

Designing Garments Using Developed Natural Flower Pigments

Dr. Jayalakshmi.I¹, Ms.Sreevijayashalini .K²

¹Associate professor, Department of Costume Design and Fashion, Chikkanna Government Arts College, Tiruppur, India

²PG Scholar, Department of Costume Design and Fashion, Chikkanna Government Arts College, Tiruppur, India

Abstract- For thousands of years, people have used natural pigments, which are derived from a variety of organic and inorganic substances present in the natural world. Pollution in the environment has increased significantly since the invention of synthetic chemical pigments. To improve ecological sustainability and mitigate the environmental damage caused by synthetic pigments, natural sources are now used instead of synthetic chemicals in pigment manufacture. It is possible to make natural pigments from flowers, fruits, bark, leaves, and even roots. Therefore, the goal of this study was to create natural pigments from real flower sources. After the created natural floral pigments were applied to the chosen textile fabrics, their effects were assessed and their color fastness was examined. Excellent results were obtained for color fastness while using natural flower pigments.

Keywords: Lake pigments, sources of flowers, soaking procedure, natural pigment.

1.INTRODUCTION

Nature is superbly colorful and is an abundant source of colorants. Both living and non-living members of nature store an unending amount of coloring substances, including both dyestuff and pigments, in their constituents suggests Zerín et al., (2019). The mankind, have mastered extracting and using those since the dawn of human civilization explains Mohammad Abbas Uddin et al. (2019). Colorants include dyes and pigments. Dyes are coloured compounds which have affinity for a substrate to which they are applied. Pigments are coloured compounds which have neither affinity nor forces to interact with the substrates, therefore they coat to the substrate's surface through the binder affirms Lutamyó Nambela et al. (2020). The term "pigment"

comes from the Latin word pigmentum meaning "drug". A pigment is a finely divided, insoluble material that is suspended in a medium and acts as a colouring agent declare Rapp (2009). Flower colour is mainly produced through pigmentation i.e., pigments, can absorb certain wavelengths of light and reflect the remaining conveys Van Der Kooi et al. (2019). Lee (2007) signify the vast range of flower colours relies on four major pigment classes: chlorophylls, carotenoids, flavonoids, and betalain.

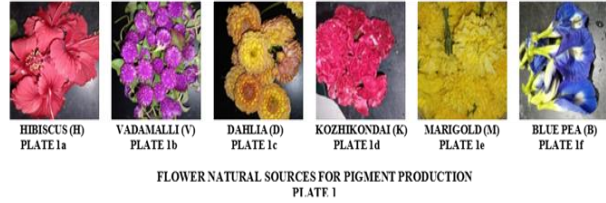
Colour plays a very important role in human life. Abel (2012) expound that man has used the colors of nature, either from minerals in the earth or from the plants and animals surrounding his environment. The earth pigments used by primitive humans were found as clay's which could have been kneaded and shaped into "crayons" for use in painting and drawing. Such artefact have been collected, for example, from Valle Caminica in Italy and in the Lascaux caves. Finlay (2002) suggest however, that there were early improvements to the simple mixture of coloured clay and water, to produce paints with improved properties. Organic pigments were employed in some of the earliest known art works. The pigments used in the paleolithic European cave paintings include charcoal and other carbon blacks, as well as animal blood. Some authorities believe that vegetable sugars may have been employed as one of the media for cave painting declare Myron (1964). The natural plant pigments do have an advantage over synthetic colors in that as they fade they remain a shade of their original color. Vegetable dyes were also developed to "fix" dyes onto a transparent white powder base to produce pigments. This is the process known as lake making. Doerner (1984) describe solutions of organic

dyes extracted from parts of plants were mixed with hydrated clay or tannin to form an insoluble pigment. Natural pigments are often biodegradable and environmentally friendly, reducing the environmental impact compared to synthetic counterparts explain Singaravel (2018). Kris-Etherton (2002) state that some natural pigments, such as those found in fruits and vegetables, may have health-promoting properties due to their antioxidant and photochemical content. Ali et al. (2017) insists natural pigments found in fruits, vegetables, and herbs often contain bio active compounds that contribute to health promoting effects when consumed. Natural pigments are generally considered non-toxic and safe for use in food, cosmetics, textiles and other applications. Natural pigments offer a wide range of colors, and the diversity of hues can be advantageous in various industries, including food, cosmetics, and textiles elucidate Berger (2003). These advantages make natural pigments a desirable choice in different fields, promoting sustainability, health, and cultural value. Natural pigments have several advantages but they also come with certain disadvantages. Natural pigments often offer a more limited color palette compared to synthetic alternatives, which can restrict their application in certain industries or artistic endeavors requiring specific shades or hues. Hence, this research on “Designing garments using developed natural flower pigments” was undertaken by the researcher with objectives such as to study on natural sources for pigments, natural process for making pigments, Application and evolution of the natural pigments.

2.METHODOLOGY

2.1SELECTION OF NATURAL SOURCES FOR PREPARATION OF NATURAL PIGMENTS

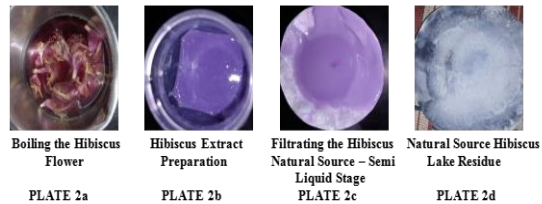
Natural source pigments produce colour at each step of our lives, because pigments are present in each organism in the world, and plants are the principal producers. They are in leaves, fruits, vegetables, and flowers states Himanshu et al. (2016). Natural sources for producing natural pigments for the study were selected as flowers by the investigator. Hibiscus (H) (Plate 1a), Vadamalli (V) (Plate 1b), Dahlia (D) (Plate 1c), Kozhikondai (K) (Plate 1d), Marigold (M) (Plate 1e) and Blue pea (B) (Plate 1f) were selected as the natural sources for the extraction of pigments (Plate 1)



2.2 PREPARATION OF EXTRACTS FOR NATURAL PIGMENTS

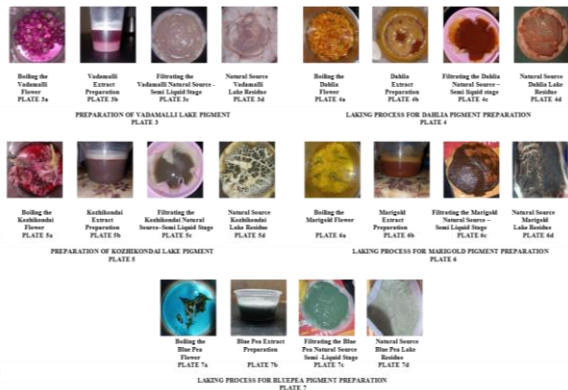
The natural pigment extracts were prepared by laking process. The laking process was by extraction of dye with alum solution followed by precipitation with soda explains Nicholas Eastaugh et al. (2004)

For the study, the first natural flower source Hibiscus (H) (Plate 1a) was taken and boiled for 5 minutes (Plate 2a). Then the mixture was filtered to obtain the hibiscus extract. 5 % KA1 (SO4)2.12H2O (alum) solution and 5% of soda ash was added to the hibiscus extract. Then the mixture was kept undisturbed at room temperature for precipitation to obtain the natural source lake pigment (Plate 2b). After settling, the mixture was filtered through a filter paper (Plate 2c). The Hibiscus pigment residue was dried on filter paper (Plate 2d). The dried natural source Hibiscus lake pigment was powdered.



LAKING PROCESS FOR HIBISCUS PIGMENT PREPARATION PLATE 2

Similarly, the other selected natural flower sources V (Plate 1b), D (Plate 1c), K (Plate 1d), M (Plate 1e) and B (Plate 1f) were also extracted using Laking process as shown below from Plates 3-7.



2.3 PILOT STUDY FOR THE SELECTION OF GUMS

2.3.1 SELECTION AND PREPARATION OF GUMS FOR BINDER PREPARATION

The binder for natural flower extract were prepared by using the two selected Moringa gum and Gum Arabic/Acacia gum for the study.



Moringa Gum
PLATE 8a



Gum Arabic/Acacia Gum
PLATE 8b

**GUMS SELECTED FOR BINDER PREPARATION
PLATE 8**

The natural Moringa and Acacia gums (plate 8) were taken and soaked separately in 200 ml of freshly boiled water for overnight. The soaked natural gms were boiled separately at 100^oc and kept aside for a couple of hours. To the prepared gums, 10 gms of honey was added to the respective baths and stirred completely. Then, 10 ms of glycerin was added to the respective Moringa and Acacia gum baths and stirred continuously until it dissolves completely. So now the Moringa gum and Acacia gum binders for the natural pigment, which is prepared and kept ready for further process.

2.3.2 TRIAL SAMPLES FOR SELECTING NATURAL GUM FOR NATURAL PIGMENT BINDER

The trial samples were prepared using both Moringa and Acacia gum binders. Each Moringa gum and Acacia gum binders were taken separately and mixed with any one natural flower pigment and painted on the cotton material. The prepared cotton material samples were subjected to washing test. The obtained results showed that the pigment prepared using Moringa gum binder washed away the pigments whereas pigment prepared using Acacia gum binder remained in the cotton material. Thus, the investigator selected Acacia Gum for preparing the binder for the final study for preparing flower natural pigments.

2.4 PREPARATION OF BINDER FOR FINAL STUDY USING ACACIA GUM

The binder for the prepared natural flower pigments was prepared from Acacia gum (Plate 9a). The Acacia gum (20g) was dissolved in 200 ml of freshly boiled water. The Acacia gum was kept aside for a couple of hours to dissolve completely. To the prepared gum solution, 10g of honey (Plate 9b) was added and stirred thoroughly. Then, 10g of glycerin (Plate 9c) was added to the gum and stirred continuously until glycerin and honey completely dissolves. Thus, the binder for the flower natural pigment (Plate 9d) was prepared and kept ready for further process.



Gum Arabic
PLATE 9a



Honey
PLATE 9b



Glycerin
PLATE 9c



Prepared Binder
PLATE 9d

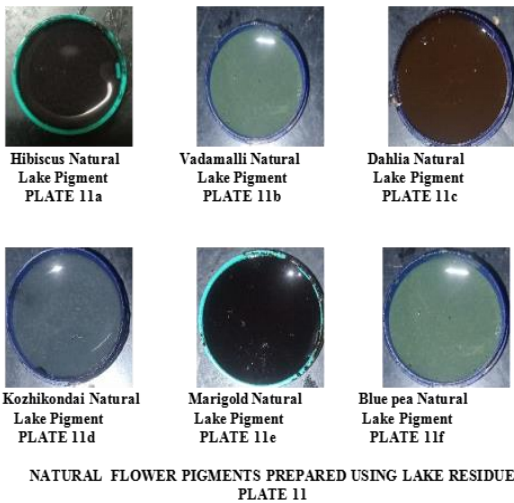
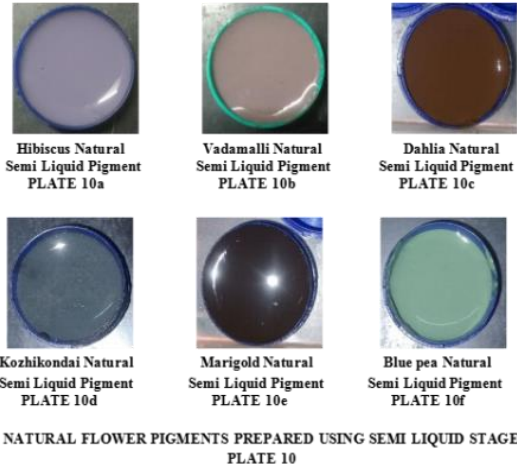
**PREPARATION OF GUM ARABIC BINDER
PLATE 9**

2.5 PREPARATON OF NATURAL SOURCE FLOWER PIGMENTS

The preparation of flower natural source pigments is done in two different methods. First method is by using the obtained semi liquid stage of filtration (Plates 2c, 3c, 4c, 5c, 6c, 7c) and by using the lake residue (Plates 2d, 3d, 4d, 5d, 6d, 7d) of the natural source pigments i.e., from H, V, D, K, M and B natural flowers.

For the first method, the prepared Acacia gum binder is mixed with the semi liquid stage of natural flower pigments. For the second method, the prepared Acacia gum binder is mixed with the lake residue of natural flower pigments. The natural semi liquid and lake pigments of H (10a, 11a), V (10b, 11b), D (10c, 11c), K (10d, 11d), M (10e, 11e) and B (10f, 11f) are taken in individual containers respectively.

For binder pigment ratio (1:10) i.e., for 1 gm of Acacia Gum binder is mixed with 10gms of respective natural flower lake pigments. The mixture should be mixed such that there are no lumps created at room temperature. After mixing thoroughly, they are kept aside for 10 min before application.



2.6 SELECTION OF MATERIAL

The Cotton (C), Silk (S), Satin (SA), Polyester (P) and Singe Jersey (SJ) were the five types of materials selected for the study.

2.7 PREPARATION FOR ACTUAL PAINTING OF FLOWER NATURAL PIGMENT

2.7.1 PRE TREATMENT OF THE SAMPLES

The selected Cotton (C), Silk (S), Satin (SA), Polyester (P) and Singe Jersey (SJ) samples were pre-treated according to the materials.

2.7.2 PILOT STUDY OF NATURAL FLOWER PIGMENT PAINTED SAMPLES

A Pilot study was conducted on the selected Cotton (C) sample material by painting the developed semi liquid and lake Hibiscus (H), Vadamalli (V), Dahlia (D), Kozhikondai (K), Marigold (M) and Blue Pea (B) flower natural pigments. These 12 samples were subjected to washing test. As some of the pigments washed away in some samples, investigator planned to give curing treatment for the 12 samples. So, again after painting, the 12 samples were given a curing process in a curing oven for 5 min at 140°C. Then, they were subjected to washing test. Now the natural flower semi liquid and lake pigments in the cotton samples didn't wash off. So, the investigator planned to subject the samples to curing treatment after painting and study between before and after curing of the Cotton (C), Silk (S), Satin (SA), Polyester (P) and Singe Jersey (SJ) fabrics.

2.8 HAND PAINTING ON SELECTED SAMPLE MATERIALS BY DEVELOPED NATURAL FLOWER PIGMENTS

A flower motif was selected by the investigator and through hand painting was painted on the selected Cotton (C), Silk (S), Satin (SA), Polyester (P) and Singe Jersey (SJ) materials using the developed Semi Liquid (Plate 10) and Lake (Plate 11) natural flower H, V, D, K, M and B pigments. They are shown in Plates 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and 23 respectively.

2.9 CONSTRUCTION OF THE GARMENT

The investigator has selected Single Jersey material for the construction of two T-shirts for 4 years old boy child.

2.10 ACTUAL PAINTING OF THE DEVELOPED NATURAL FLOWER SEMI LIQUID AND LAKE PIGMENTS ON THE GARMENT

The investigator has selected two cartoon motifs for the actual painting of the developed natural H, V, D, K, M and B flower semi liquid and lake pigments on the T shirts.



**APPLICATION OF HIBISCUS SEMI LIQUID PIGMENT (H^{SLP}) ON SELECTED MATERIALS
PLATE 12**



**APPLICATION OF VADAMALLI SEMI LIQUID PIGMENT (V^{SLP}) ON SELECTED MATERIALS
PLATE 13**



**APPLICATION OF DAHLIA SEMI LIQUID PIGMENT (D^{SLP}) ON SELECTED MATERIALS
PLATE 14**



**APPLICATION OF KOZHIKONDAI SEMI LIQUID PIGMENT (K^{SLP}) ON SELECTED MATERIALS
PLATE 15**



**APPLICATION OF MARIGOLD SEMI LIQUID PIGMENT (M^{SLP}) ON SELECTED MATERIALS
PLATE 16**



**APPLICATION OF BLUEPEA SEMI LIQUID PIGMENT (B^{SLP}) ON SELECTED MATERIALS
PLATE 17**



H^{LP} C PLATE 18a **H^{LP} S** PLATE 18b **H^{LP} SA** PLATE 18c **H^{LP} P** PLATE 18d **H^{LP} SJ** PLATE 18e

**APPLICATION OF HIBISCUS LAKE PIGMENT (H^{LP}) ON SELECTED MATERIALS
PLATE 18**



V^{LP} C PLATE 19a **V^{LP} S** PLATE 19b **V^{LP} SA** PLATE 19c **V^{LP} P** PLATE 19d **V^{LP} SJ** PLATE 19e

**APPLICATION OF VADAMALLI LAKE PIGMENT (V^{LP}) ON SELECTED MATERIALS
PLATE 19**



D^{LP} C PLATE 20a **D^{LP} S** PLATE 20b **D^{LP} SA** PLATE 20c **D^{LP} P** PLATE 20d **D^{LP} SJ** PLATE 20e

**APPLICATION OF DAHLIA LAKE PIGMENT (D^{LP}) ON SELECTED
MATERIALS
PLATE 20**



K^{LP} C PLATE 21a **K^{LP} S** PLATE 21b **K^{LP} SA** PLATE 21c **K^{LP} P** PLATE 21d **K^{LP} SJ** PLATE 21e

**APPLICATION OF KOZHIKONDAI LAKE PIGMENT (K^{LP}) ON SELECTED
MATERIALS
PLATE 21**



M^{LP} C PLATE 22a **M^{LP} S** PLATE 22b **M^{LP} SA** PLATE 22c **M^{LP} P** PLATE 22d **M^{LP} SJ** PLATE 22e

**APPLICATION OF MARIGOLD LAKE PIGMENT (M^{LP}) ON SELECTED MATERIALS
PLATE 22**



B^{LP} C PLATE 23a **B^{LP} S** PLATE 23b **B^{LP} SA** PLATE 23c **B^{LP} P** PLATE 23d **B^{LP} SJ** PLATE 23e

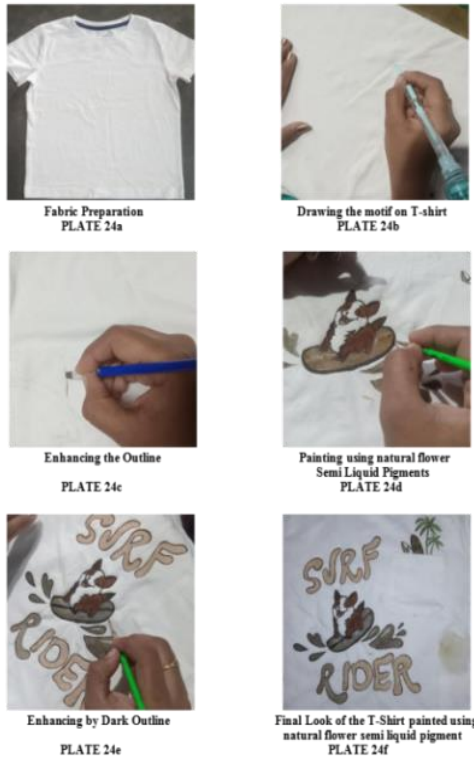
**APPLICATION OF BLUEPEA LAKE PIGMENT (B^{LP}) ON SELECTED MATERIALS
PLATE 23**

2.10.1 STEPS INVOLVED IN PAINTING THE MOTIFS USING NATURAL FLOWER SEMI LIQUID LAKE PIGMENTS ON THE GARMENTS

The chosen cartoon motifs were transferred to the T-shirts by hand painting technique. The painting was done as enlisted:

- Step 1: Place the T-shirt on a flat and a clean surface.
- Step 2: Start on drawing the selected motif on the T-shirt using pencil.
- Step 3: Start to enhance the outline and give a perfect sketch on the selected motif on the T-shirt.
- Step 4: Then apply the developed natural H, V, D, K, M and B Pigments inside the motif. After completing the painting the T-shirt is allowed to dry for some time.
- Step 5: After drying start to finish the outline with black paint.
- Step 6: Then again let it to dry and Iron it.

The investigator followed the above mentioned process for the actual paining of the developed natural H, V, D, K, M and B Semi Liquid and Lake Pigments. Two T-shirts was fully designed by a cartoon motif. One with the semi liquid pigment and another one with lake natural flower H, V, D, K, M, and B pigments. The step wise process is shown step wise in Plates 24 and 25 respectively.



STEPS FOLLOWED FOR THE APPLICATION OF DEVELOPED NATURAL SEMI LIQUID PIGMENT ON T-SHIRT
PLATE 24



STEPS FOLLOWED FOR THE APPLICATION OF DEVELOPED NATURAL LAKE PIGMENT ON T-SHIRT
PLATE 25

2.10.2 CURING OF THE NATURAL FLOWER SEMI LIQUID AND LAKE PIGMENTS PAINTED T-SHIRTS

The completed semi liquid and lake pigment painted T-shirts (Plate 24f and 25f) were now taken to be given curing process. The curing process is normally given for printed / painted / dyed materials typically which involves a heat set for the Printed / Painted / dyed pigments to make it permanent. The two T-shirts Plates 24f and 25f painted with natural flower pigments is sent into a curing oven at 140°C for 5 min. After the desired time of curing process, the T-shirts are ironed well to be free of wrinkles. The completed cured T-shirt's using Natural Flower Semi Liquid Pigment (SLP) is shown in Plate 26 and with Natural Lake Pigment (LP) is shown in Plate 27. The T-shirts were visually evaluated by 500 students of Chikkanna Government Arts College, Tirupur for material selection, pigment colours used, texture and for its overall appearance.



T-Shirt Painted using Natural Flower semi liquid Pigment
PLATE 26



T-Shirt Painted using Natural Flower Lake Pigment PLATE 27

2.11 EVALUATION

Evaluation refers to the process of determining the merit, worth or value of the process. The evolution process provides useful information for judging decision alternatives describe Scriven (1991). The evaluation for this study is conducted by subjective and colour fastness tests.

2.11.1 SUBJECTIVE TESTS

The subjective evaluation refers to supervisors discretion in evaluating the performance to address imperfections in the process explain Jonne (2022). The developed natural flower semi liquid and lake pigments which were painted on sample materials through hand painting was given to 500 students of Chikkanna Govt. Arts College, Tirupur who were selected as subjects. They were shown the 60 sample materials (Plates 12 - 23) and asked to check the texture, pigment colour, material selection and the overall appearance. The results obtained were reviewed in results and discussion.

2.11.2 COLOUR FASTNESS TESTS

Colour fastness is defined as property of pigment or dye to retain its original hue, especially without fading, running, or changing when washed and cleaned, when exposed to light, heat, or other influences define Jay Trivedi (2024). Colour fastness also refers to the resistance of colours to fade or bleed against various influences such as sunlight, washing, crocking, perspiration and pressing.

3 RESULTS AND DISCUSSION

The results and discussion for the study is tabulated and discussed using the following tests:

3.1 EVALUATION

The evaluation for the study of developed natural flower semi liquid (SLP) (30) and lake pigments (LP)

(30) H^{SLP} C, H^{SLP} S, H^{SLP} SA, H^{SLP} P, H^{SLP} SJ, V^{SLP} C, V^{SLP} S, V^{SLP} SA, V^{SLP} P, V^{SLP} SJ, D^{SLP} C, D^{SLP} S, D^{SLP} SA, D^{SLP} P, D^{SLP} SJ, K^{SLP} C, K^{SLP} S, K^{SLP} SA, K^{SLP} P, K^{SLP} SJ, M^{SLP} C, M^{SLP} S, M^{SLP} SA, M^{SLP} P, M^{SLP} SJ, B^{SLP} C, B^{SLP} S, B^{SLP} SA, B^{SLP} P, B^{SLP} SJ, H^{LP} C, H^{LP} S, H^{LP} SA, H^{LP} P, H^{LP} SJ, V^{LP} C, V^{LP} S, V^{LP} SA, V^{LP} P, V^{LP} SJ, D^{LP} C, D^{LP} S, D^{LP} SA, D^{LP} P, D^{LP} SJ, K^{LP} C, K^{LP} S, K^{LP} SA, K^{LP} P, K^{LP} SJ, M^{LP} C, M^{LP} S, M^{LP} SA, M^{LP} P, M^{LP} SJ, B^{LP} C, B^{LP} S, B^{LP} SA, B^{LP} P, B^{LP} SJ total 60 samples were carried out by subjective and colour fastness tests (before and after curing).

3.1.1 VISUAL EVALUATION OF THE HAND PAINTED SAMPLES USING SEMI LIQUID AND LAKE NATURAL FLOWER PIGMENTS

The 60 hand painted samples using Semi liquid (30) and Lake pigments (30) were given to 500 students who were selected as subjects in Chikkanna Govt. Arts College, Tirupur to visually evaluate for texture, pigment colour, material selection and overall appearance. The obtained visual evaluation of the 60 hand painted samples shows that the texture, pigment colour, material selection and overall appearance rated excellent by all the subjects for the hand painted Cotton (C), Silk (S), Satin (SA), Polyester (P) and Single Jersey (SJ) materials using natural flower semi liquid (SLP) and Lake (LP) Pigments.

3.1.2 ANALYSIS OF COLOUR FASTNESS TESTS

The colour fastness tests were analyzed for 60 hand painted natural flower semi liquid and lake pigment samples subjected to sunlight, washing, crocking, perspiration and pressing before and after curing.

3.1.2.1 ANALYSIS OF COLOUR FASTNESS TEST TO SUNLIGHT

The result obtained for colour fastness to sunlight when analyzed for cured 60 hand painted with natural flower semi liquid and lake pigments showed slight change to no change.

3.1.2.2 ANALYSIS OF COLOUR FASTNESS TEST TO WASHING

Regarding to colour fastness to washing, the result shows that there is meagre colour fading in V^{SLP} SA , K^{SLP} S, V^{LP} S and K^{LP} S sample materials hand painted with natural flower semi liquid and lake pigments whereas other samples exhibited no colour change before curing. When checked for staining of 60 before

curing sample materials hand painted with natural flower semi liquid and lake pigments showed no colour staining. After curing, all the natural flower pigment samples exhibit no colour change and colour staining to washing.

3.1.2.3 ANALYSIS OF COLOUR FASTNESS TEST TO CROCKING

Crocking is carried out in both dry and wet medium. The result for dry and wet crocking shows that there is slight colour change in V^{SLP} SA, K^{SLP} S, V^{LP} S and K^{LP} S before curing materials hand painted with natural flower semi liquid and lake pigments whereas other samples exhibited no colour change. When checked for staining there was no colour staining in all the before curing samples. After curing, all the natural flower pigment samples exhibit no colour change and colour staining to crocking.

3.1.2.4 ANALYSIS OF COLOUR FASTNESS TEST TO PERSPIRATION

Perspiration is carried out in both acid and alkaline medium. The result for acid and alkali shows that there is slight colour change in some of the before cured sample materials hand painted with natural flower

semi liquid and lake pigments. When checked for staining, there was no colour staining in before curing samples. After curing, all the natural flower pigment samples exhibit no colour change and colour staining to perspiration.

3.1.2.5 ANALYSIS OF COLOUR FASTNESS TEST TO PRESSING

Pressing is carried out in both dry and wet ironing. The result shows that there is no colour change and staining in dry and wet ironing / pressing for both the before and after cured flower natural pigment samples.

3.1.3 VISUAL EVALUATION OF HAND PAINTED GARMENTS USING SEMI LIQUID AND LAKE FLOWER PIGMENTS

The constructed garments using semi liquid and lake natural flower pigments were both subjected to visual evaluation. The garments were given to 500 students who were selected as subjects in Chikkanna Government Arts College, Tirupur to visually evaluate material selection, pigment colors used, texture and overall appearance. The obtained visual evaluation of the constructed garment is recorded in Table I.

TABLE I VISUAL EVALUATION OF HAND PAINTED GARMENTS USING NATURAL FLOWER SEMI LIQUID AND LAKE PIGMENTS

PLATE No.	NAME OF THE GARMENT	VISUAL EVALUATION OF NATURAL FLOWER PIGMENT PAINTED GARMENTS (in %)															
		MATERIAL SELECTION				PIGMENT COLOURS USED				TEXTURE				OVERALL APEARANCE			
		EXCELLEN T	GOOD	FAIR	POOR	EXCELLEN T	GOOD	FAIR	POOR	EXCELLEN T	GOOD	FAIR	POOR	EXCELLEN T	GOOD	FAIR	POOR
PLATE 26	T-SHIRT PAINTED USING FLOWER SEMI LIQUID PIGMENT	10	-	-	-	10	-	-	-	10	-	-	-	10	-	-	-
PLATE 27	T-SHIRT PAINTED USING FLOWER LAKE PIGMENT	10	-	-	-	10	-	-	-	10	-	-	-	10	-	-	-

From Table I, it shows that the material selection, pigment colours used, texture and overall appearance of two T-shirt’s hand painted using semi liquid and lake natural flower pigments was rated excellent by all the subjects.

CONCLUSION

When coloring textiles, natural pigments made from flowers provide a sustainable and environmentally beneficial substitute for synthetic dyes. Beautiful and unique designs can be made through the creative and fulfilling process of extracting and applying floral pigments to textiles. Furthermore, using natural floral

pigments aids nearby communities who still utilize traditional dyeing techniques and encourages environmental sustainability. Furthermore, natural floral pigments are a popular option for people looking for sustainable fashion and textile options since they meet the growing market demand for products that are environmentally conscientious.

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