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EXTRACTION OF NATURAL DYE FROM FRUIT PEELS PERMEATE IN COTTON EMBROIDERY THREADS

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ABSTRACT

The main idea of extracting dye from plants (natural) sources is to avoid the environmental pollution. Present days with global concern over the use of eco-friendly and biodegradable materials, considerable research work is being undertake around the world on the application of natural dyes in textile materials. This review is aimed at a discussion of different raw materials used for extraction of natural dyes alternative for toxic synthetic dyes, the extraction process, and the properties of embroidery threads dyed by those dyestuffs. Most of the natural dyes showed a very good fastness property in researches. The dyes are extracted from *Punica granatum* peel, *Carica papaya* peel, *Vitis vinifera* peel and S*elenicereus undatus* fruit peel as sources. Most of the natural dyes exhibit special properties like anti-microbial, less toxicity, less allergenic, etc., were studied in collected reviews.

Keywords: Natural dye, Eco-friendly, Extraction Process. properties; Embroidery thread, *Punica granatum*, *Carica papaya*, *Vitis vinifera*, *Selenicereus undatus*.

1. INTRODUCTION

The use of natural dyes dates back thousands of years, with evidence of their use found in archaeological sites around the world. Some of the earliest evidence of natural dyes can be traced back to prehistoric times, where remnants of dyed fibers have been found in caves and ancient settlements.[1]

The development of natural dyes took place at the same time after the technique of weaving had been discovered in about 5000 BC. In India, the use of natural dyes for dyeing, painting and printing goes to the prehistoric periods. Ajanta paintings, dated as far back as 1st century AD, were painted with natural dyes.[2] Natural dyes or organic dyes are colors that are extracted from natural resources surrounding our environment; they are extracted from insects, mineral components such as iron ore, plants or parts of a plant. Muezart uses roots, leaves, flowers, fruits and even seeds to naturally dye Eri silk yarn with plants.[3]

The earliest traces of the use of natural dyes were found in China in the year 2600 BC. Later, colored pigments were found in Egypt in the tomb of King Tutankhamun. The lives of natural dye artisans play a crucial role in preserving and advancing the art of natural dyeing. They often work closely with botanists and scientists to discover and develop new sources of natural dyes. Their work is labor-intensive and requires expertise in plant

chemistry, color extraction, and dyeing techniques. Manmade these dyes are designed to provide a wide range of colors and shades for various applications, including textiles, paper, plastics, food, cosmetics, and more. They are produced through chemical processes, often involving the use of petroleum-based compounds. Synthetic dyes are known for their color stability, ease of use, and ability to produce vibrant and long-lasting colors. The use of natural dyes for textile dyeing purposes decreased to a larger extent after the discovery of synthetic dyes in 1856.[4]

(Pomegranate) *Punica granatum L.*is an ancient fruit that is particularly cultivated in west Asia, though it is also cultivated in the Mediterranean region and other parts of the world. Since ancient years, its consumption has been associated with numerous health benefits. It's antioxidative, antimicrobial and anti-inflammatory. Furthermore, human-based studies have shown promising results and have indicated pomegranate potential as a protective agent of several diseases.[5]

(Papaya) *Carica papa*ya, a juicy and tasty fruit, belonging to family Caricaceae is scientifically known as Carica papaya L. It is grown in various parts of the world, including India, tropical America and Europe. Papaya tree is basically a short-lived Indian tree. In historic times, it was considered an exotic fruit because of its buttery taste and appearance. Papaya was the first genetically modified fruit consumed by human beings for its nutritional and medicinal properties.[6]

(Grapes) *Vitis vinifera*, one of the most popular and widely cultivated and consumed fruits in the world, are rich in phytochemicals. Epidemiological evidence has linked the consumption of grapes with reduced risk of chronic diseases, including certain types of cancer and cardiovascular disease. In vitro and in vivo studies have shown that grapes have strong antioxidant activity, inhibiting cancer cell proliferation and suppressing platelet aggregation, while also lowering cholesterol. Grapes contain a variety of phytochemicals, like phenolic acids, stilbenes, anthocyanins, and proanthocyanidins, all of which are strong antioxidants.[7]

(Dragon fruit) *Selenicereus undatus* are grown in Deccan region of India contributes large portion shallow basaltic landforms where rain, high temperature and edaphic constraints exist. Generally, these harsh landforms are more suited for horticultural crops as compared to field crops from crop adaptation and production management point. The potential health benefits of these phytochemicals in individuals or in matrices are discussed, including antioxidant, anti-inflammatory, anti-angiogenic, prebiotic, antibacterial, antiproliferative and cytotoxic activities, and blood lipid profile improvement. These analyses provide insights in the development of the products and bioactive compounds derived from dragon fruit peels for human consumption to prevent chronic diseases such as cardiovascular disease, diabetes and cancer.[8]

2. Materials and Methods

2.2 Selection of Thread

Fig 01: Embroidery thread

Embroidery thread is yarn that is manufactured or hand-spun specifically for embroidery and other forms of needlework. Embroidery thread often differs widely, coming in many different fiber types, colors and weights.

Hand embroidery threads can be used for various patchwork projects like making rugs, wall hangings, bags, warm jackets, cushion covers. Textile artists use embroidery threads for any embroidery patchwork.

Embroidery thread that comes on spools rather than in hanks is usually either made from rayon or polyester and sometimes nylon. It has a higher sheen than regular sewing thread which is often cotton wrapped in polyester.

2.2 Selection of herb

Herbal dyeing is a natural and eco-friendly method of dyeing textiles using plant-based materials. Various parts of plants, such as leaves, roots, and flowers, are used to extract natural dyes. These dyes can be applied to fabrics like cotton, silk, or wool to create a range of colors. Herbal dyeing is popular for its sustainability and the avoidance of harmful chemicals often found in synthetic dyes. It's a great choice for those looking to create environmentally friendly and non-toxic textiles.

2.2.1 *Punica granatum* outer skin

The selected raw material is pomegranate's outer skin. The leathery outermost layer of the pomegranate is called the pericarp or exocarp. It is usually red or yellow in color and serves as a protective layer for the inner fruit. The pomegranate peels are used to extract color through boiling method. This is sourced locally from my residential area P.N road, Tirupur.

Fig 02: *Punica granatum* outer skin

2.2.2 *Carica papaya* outer skin

The selected raw material is papaya outer skin. Papaya outer skin, also known as the peel or rind, is typically green when the fruit is unripe and turns yellow or orange as the papaya ripens. Papaya peels are used to extract color through boiling method. This is sourced locally from my residential area P.N road, Tirupur.

Fig 03: *Carica papaya* outer skin

2.2.4 *Vitis vinifera* outer skin

The selected raw material is grape outer skin. The outer layer of the grape is either green, red, or purplish black in color. The selected color is purplish black. The grape peels are used to extract color through boiling method. This is sourced locally from my residential area P.N road, Tirupur.

Fig 04: *Vitis vinifera* outer skin

2.2.5 *Selenicereus undatus* outer skin

The selected raw material is dragon fruit outer skin. Dragon fruit has a distinctive outer skin with bright pink or yellowish scales. The selected color is bright pink. The dragon fruit peels are used to extract color through boiling method. This is sourced locally from my residential area P.N road, Tirupur.

Fig 05: *Selenicereus undatus* outer skin

2.3 Dye Extraction Process

2.3.1 *Punica granatum* peel


(a) (b)

Fig 06: (a) *Punica granatum* peel (b) *Punica granatum* peel extract

First the yellow, pink pomegranate peels are picked, then the picked raw material is boiled in water in double boiling method for 90 minutes in low flame. Then after that is cooled down the dye is obtained.

2.3.*2 Carica papay*a peels


(a) (b)

Fig 07:(a) *Carica papay*a peel

(b) *Carica papay*a peel extract

First the yellow papaya peels are picked, then the picked raw material is boiled in water in double boiling method for 90 minutes in low flame. Then after that is cooled down the dye is obtained.

2.3.*3 Vitis vinifera* peels


(a) (b)

Fig 08: (a) *Vitis vinifera peel (b) Vitis vinifera peel extract*

First the black grapes peel are picked, then the picked raw material is boiled in water in double boiling method for 90 minutes in low flame. Then after that is cooled down the dye is obtained.

2.3.*4 Selenicereus undatus* peels

(a)

(b)

Fig 09:(a) *Selenicereus undatus peel (b) Selenicereus undatus peel extract*

First the dragon fruit peel are picked, then the picked raw material is boiled in water in double boiling method for 90 minutes in low flame. Then after that is cooled down the dye is obtained.

2.4 Method of Dyeing the Embroidery Threads

2.4.1 Dip and Dye

The selected dyeing method is the dip and dye method. This dyeing refers to dipping textiles in a dyeing solution for a certain period, the fabric and dye are in contact with each other so that the dye is fixed in the fiber. This dyeing method is suitable for all kinds of textiles

Fig 10: Thread dipped in dye

The dip and dye method are a creative and versatile technique used for coloring or creating patterns on various materials, primarily fabrics. In this method, the material is submerged or dipped into a dye solution to achieve the desired color or design. The depth and duration of the dip, the type of dye used, and the application process all influence the final outcome, allowing for a wide range of colorful and artistic effects. It's commonly used in crafts, tie-dyeing, and textile art. Dip and dyeing embroidery thread is a creative way to achieve beautiful color gradients or ombre effects.

Materials required

1. Embroidery thread
2. Fabric dye in your desired colors
3. Plastic containers or bowls
4. Rubber gloves
5. Stirring utensils (plastic or metal)
6. Plastic or newspaper to protect your work surface
7. Access to water for rinsing

Prepare the Dye Bath

Mix the dye according to the manufacturer's instructions. The concentration of the dye will affect the color intensity.

Pre-Wet the Thread

Soak the thread in water to make it wet. This helps the dye penetrate evenly.

Dip the Thread

Submerge the pre-wet thread into the dye bath. You can fully immerse it in uniform coloring or partially dip it for a gradient effect. Ensure that the thread is fully saturated.

Agitate and Soak

Depending on the dye's instructions, you may need to gently agitate the thread in the dye bath to ensure even coloring. Allow it to soak for the recommended time, typically 10-30 minutes.

Rinse

Remove the thread from the dye bath and rinse it under cold water to remove excess dye. Gradually increase the water temperature to warm and then hot, following the dye's instructions. Continue rinsing until the water runs clear.

Wash and Dry

After rinsing, wash the dyed thread separately with mild detergent to remove any remaining dye and impurities. Then let it air dry or use appropriate drying methods.

Final Dyed Threads

If you wish to create specific designs or patterns with the dyed thread, you can use additional techniques or steps such as tying, twisting, or using multiple colors.

Fig 11: Natural Dyed Embroidery Threads

2.5. Evaluation of final product

2.5.1 Color Fastness to Washing

Procedure:

1. Cut the sample to the size of 2-inch X 2 inch.
2. Cut the standard covering fabric to the sample size.
3. Take distilled water in 1:50 ratio and fully wet the sandwiched specimen for 30 min.
4. Now place the dried sample between two plastic plates and place all plastic plates one above the other.
5. Now transfer the plates onto the bottom metal plate.
6. Place the top metal plate and adjust the load with the help of thumb screws.
7. Then keep the loaded instrument in the air oven for 4 hours at a temperature of 38+-1°C
8. After 4 hours remove the sample specimen from the instrument and remove the stitching Compare the test specimen with the original sample for change in color compare with scale also.
9. Compare the standard covering cloth with the fresh sample.

Wash fastness is a crucial characteristic of dyes, whether they are synthetic or natural. It describes a dye's capacity to hold onto its color after going through various washing and laundering procedures. The type of dye,

the mordants used, and the cloth to which the dye is applied can all affect how washable natural dyes are. It is decisive to consider that natural dyes often have poorer wash fastness compared to synthetic dyes. Several methods and procedures, such as the use of mordants, dye fixatives, and post-treatment procedures, can be used to increase the wash fastness of natural dyes. Additionally, choosing dyes recognized for their excellent wash fastness and employing suitable dying methods might aid in getting superior outcomes.

The washability of various natural dyes varies. And the wash fastness of natural dyes can also be affected by the mordant chosen. Here there is no mordants are used to fixing the color. The wash fastness of a natural dye can also be influenced by the type of fabric to which it is applied. Natural fibers like cotton, silk, and wool can respond to dyes and washing in various ways, which can affect how effectively the dye sticks to the cloth.

2.5.2 Color Fastness to Sunlight

Light fastness is the resistance to fading of dyed textiles when exposed to daylight. Exposure to sunlight behavior of the sample under actual conditions of use takes long time.In standard condition-The sample and standards are mounted half covered and half exposed to daylight. The sample must be protected from rain by a glass sheet not less than Sem away (well ventilation due to moisture and heat). The specimen and standards should be kept under sun and continue 24hrs until sufficient fading. 3 Reference sample and the tested sample are cut at same accommodated on the template. The specimens are mounted in a frame facing south in the northern hemisphere and facing north in the southern hemisphere at an angle equal to the latitude of the place. The way of carrying out the test is to mount the standards and specimens. The sample must be protected from rain by a glass sheet. One quarter of the sample and standards are covered with opaque fabric. Thus, it is exposed until standard-I will be fade and equivalent to standard-4 on change in color grey scale. Then cover up one quarter of the previously exposed portion of the sample and standards with another sheet. Thus, it is exposed until standard-7 will be fade and equivalent to standard-4 on change in color grey scale.

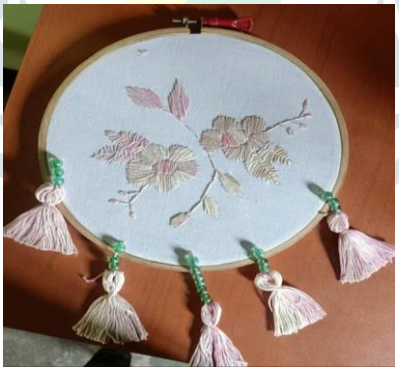

Fig 12: Final Product

3.RESULT AND DISCUSSION

3.1 Color Fastness to Washing

Color fastness to washing refers to the ability of a fabric or textile dye to withstand repeated washing without fading or bleeding. It's an important characteristic, especially for clothing and textiles that are expected to undergo frequent laundering.

***Punica granatum* Extract Sample**

NAME OF COMPONENT	GRADE	DEGREE OF FADES
Punica granatum	GRADE 8	HIGH COLOR
Punica granatum	GRADE 6	SLIGHTLY FADED
Punica granatum	GRADE 6	SLIGHTLY FADED

Color fastness test might be more important depending on the design and intended use of textile products. Standards test for color fastness to water wash, soap and other unique conditions. The result was finding that the color fastness properties of a *Punica granatum* in Cotton embroidery thread is good and the color fastness is outstanding after 5 washes.

***Carica papaya* Extract Sample**

NAME OF COMPONENT	GRADE	DEGREE OF FADES
Carica papaya	GRADE 8	HIGH COLOR
Carica papaya	GRADE 7	SLIGHTLY FADED
Carica papaya	GRADE 6	SLIGHTLY FADED

Color fastness test might be more important depending on the design and intended use of textile products. Standards test for color fastness to water wash, soap and other unique conditions. Result was finding that the color fastness properties of a *Carica papaya* in Cotton embroidery thread is good and the color fastness is outstanding after 5 washes.

***Vitis vinifera* Extract Sample**

NAME OF COMPONENT	GRADE	DEGREE OF FADES
Vitis vinifera	GRADE 8	HIGH COLOR
Vitis vinifera	GRADE 6	SLIGHTLY FADED
Vitis vinifera	GRADE 5	SLIGHTLY FADED

Color fastness test might be more important depending on the design and intended use of textile products. Standards test for color fastness to water wash, soap and other unique conditions. The result was finding that the color fastness properties of a *Vitis vinifera* in Cotton embroidery thread is good and the color fastness is outstanding after 5 washes.

***Selenicereus undatus* Extract Sample**

NAME OF COMPONENT	GRADE	DEGREE OF FADES
Selenicereus undatus	GRADE 8	HIGH COLOR
Selenicereus undatus	GRADE 7	SLIGHTLY FADED
Selenicereus undatus	GRADE 5	SLIGHTLY FADED

Color fastness test might be more important depending on the design and intended use of textile products. Standards test for color fastness to water wash, soap and other unique conditions. The result was finding that the color fastness properties of a *Selenicereus undatus* Cotton embroidery thread is good and the color fastness is outstanding after 5 washes.

3.2 Color Fastness to Sunlight

Color fastness to sunlight, also known as lightfastness, refers to the ability of a material, such as a fabric or dye, to resist fading or discoloration when exposed to sunlight or other sources of light over time. Sunlight contains ultraviolet (UV) radiation, which can break down the chemical bonds in dyes and pigments, leading to fading or changes in color.

***Punica granatum* Extract Sample**

NAME OF THE COMPONENT	GRADE	DEGREE OF FADING
Punica granatum	GRADE 8	NO FADED
Punica granatum	GRADE 7	NO FADED

Color fastness to sunlight refers to the ability of the fabric to withstand the daylight. The resistance properties of the below dyes are evaluated and resulted. It gives good and excellent color fastness to the Cotton embroidery thread

***Carica papaya* Extract Sample**

NAME OF THE COMPONENT	GRADE	DEGREE OF FADING
Carica papaya	GRADE 8	HIGHILY
Carica papaya	GRADE 6	SLIGHTLY FADED

Color fastness to sunlight refers to the ability of the fabric to withstand the daylight. The resistance properties of the below dyes are evaluated and resulted. It gives good and excellent color fastness to the Cotton embroidery thread

***Vitis vinifera* Extract Sample**

NAME OF THE COMPONENT	GRADE	DEGREE OF FADING
Vitis vinifera	GRADE 8	HIGHILY
Vitis vinifera	GRADE 5	SLIGHTLY FADED

Color fastness to sunlight refers to the ability of the fabric to withstand the daylight. The resistance properties of the below dyes are evaluated and resulted. It gives good and excellent color fastness to the Cotton embroidery thread.

***Selenicereus undatus* Extract Sample**

NAME OF THE COMPONENT	GRADE	DEGREE OF FADING
Selenicereus undatus	GRADE 8	HIGHILY
Selenicereus undatus	GRADE 7	SLIGHTLY FADED

Color fastness to sunlight refers to the ability of the fabric to withstand the daylight. The resistance properties of the below dyes are evaluated and resulted. It gives good and excellent color fastness to the Cotton embroidery thread.

4. Conclusion

The present scenario is focused more on the utilization of the vast diversity of natural resources of color pigments for their use in food materials, pharmaceuticals and textiles, in place of their synthetic counterparts. This

trend is aimed at safeguarding human health as well as protecting and prolonging life on earth. Therefore, if natural dyes have to be commercialized, they need to conform to the same stringent standards of performance that are applied to synthetic dyes. It thus follows that much more research and developmental effort is needed in this area. Achieve a wide range of colors using dyes sourced from natural materials like plants, roots, leaves, and insects. Create environmentally friendly and non-toxic dyes, minimizing the impact on the environment. Maintain the integrity of the embroidery thread, ensuring it remains strong and durable after dyeing. Preserve the artisanal and traditional aspects of embroidery by using sustainable and culturally significant dyeing methods. Promote eco-friendly and socially responsible practices in the crafting and textile industry. Produce unique and one-of-a-kind threads with a connection to nature and cultural heritage

Future scope

The future scope of natural dyes is promising due to several factors:

- **Sustainability**: Natural dyes are eco-friendly and sustainable, aligning with the growing demand for environmentally responsible products.
- **Health and Safety**: Natural dyes are non-toxic, making them a safer choice for consumers and workers in the textile industry.
- **Market Demand**: As consumers become more conscious of the environmental impact of synthetic dyes, there is a growing market demand for products dyed with natural alternatives.
- **Artisanal and Craft Markets**: Natural dyes provide unique colors and textures, making them popular in artisanal and craft markets, including handcrafted textiles and clothing.
- **Research and Innovation**: Ongoing research is leading to improved extraction methods and color stability, expanding the color palette of natural dyes.
- **Collaboration with Fashion Industry**: Many fashion brands are integrating natural dyes into their collections, fostering innovation and awareness.
- **Agricultural Benefits**: The cultivation of dye plants can provide additional income for farmers and support biodiversity.

In summary, the future of natural dyes is likely to involve increased adoption, innovation, and integration into various industries, including textiles, fashion, and cosmetics.

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