berries; the number of minutes in simmering may be tested to its relation on the color it produces on the fabric; the number of hours it takes in soaking the fabric on to the dye solution may also be varied and tested to see its effect on the fabric's absorption of the natural dye. Testing on the natural fabric dye with the use of varied fixatives or mordants may also be performed. The researcher further recommends varying the number of times the fabric is washed to further compare the colorfastness of the dye produced.

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STATEMENT OF AUTHORSHIP

The author conducted the literature review, identified the materials, documented and performed the experiment, examined and analyzed the results, as well as formulated the conclusion and recommendations. Most importantly, the author prepared the draft and finalized the writing of the research paper.

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