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DEVELOPMENT OF SUSTAINABLE INJECTION GARMENT DYEING TECHNIQUE

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ABSTRACT - *Now a days climatic change is becoming a global threat and it is estimated to be 55 giga tonnes greenhouse gas emission by 2030. Currently India is fourth largest green house gas emitting country, whilst China is placed at the top of the table. In recent years, many countries have raised their concern on green house gas emission and steep increase in earth's temperature. In recent Paris agreement, all the countries have agreed to take necessary measures to bring down the average temperature by 2°C.To achieve this goal, many countries have started to encourage sustainable products to reduce carbon foot print. Since garment industry has a major share in green house gas emission, this has opened up huge potential to produce sustainable garments. Sustainable methods can be implemented in different stages, starting from fiber to finished garments. Currently there are many sustainable methods and products in fiber and fabric dyeing methods. But still garment dyeing is less explored for sustainable methods. This prompted to develop a new method, which is both sustainable and high fashion in garment dyeing. So introducing a new technique called "INJECTION GARMENT DYEING TECHNIQUE" using sustainable dyes and methods. This new method is very effective in reducing the MLR and minimizing the design inconsistency. With the reduced MLR, We can achieve less effluent, less water consumption and less chemical consumption. These benefits makes this very effective sustainable process. We are further enhancing the sustainability by the usage of natural dyes for color application.*

Key Words: CLIMATE CHANGE, GREEN HOUSE GAS EMISSION, SUSTAINABLE, NATURAL DYES, INJECTION, GARMENT DYEING, MLR.

1.INTRODUCTION

Dyeing was introduced in our civilization as an art for imparting colors on textile clothing in order to enhance the dignity of the people. Along with traditional piece dyeing techniques, garment dyeing techniques have evolved to make a major contribution in terms of volume. Below are the major commercially available garment dyeing techniques.

1. Pigment Dyeing - Pigments are particles, which sticks on the surface of the fabric with the help of binders. In this method, will get poor color fastness, huge effluent load and difficult in achieving dark shades.
2. Tie and Dye - Garments are tied as per the design requirement and dyeing is carried out. Wherever the garment is tied, dye uptake will not be there, resulting in design on the garment. In this method, Will get poor color fastness, huge effluent load and dye liquor cannot be stored for too longer period.
3. Die and Dye - Garment is dipped in the dye solution and taken out for drying to get ombre effect on the garment. In this method, Will get poor color fastness, huge effluent load and dye liquor cannot be stored for too longer period.

To address the disadvantages of conventional garment dyeing, we have come up with new garment dyeing technique called Injection garment dyeing. This research work is about a new Tie & dye garment dyeing method, which is both sustainable and high fashion.

2. OBJECTIVES

1. To develop a 100% sustainable garment dyed product..
2. To develop a new Tie and dye garment dyeing technique with ultra lower Liquor ratio..
3. To reduce the effluent load.
4. To reduce the chemical/auxiliaries consumption.

5. To reduce the design inconsistency.
6. To reduce the power/energy consumption.

3. MATERIALS AND METHODOLOGY

3.1 RAW MATERIAL

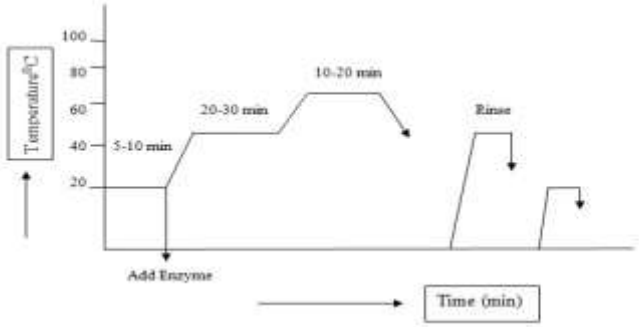
RFD knitted garment made from 100% Organic Cotton, 100% herbal natural dyestuff (Three different dyestuff extracted from Manjistha, Acacia Catechu and Pomegranate peel), Medical Syringe.

3.2 RFD GARMENT

The RFD garment is made from Bio-scoured 100% Organic Cotton Single Jersey fabric for body and 97% Organic Cotton 3% Spandex 1x1 Rib for neck rib using the following recipe.

Enzyme (Pectinases) : 0.5%
Sequestering agent : 1 g/l
Wetting agent : 2 g/l
Soda ash : 2g/l (to maintain Ph)
Temperature : 60°C
Time : 30 min
M: L : 1:10
Ph : 8 -9

3.2.1 BIO-SCOURING PROCESS



3.2.2 TESTING THE EFFICIENCY OF BIO-SCOURED FABRIC

Standard drop penetration test was carried out for the absorbency. The absorbency test standard is AATCC-79-2000. A drop of water allowed falling from a fixed height on to taut fabric and the time required for specular reflection of the water drop to disappear is measured and recorded as wetting time.Bio-scoured fabric is clamped in a embroidery frame. In a pipette, Water is taken and water drop is dropped on the scoured fabric and the absorption of the water drop is observed visually using stop watch. The standard time for the absorption of one drop is 0.5 to 0.8 sec upto 1 sec. The Bio- scoured fabric has taken below 1sec to absorb the one drop of water. Now garment is made with this Bio-scoured 100% Organic Cotton knitted fabric.

3.3 100% HERBAL NATURAL DYESTUFF

In this article, the raw material sourced for the extraction of natural dyes are with medicinal importance and are extracted in powder form.

Manjistha (Rubia Cordfolia - DARK PURPLE)

Acacia Catechu (Senegalia Catechu - DARK BROWN)

Pomegranate (Punica granatum - LIGHT BROWN)

3.3.1 MANJISTHA(DARK PURPLE)

Manjistha is a perennial climber that it perhaps best known as a lymph mover or blood purifier. According to Ayurveda, the lymph (rasa) and blood (rakta) are the first tissue to become congested when the body is not detoxifying properly. Manjistha is an Ayurvedic bitter and astringent herb which pacifies Kapha and Pitta dosha.

3.3.1.1 HEALTH BENEFITS OF MANJISTHA

These benefits are based on the traditional uses of Manjistha as mentioned in the Ayurvedic material medical and Ayurvedic pharmacopoeia as well as scientific research findings.

1. For Digestive health
2. Maintains normal blood circulation and improves heart health
3. For healthy and glowing skin
4. It acts as rejuvenating agent and delays aging.
5. One of the best cleansing and purifying herbs.

3.3.1.2 DYESTUFF EXTRACTION

The roots of manjistha is used here to extract the dyestuff. The extraction procedure consists of,

1. Collecting/Drying(Bone dry)of raw material.
2. Crushing(Granular) the raw material.
3. Extraction in water.
4. Evaporation/Drying.
5. Grinding(Fine Powder).

POWDERED DYESTUFF EXTRACTED FROM MANJISTHA ROOT

3.3.2 ACACIA CATECHU (DARK BROWN)

Acacia catechu is a decidious tree with a light feathery crown and dark brown, glabrous, slender, thorny, shining branchlets, usually crooked. Bark dark brown or dark grey, brown or red inside, nearly 12-15 mm in thickness, rough, exfoliating in long narrow rectangular flakes which often remain hanging. Blaze very hard, colour brown and then deep pink.

3.3.2.1 HEALTH BENEFITS OF ACACIA CATECHU

The different parts of the tree have a variety of medicinal uses, which in haemoptysis (spitting of blood). A paste of the bark is useful in conjunctivitis.

1. Antifungal activity.
2. Helps in clotting of blood in case odd excessive bleeding.
3. Used for the purpose of gargling to relieve from gingivits.
4. Used for the management of life threatening diseases like Leukaemia.
5. Relieve sores and the problems of skin afflications.
6. To cure skin disorders.

3.3.2.2 DYESTUFF EXTRACTION

The heart wood of acacia catechu tree (after extracting khtha) is used here to extract the dyestuff. The extraction procedure consists of,

1. Collecting/Drying(Bone dry)of raw material.
2. Crushing(Granular) the raw material.
3. Extraction in water.
4. Evaporation/Drying.
5. Grinding(Fine Powder).


POWDERED DYESTUFF EXTRACTED FROM HEARTWOOD OF ACACIA CATECHU

3.3.3 POMEGRANATE PEEL (LIGHT BRWON)

The pomegranate(Punica granatum) is a fruit-bearing deciduous shrub in the family Lythraceae, subfamily Punicoideae, that grows between 5 and 10 m (16 and 33 ft) tall. The pomegranate originated in the region extending from Iran to northern India, and has been cultivated since ancient times throughout the Mediterranean region.

3.3.3.1 HEALTH BENEFITS OF POMEGRANATE PEEL

Pomegranates are known for their taste and amazing health benefits. Whilst most of us chomp on the red tangy tiny seeds or the fruit to reap its benefits, its tough red skin is often discarded. However, like the fruit, the peel too has lots of offer.

1. Fights Acne, Pimples and Rashes.
2. Prevents Wrinkle and signs of ageing.
3. As a natural moisturizer.
4. As effective facial scrub.
5. As natural sunscreen.

3.3.3.2 DYESTUFF EXTRACTION

The pomegranate peel is used here to extract the dyestuff. The extraction procedure consists of,

1. Collecting/Drying(Bone dry)of raw material.
2. Crushing(Granular) the raw material.
3. Extraction in water.
4. Evaporation/Drying.
5. Grinding(Fine Powder).


POWDERED DYESTUFF EXTRACTED FROM POMEGRANATE PEEL

3.4 INJECTION GARMENT DYEING

In this technique, medical syringe is used to transfer the dye liquor to the garment. Dye liquor will be loaded into the syringe and the dye liquor is injected to the specific areas of garment to get required design. This technique helps in optimum utilization of dye liquor and dyeing effect consistency can be maintained during bulk garment dyeing.

A TYPICAL PLASTIC MEDICAL SYRINGE, FITTED WITH A DETACHABLE STAINLESS STEEL NEEDLE

3.4.1 INJECTION GARMENT DYEING PROCEDURE

Injection Tie & Dye garment dyeing procedure consists of

Natural Dye liquor preparation

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Wetting treatment of RFD garment

↓

Mordanting

↓

Tieing the RFD garment

↓

Injecting dye liquor by using medical syringe

↓

Untieing & Drying

↓

After Treatments

3.4.1.1 NATURAL DYE LIQUOR PREPARATION

RECIPE

Weight of the garment : 80g

Weight of two fabric bits : 160g (For Testing)

Total fabric weight : 240g

M:L : 1:1

Total Liquor : 240 ml

Shade Depth : 3%

Combination : Tri-Color Combination

3g of dyestuff is required to dye 100g of textile material. Hence 7.2g of dyestuff is used to dye 240g of substrate.

Since 3 different colors are being used, 2.4g of each dyestuff is weighed accurately and taken.

Manjistha : 2.4g

Catechu : 2.4g

Pomegranate Peel : 2.4g

PROCEDURE

1. Accurately weighed three different natural dyestuff is pasted using wetting agent to get lumps free dye paste.
2. 80ml of distilled water is added to each and every natural dyestuff dyepaste.
3. Now filtered using cloth filter, to make sure lumps free dye liquor is used for dyeing.

3.4.1.2 WETTING TREATMENT OF RFD GARMENT

RECIPE (Saturation Technique)

Total weight of the substrate : 240g

Wetting Agent : 2gpl

M:L : 1:2

Total Liquor : 480ml

Temperature : Room Temperature

Time : 15 Mins

Ph : Neutral

2g of wetting agent is required for 1000ml of liquor, Hence 0.96g of wetting agent is used to reduce the surface tension of RFD substrate.

PROCEDURE

1.240g of textile substrate is soaked in 480ml of distilled water mixed with 0.96g of wetting agent for 15 mins at room temperature using saturation technique.

2. Hand squeezed.

SATURATION TECHNIQUE

3.4.1.3 MORDANTING :-

RECIPE (Saturation Technique)

Total weight of the substrate : 240g

Mordant : 10%

M:L : 1:1

Total Liquor : 240ml

Temperature : Room Temperature

Time : 60 Mins

Ph : Neutral

10g of Mordant is required for 100g of substrate, Hence 24g of mordant is used to improve the fastness property after garment dyeing.

PROCEDURE

1.240g of wet textile substrate is soaked in 240ml of distilled water mixed with 24g of mordant for 60 mins at room temperature using saturation technique.

2.Hand squeezed.

3.Dried.

3.4.1.4 TIEING THE RFD GARMENT/DYE LIQUOR INJECTION

PROCEDURE

DRIED RFD GARMENT IS INTRODUCED WRINKLES WRINKLED TEXTILE

FOLDED BY JOINING TWO IN THE GARMENT SUBSTRATE IS TIED SLEEVES TOGETHER TIGHTLY USING RUBBER BANDS

TIGHTLY TIED WRINKLED TIGHTLY TIED WRINKLED TEXTILE SUBSTRATE IS

TEXTILE SUBSTRATE IS DYED WITH THREE DIFFERENT NATURAL DYES

PLACED ON A PLASTIC MESH USING MEDICAL SYRINGE

FOR DYEING (INJECTION GARMENT DYEING TECHNIQUE)

RIGHT SIDE :**MANJISTHA(DARK PURPLE)**

MIDDLE :**POMEGRANATE PEEL(LIGHT BROWN)**

LEFT SIDE :**ACACIA CATECHU(DARK BROWN)**

RUBBER BANDS IN THE NATURAL DYED

TEXTILE SUBSTRATE IS REMOVED AFTER TWO HOURS

AND NATURALLY DRIED

SLEEVE: **ACACIA CATECHU(DARK BROWN)**

MIDDLE : **MANJISTHA(DARK PURPLE)**

BETWEEN SLEEVE

AND MIDDLE **: POMEGRANATE PEEL(LIGHT BROWN)**

3.4.1.5 AFTER TREATMENTS

Natural dyed substrate is

Dried naturally

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Cold washed using saturation technique

With M:L - 1:2

At room temperature for 10 mins

↓

Hand squeezed

↓

Cold soaping (Non-ionic) using saturation technique

With M:L - 1:1

At 70°C for 15 mins

↓

Hand squeezed

↓

Cold washed using saturation technique

With M:L - 1:1

At room temperature for 10 mins

↓

Hand squeezed

↓

Dried

4. TESTING :-

The Finished garment is given for testing in a NABL accredited lab for the following tests.

1. Color Fastness to Water.
2. Color Fastness to Perspiration.
3. Color Fastness to Crocking.
4. Color Fastness to Washing.
5. Appearance after Washing.

4.1 COLOR FASTNESS TO WATER: (TEST METHOD: AATCC 107-2013)

PARAMETERS ACHEIVED REQUIREMENT

(RATING) (RATING)

Color Change 4 4

Staining on Acetate 4-5 4

Staining on Cotton 4-5 4

Staining on Nylon 4-5 4

Staining on Polyester 4-5 4

Staining on Acrylic 4-5 4

Staining on Wool 4-5 4

4.2 COLOR FASTNESS TO PERSPIRATION: (TEST METHOD: AATCC 15-2013)

PARAMETERS ACHEIVED REQUIREMENT

(RATING) (RATING)

Color Change 3-4 4

Staining on Acetate 4-5 4

Staining on Cotton 4-5 4

Staining on Nylon 4-5 4

Staining on Polyester 4-5 4

Staining on Acrylic 4-5 4

Staining on Wool 4-5 4

4.3 COLOR FASTNESS TO CROCKING: (TEST METHOD: AATCC 8-2016)

PARAMETERS ACHEIVED REQUIREMENT

(RATING) (RATING)

Dry Rub 4-5 3-4

Wet Rub 3 2-3

4.4 COLOR FASTNESS TO WASHING: (TEST METHOD: AATCC 61-2013)

PARAMETERS ACHEIVED REQUIREMENT

(RATING) (RATING)

Color Change 3 4

Staining on Acetate 4-5 4

Staining on Cotton 4-5 4

Staining on Nylon 4-5 4

Staining on Polyester 4-5 4

Staining on Acrylic 4-5 4

Staining on Wool 4-5 4

4.5 APPEARANCE AFTER WASHING: (VISUAL ASSESSMENT, AS PER CARE)

PARAMETERS ACHEIVED REQUIREMENT

(RATING) (RATING)

AFTER 1st WASH

Color Change (Without Suppressor) 3-4 4

Color Change (With Suppressor) 3-4 4

OBSERVATION

Moderate Color Change of Base was observed.

Slight fuzzing effect was Observed/No Pilling Was Found.

AFTER 3RD WASH

Color Change (Without Suppressor) 3-4 4

Color Change (With Suppressor) 3-4 4

OBSERVATION

Moderate Color Change of Base was observed.

Slight fuzzing effect was Observed/No Pilling Was Found..

5. COMPARITIVE STUDY WITH OTHER GARMENT DYEING TECHNIQUES

PARTICULARS	CONVENTIONAL TIE & DYE TECHNIQUE	CONVENTIONAL DIP & DYE TECHNIQUE	INJECTION TIE AND DYE GARMENT DYEING
Wetting Treatment M:L	'1 :4	'1 :4	1 :2
Effluent Created in Wetting treatment	200 ml	200 ml	80 ml
Mordant Dosage M:L	'1 :4	'1 :4	1 :1
Effluent Created in Mordanting	320 ml	320 ml	80 ml
Dyeing M:L	'1 :4	'1 :4	1 :1
Dye Liquor Required for 80g Kids garment	320 ml	320 ml	80 ml
Conc. Dye Liquor Effluent Created after dyeing	320 ml	320 ml	**NIL**
Dyeing Time	1 Hour	1 Hour	2 Hours
Drying/Fixation	Natural dried	Natural dried	Natural dried

Washing Sequence	Cold Wash , Cold Soaping, Coldwash.	Cold Wash, Cold Soaping, Coldwash.	Cold Wash, Cold Soaping, Coldwash.
Effluent Created in Washing Proces	960 ml	960 ml	320 ml
Total Effluent	1.8 Litres	1.8 Litres	560 ml (65% less effluent load)

6. DISCUSSION

1. Unlike conventional techniques, In this method, the dyeing process is started in dry state, which is resulting in more shade depth.

2. Pre and after treatments were carried out using saturation technique, which is resulting in 65% less effluent load.

3. Observed that fastness properties of natural dyed sample using the Injection garment dyeing is showing better performance and test results are similar to best performing synthetic dyed sample.

4. Since dye liquor injection is very controlled and precise, design outcome is very consistent.

7. CONCLUSION

The whole process of 100% Herbal natural dyestuff extraction and dyeing is ecologically safe. Due to the ultra lower liquor ratio in both dyeing and pre/post treatment, There is a huge reduction of water consumption, chemical and auxiliaries consumption and 65% less effluent load. The most highlight on this research work is, the concentrated dye liquor effluent discharge after dyeing is Nil, Even though dye coverage is 80%. This is achieved due to controlled and precise use of dye liquor. This technique exhibited excellent fastness properties. As with high water conservation, reduction in energy usage and very low effluent load can result is substantial saving to garment dyers and environment as well.

By considering the above parameters, it can be concluded that adaptation of bulk- scale production is feasible with this **INJECTION GARMENT DYEING** technology with ultra low liquor ratio.

8. SCOPE FOR FUTURE STUDY

In this technique, concentrated dye liquor effluent is Nil, so the only possible dye effluent will be in wash off. So dye effluent will be minimal, when compared to other conventional techniques. So there is a scope for analyzing the dye effluent characteristics, if the effluent characteristics is in the permissible limit of pollution control board, We can avoid Effluent treatment plant. Which is a substantial saving in investment and it will attract many start ups.

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