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Natural Dyeing of Cotton Fabrics with Pigment Extracted from *Roseomonas Fauriae*

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Abstract:

Natural dyeing is a technique to dye the textile fabrics with the colours extracted from natural sources like plants, animals and minerals, microorganisms etc. They are eco-friendly, biodegradable and non-carcinogenic in comparison to synthetic dyes. In this research work, the pigment was extracted from *Roseomonas fauriae* using aqueous media. The dye potential of the extract was evaluated by dyeing on 100 % cotton fabrics under normal dyeing conditions. These findings reveal that the extract of pink pigment can be used for coloration of 100 % cotton. The relative colour strength of the dye was found to be more in case of cotton clothes mordant with alum. Air permeability of the treated cotton fabric was not much affected by the treatment. The slight decrease in tensile and tear strength was noticed in the treated samples. The aqueous pigment finished fabric has the best fastness criteria to washing. After treatment the stiffness of fabric was moderately increased.

Keywords: *Roseomonas fauriae,* aqueous pigment, dye-ability, cotton fabric, K/S value, wash fastness, air permeability, tensile strength, tear strength

1.0 Introduction:

The global consumption of textiles is estimated at around 30 million tonnes, which is expected to grow at the rate of 3% per annum. The colouration of this huge quantity of textiles needs around 700,000 tonnes of dyes which causes release of a vast amount of unused and unfixed synthetic colourants into the environment (Rungruangkitkrai and Mongkholrattanasit, 2012). The rapid growth in technical textiles and their uses has generated many opportunities for the application of innovative finishes (Aberoumand, 2011). The textile industries are to satisfy the ever growing demands in terms of quality, variety, fastness and other technical requirements. The Indian textile industries now predominantly use synthetic organic dyes like direct dyes, processing dyes, reactive dyes, etc. The large variety of dyes and chemicals used in an attempt to make attractive popular shades of fabrics for a competitive market render them very complex (Mathur *et al*., 2005). The harmful effects of synthetic dye and chemicals used at the time of dyeing have forced to concern about the alternative preparation of dye using natural sources.Production of synthetic dyes is dependent on petrochemical source and some of synthetic dyes contain toxic or carcinogenic amines which are not eco-friendly. Synthetic dyes are substituted by natural colour additives and growing at round 2 % annually. Natural colours are easier to metabolize than synthetic counert parts (De-Carvalho *et al*., 2014). A number of commercial dyers and small textile export houses have started looking at the possibilities of using natural dyes for regular basis dyeing and printing of textiles to overcome environmental pollution caused by the synthetic dyes (Samanta and Agarwal, 2009). World wise growing consciousness for use of eco-friendly products in daily life has generated renewed interest of consumers towards use of textiles from natural fibers, dyed with eco-friendly natural dyes. Most of the commercial dyers and textile export houses have started re-looking to the maximum possibilities of using natural dyes for dyeing and printing of different textiles for targeting niche market. Natural dyes produce very uncommon, soothing and soft shades as compared to synthetic dyes. On the other hand, synthetic dyes, which are widely available at an economical price and produce a wide variety of colours, causes skin allergy and other harmfulness to human body, produces toxicity/chemical hazardsduring its synthesis, releases undesirable/hazardous/toxic chemicals etc.

The natural bio-pigments are gaining importance because of health and hygiene and environmental consciousness. Colors derived from minerals (lead chromate, copper sulphate) may cause serious health problems. However, in last few decades, synthetic dyes are severely criticized and consumers show inhibition toward these products, consequently they prefer to use the natural colorants. Pigments from natural sources have been obtained since long time ago and their interest has increased due to the toxicity problems caused by those of synthetic origin. According to green technology, less toxic products and more natural starting material is favourable for today's production lines. Natural pigments are extensively used in various fields of everyday life including food production, textile industry, paper production, agricultural practice and research. The harmful effects of synthetic dye and chemicals used at the time of dyeing have forced to concern about the alternative preparation of dye using natural sources (Joshi *et al*., 2003). In this way the pigments from microbial sources are a good alternative. The new area in natural dyes can be colors produced by microorganisms. Many microorganisms including bacteria, fungi, algae and actinomycetes produce pigments (Sanglier *et al*., 1993). Microorganism produced a large variety of stable pigments such as carotenoids, flavonoids, quinones, and rubramines. The fermentation has higher yields in pigments and lower residues compared to the use of plants and animals. Thus, biosynthesis of dyes and pigments via fermentation processes has attracted more attention in recent years (Duran *et al*., 2002).

Microbial pigments are suitable for mass production, when compared with vegetable or animal extracts (De-Carvalho *et al*., 2014). The various advantages of producing pigments from microorganisms make widespread use of microbial pigments in many industries like food industry, textile industry, pharmaceutical industry, plastic industry etc. Liu *et al*., (2013), purify prodigiosin red pigment from Serratia marcescens for textile application. During 2012, Sharma *et al*., extracted pigment from fungal origin. They isolated pigments from *Curvalaia lunata, Trichoderma virens and Alternaria alternata.* Violacein pigment was isolated from *Chromobacterium violaceum*. The pigment showed several biological activities and also used in textile, cosmetic and phrmaceutical industries (Duran *el al.,* 2011). The higher production of pigment, chemical and light stability is essential features for industrial applications of microbial pigments (Gunasekaran and Pooraniammal, 2008). The dyed fabrics showed a cidal effect on the micro-organisms under study, increasing the value of the fabric for commercial use. The cultivation of microorganisms and production of pigment in the large scale, in laboratory, is independent of seasons, controllable and with a predictable yield (Adivarekar and Kanoongo, 2008). The bright red pigment prodigiosin from *Vibrio* sp and *Serratia* sp could be used to dye many fibers like wool, nylon, acrylics and silk (Alihosseini *et al.,* 2008). Genus *Roseomonas* was first described as unnamed pink-pigmented oxidative bacteria by Gilardi and Aur *(*1984). *Roseomonas* was proposed as genus name by Rihs *et al*., (1993). There are thirteen different species recognized so far. There are also reports from environmental samples such as fresh water, soil and air (Furuhata *et al*., 2008). Gallego *et al*., (2006) have been isolated *Roseomonas* species from aqueous environment. The pink pigment of *Roseomonas* sp., have the ability to produce pigment for the textile fabrics. The present research was carried out the evaluation of dyeability nature of the pigment extracted from *Roseomonas fauriae* on cotton fabric.For successful commercial use of natural dyes for any particular fibres, the appropriate and standardized techniques for dyeing for that particular fibre-natural dye system need to be adopted. Therefore to obtain newer shade with acceptable colour fastness behaviour and reproducible colour yield, appropriate scientific dyeing techniques/procedures are to be derived. Thus, relevant scientific studies and its output on standardization of dyeing methods, dyeing process variables, dyeing kinetics and test of compatibility of selective natural dyes have become very important, however the information on which is insufficient.

2.0 Materials and method

2.1 Sample collection

From the pink pigmented *Roseomonas fauriae* (Fig.1) the aqueous extracted pigment (Fig.2) was obtained from the Department of Microbiology, Sri Ramakrishna College of Arts and Science for Women, Coimbatore, Tamil Nadu.

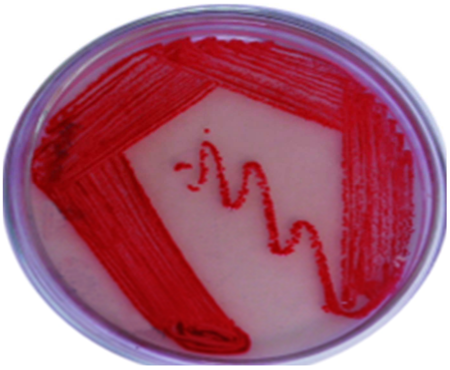

Fig 1. ***Roseomonas fauriae*., on Nutrient agar plate**

Fig 2. Aqueous extract of *Roseomonas fauriae*., pigment

2.2 Dyeing of scored cotton fabric with *Roseomonas fauriae* pigment *Pad -Dry-Cure method* (Thamarai selvi *et al*., 2011)

The pigment extract of *Roseomonas fauriae* ., and alum were applied on cotton fabric using pad-dry-cure method. The 40s count, desized, 100% cotton fabric was cut to the size of 30 X 30 cm and immersed in the test solutions. *Roseomonas fauriae*., aqueous pigment extract (2%) and alum (6%) was used. The sample fabric was immersed in the solution for 5 min and then it was passed through a padding mangle, running at a speed of 15 m/min with a pressure of 1kgf/cm^2 to remove excess solution. A 100% wet pick-up was maintained for all of the treatments. After padding, the fabric was air-dried and cured for 3 min at 80°C.

2.3 Evaluation of finished fabric

2.3.1 Determination of colour strength (K/S value) of cotton fabrics finished with the pigment extract (AATCC manual)

The K/S value of dyed material was directly proportional to the amount of dye present in the material. The finished cotton fabrics were evaluated for dye uptake, K/S value, using UV-Vis spectrophotometer using the formula,

$$K/S = (1-R)^2 / 2R$$

Where,
K is the coefficient of absorption,
S is the coefficient of scattering,
R is the reflectance value of the fabric at λ max.

2.3.2 Wash fastness- Launder-O-Meter (AATCC, 110106)

About 6”x2” sample fabric was taken. Staple multi-fibre test fabric along one edge of technical face of sample. 150 ml of water and 0.225 g of detergent (0.15% wt of liquor) were added to each canister. 50 steel balls were added into canister. Blank gasket was placed into canister lid. Sample was pressed into lid and lid was closed. Then rotor was started and run for 2 minutes at 410°C to pre-heat the canister and the solution. The samples were added to each canister in the row. After finishing, the row was re-clamped again. Rotor was manually turned to the next row. The process was repeated until all samples were loaded. Sample was dried in oven (106°F or 71°C) for 1 hour before evaluation.

2.4 Determination of physical characteristics of cotton fabrics finished with aqueous extracted pigment of *Roseomonas sp.,* (Rajendran *et al*., 2010)

2.4.1 Air Permeability of finished fabrics (ASTM D737- 2004)

This test method covers the measurement of the air permeability-the rate of air flow passing perpendicularly through a known area under a prescribed air pressure (c.c/cm.sq /sec) differential between the two surfaces of a textile material. Construction factors and finishing techniques can have an effect upon air permeability by causing a change in the length of airflow paths through a fabric. This test was done with an air permeability testing apparatus. Pressure gauge and flow meter were used to measure the air permeability. The samples were tested at a relative humidity 65% and at a temperature of 21°C. Ten readings were taken for each sample.

2.4.2 Tensile strength - Grab Test of finished fabrics (ASTM D 5034– 95- 2001)

A tensile testing machine was used and this test determined the breaking strength and elongation of most textile fabrics. The specimens were conditioned to moisture at equilibrium as directed in ASTM D 1776. This test was performed either wet or dry and samples were cut in both the warp and weft directions. The specimen was mounted in the clamp of the testing machine. It was made sure that the tension on the specimen was uniform across the clamped width. Uniform and equal tension was achieved by attaching an auxillary clamp to the bottom of the specimen and at the point below the lower clamp of the testing machine. The lower clamp was tightened and auxillary clamp was removed. The machine was operated to break the specimen. The breaking force was read from the testing machine indicating mechanism.

2.4.3 Tear strength of finished fabrics(ASTM D 2261-96)

The tearing strength of the treated and untreated fabrics were measured by the tongue (slip rip) procedure using constant-rate-of-extension tensile testing machine recording. The specimens were conditioned in the standard atmosphere for testing textiles, which was 21 ± 1ºC (70 ± 2ºF) and 65 ± 2% relative humidity. A rectangular specimen was cut in the center of a short edge to form a two- tongued (trouser shaped) specimen, in which one tongue of the specimen was gripped in the upper jaw and the other tongue was gripped in the lower jaw of the tensile testing machine. The separation of the jaws was continuously increased to apply a force to propagate the tear. At the same time the force developed was recorded. The force to continue the tear was calculated from autographic chart recorders or microprocessor data collection systems.

2.4.4 Fabric Stiffness Test for finished fabrics

Stiffness is an important characteristic of a fabric. The importance of stiffness depends on the end use of the fabric. A rectangular strip of fabric was mounted on a horizontal platform in such a way that it overhangs, like cantilever and bends downwards. Bending length was the length of fabric that will bend under its own weight to a definite extent. From the length (L) and the angle ϴ, the numbers of values were determined.

Bending length L= $LF1(\emptyset)$

3.0 Results and Discussion:

The pink colour aqueous pigment extract was used for the study. Along with alum the pigment was coated on the scored cotton fabric. It was observed that the K/S value of the treated fabric was 3.98 (Fig 3).

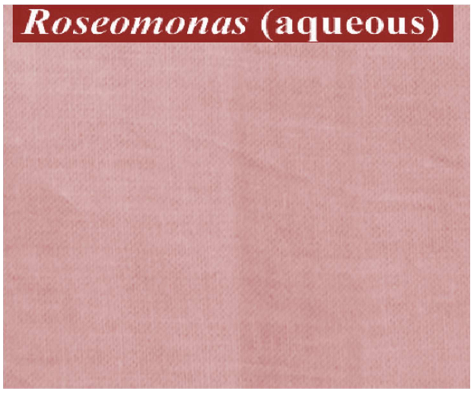

Fig 3. Cotton fabric finished with *Roseomonas fauriae*., pigment

When mordant is used, the dye is complex with the mordant by formation of coordinate bonds and is rendered insoluble and hence it cannot leached out to give a good activity (Gupta and Laha, 2007). During 2011, Mabrouk *et al.*, also noticed that the K/S value of cotton fabric dyed with brown pigment produced by *Acrostalagmus*sp. (NRC 90) was 10.4. The result of the color fastness to washing was 4 when compared with control fabric. It indicated that, the pigment treated fabric has good washing fastness. The color fastness properties of treated and untreated cotton fabrics to perspiration were tested according to ISO standard methods and are shown in table 1. According to the standard grey scale for color change, the results were good.

Table 1: Colour fastness to washing of finished fabric

S.No	Colour fastness to Washing	Untreated (control)	*Roseomonas sp* Pigment treated (Aqueous)
1	Change in colour	3-4	4
2	Staining on wool	4-5	4-5
3	Acrylic	4-5	4-5
4	Polyester	4-5	4-5
5	Nylon	4-5	4-5
6	Cotton	4	4
7	Acetate	4-5	4-5

1-Very poor 2-Poor 3- Moderate 4- Good 5 – Excellent

The related result was noticed in the following study. Mabrouk *et al.,* (2011) dyed wool with deep brown dye produced by *Penicillium chrysogenum* (NRC 74) exhibited good to very good fastness properties to washing.

Table 2. Physical characteristics of cotton fabrics finished with aqueous extracted pigment of *Roseomonas sp.,*

Sample Fabrics	Tensile Strength			
	Warp strength (Kg)	Warp elongation %	Weft strength (Kg)	Weft elongation %
Untreated (control)	41.95	13.17	32.86	19.95
Roseomonas sp., pigment treated (aqueous)	34.28	11.61	22.95	17.58

Air permeability of control and finished fabrics were tabulated in table 2. Based on the results, the air permeability of the cotton fabric was not much affected after the treatment using alum and aqueous extract of *Roseomonas* sp pigment. Related results were reported by Nelson *et al*., (2002) that wool fabric dyed with brown pigment produced by *Alternaria* sp. (NRC 97) does not affect air permeability of the sample.

Table 3: Tensile Strength of finished fabrics

S.No	Experiments	Control fabric	Treated Fabric
1	**Air permeability (cc/cm sq/sec)**	49.3	43.2
2.	**Tear strength** Warp strength (gf)	1472.0	1290.0
	Weft strength **(gf)**	1392.0	1170.0
3.	**Stiffness** Warp strength (cm)	1.91	1.98
	Weft strength **(cm)**	1.45	1.69

The results of fabric tear strength of untreated and treated samples were presented in Table 2. The slight decrease in tear strength was noticed in all the treated samples compared with untreated fabric (warp - 1472.0 gf and weft - 1392.0 gf). The fabric was dyed with aqueous extract of *Roseomonas* sp., pigment and the following warp (1290.0 gf) and weft strength (1170.0 gf) was observed. There was a less tear strength difference were noted in all the treated samples both in warp way and weft ways. Hussain and Ali, (2009), reported that the tear strength of the cotton was decreased with the increased amount of pigment and binder. Stiffness and abrasion resistance of control and treated fabrics were presented in table 2. According to the result, the stiffness of the fabric was slightly increased after finishing with aqueous pigment. Tensile strength value of control and finished fabrics were presented in table 3. There was a significant decrease in warp tensile strength. In case of treated fabric, the warp strength reduction occurs from 41.95 Kg to 34.28 Kg with *Roseomonas* sp., aqueous pigment treatment. There was only 1.56 % warp elongation for the fabric treated with *Roseomonas* sp., pigment.

Hussain and Ali, (2009) reported that there was no significant change in tensile strength of the fabric after treated with natural pigment. Tensile strength of the dyed fabric and untreated samples were found to be almost same (Periyasamy and Dhurai, 2011). In this study reported that after the treatment with the pigment there was a slight decrease in the strength about 1.56%. The aqueous extracted pigment of *Roseomonas fauriae*., has exellent ability to dye on cotton fabric. After finishing the colour strength, wash durability was good. Air permeabilityof the treated cotton fabric was not much affected by the treatment. The has no adverse effect of these dyes on tensile and tear strength of the fabric. The aqueous pigment finished fabric has the best fastness criteria to washing. After treatment the stiffness of fabric was moderately increased. Based on the bove results the aqueous extract of *Roseomonas fauriae*., pigment have the potential to replace some of the toxic, sensitizing and carcinogenic dyes and intermediates. These natural dye can be commercially produced on mass scale in an inexpensive and environmentaly friendly manner.

4.0 Conclusion:

The results of the present study proved that the aqueous extract of *Roseomonas fauriae*., pigment distributed evenly in the fabric giving a pleasing appearance. Moreover application of the natural pigment promotes consumers health protection and allows manufacturing of fully eco friendly pigment without any synthetic mix. Thus, use of eco-friendly fibres and fabrics are gradually gaining importance throughout the world. Over the course of coming century, naturally occurring organic pigments have been completely displaced by synthetic molecules. The harmful effects of synthetic dye and chemicals used at the time of dyeing have forced to concern about the alternative preparation of dye using natural sources.

Reference:

1) Adivarekar, R.V. and Kanoongo, N. (2008): Processing, dyeing and finishes. *The Indian Textile Journal,* 118: 47-55.

2) Alihosseini, F. Ju, K.S. Lango, J. Hammock, B.D. and Sun, G. (2008):Antibacterial colorants. Characterisation of prodiginines and their applications on textile materials. *Biotechnology,* 24: 742-747.
3) De-Carvalho, J.C. Cardosa, L.C. Ghiggi, V. Woiciechowski, A.L. Vandenberghe, L.P. and Soccol,C.R. (2014): Microbial pigments. Biotransformation of waste biomass into high value Biochemicals, pp 73-97.
4) Durán N. Teixeira M.F.S. Conti, R. and Esposito, E. (2002): Ecological- friendly pigments from fungi. *Critical Review In Food Science And Nutrition ,* 42(1): 53 - 66.
5) Duran, M. Ponezi, N.A. Faljoni-Alario, A. Teixeira, M.F.S. Justo, G.Z. and Duran, N. (2012): Potential application of violacein- a micribial pigment. *Medicinal Chemistry Research,*21(7): 1524-32.
6) Furuhata, K. Miyamamoto, H. Goto, K. Kato, Y. Hara, M. and Fukuyama, M. (2008: *Roseomonas stagni* sp. nov., isolated from pond water in Japan. *Journal of General Applied Microbiology,* 54: 167 -171.
7) Gallego, V. Sanchez-Porro, C. Garcia, M.T. and Ventosa, A.(2006): *Roseomonas aqutica* sp nov.,isolated from drinking water. *International Journal of Systematic and Evolutionary Microbiology,* 56: 2291-2295.
8) Gilardi, G.L. and Aur, Y.C. (1984): *Pseudomonas mesophilica* and unnamed taxon, clinical isolates of pink pigmented oxidative bacteria. *Journal of clinical Microbiology*, 20: 626-629.
9) Gunasekaran, S. and Poorniammal, R. (2008): Optimization of fermentation conditions for red pigment production from *Penicillium* sp. Under submerged cultivation. *African Journal of Biotechnology.* 7(12): 1894 - 1898.
10) Gupta, D. and Laha, A. (2007): Antimicrobial activity of cotton fabric treated with *Quercus infectoria* extract. *Indian Journal of Fiber and textile Research.* 32: 88 -92.
11) Hussain, T. and Ali, R. (2009): Comparison of properties of cotton fabric dyed with pigment and reactive dye. *Journal of the Textile Institute,* 100: 95 - 98.
12) Joshi, V.K. Attri, D. Bala, A. and Bhushan, S. (2003): Microbial pigments. *Journal of Industrial Biotechnology,* 2: 362-369.
13) Liu, X. Wang, Y. Sun,S. Zhu,C. Xu,W. Park,Y. And Zhou, H. (2013): Mutant breeding of *Serratia marcescens* strain for enchancing prodigiosin production and application of textiles. *Preparative Biochemistry and Biotechnology*, 43 (3) 271-284.
14) Mabrouk, A.M. El-khrisy, E.A.M. Youssef, Y.A. and Asem, A.M. (2011): Production of textile reddish brown dyes by fungi, *Malaysian Journal of Microbiology*, 7(1): 33-40.
15) Mathur, N. Bhatnagar, P. and Bakre, P. (2005): Assessing mutagenicity of textile dyes from Pali (Rajasthan) using Ames bioassay. *Applied ecology and environmental research,* 4(1): 111-118.
16) Nelson, D. Maria, F.S. Roseli, D. and Elisa, E. (2002): Ecological friendly pigments from fungi. *Criteria and Review of Food Science Nutrition,* 42(1): 53-66.
17) Periyasamy, A.sP. and Dhurai, B. (2011): Salt free dyeing - A new method of dyeing on Lyocell / Cotton blended fabrics with Reactive dyes. *Pakistan Textile Journal,* pp 100-109.
18) Rajendran, R. Balakumar, C. Hasabo, A. Mohammed Ahammed, Jayakumar, S. Vaideki, K. and Rajesh, E.M. (2010): Used Zinc Oxide nano particles for production of antimicrobial textiles. *International Journal of Engineering, Science and Technology,* 2(1): 202-208.
19) Rihs, J.D. Brenner, D.J. Weaver, R.E. Steigerwalt, A.G. Hollis, D.G. and Yu, Y.L.1993): *Roseomonas* sp*.,* a new genus associated with bacteremia and other human infections. *Journal of Clinical Microbiology,* 31: 3275-3283.
20) Rungruangkitkrai,N. and Mongkholrattanasit, R. (2012) : Ecofriendly of textiles dyeing and printing with natural dyes.RMVTP International conference: Textiles and Fashion. July 3-4, 2012, Bangkok, Thailand, 1-17.
21) Samanta, A. K. and Agarwal, P.(2009): Application of natural dyes on textiles, *Indian Journal of Fibre and Textile Research,* 34 (4) : 384-399
22) Sanglier, J.J. Wellington, E.M. Behal, V. Fiedler, H.P. Ellouz, G.R. Finance, C. Hacene, M. Kamoun, A. Kelly, C. and Mercer, D.K. (1993): Novel bioactive compounds from *actinomycetes . Res Microbiology*, 144 : 661-663.
23) Sharma, D. Gupta, C. Aggarwal, S. And Nagpal, N. (2012): Pigments extraction from fungus for textile dyeing. Indian Journal of Fibre and Textile Research, 37: 68-73.
24) Thamaraiselvi, B. Rajendran, R. Nithyalakshmi, B. and Gayathirignaneswari, S. (2011): Antimicrobial activity of cotton fabric treated with *Aloe vera* extract. International Journal of Applied Environmental Sciences.6 (2): 127-131.