Vol 4 Issue 8 Feb 2015 ISSN No :2231-5063

International Multidisciplinary Research Journal

Golden Research Thoughts

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RNI MAHMUL/2011/38595 **ISSN No.2231-5063**

Golden Research Thoughts Journal is a multidisciplinary research journal, published monthly in English, Hindi & Marathi Language. All research papers submitted to the journal will be double - blind peer reviewed referred by members of the editorial board.Readers will include investigator in universities, research institutes government and industry with research interest in the general subjects.

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Golden Research Thoughts
ISSN 2231-5063
Impact Factor : 3.4052(UIF)
Volume-4 | Issue-8 | Feb-2015
Available online at www.aygrt.isrj.org

DYING COTTON AND SILK WITH SOME NATURAL DYES USING SINGLE POT METHOD CONTAINING ENZYMES

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Abstract:-The synthetic dye industries are most polluting industries in modern days. The dyes, use of chlorine for bleaching, caustic soda for scoring and heavy metal salts for mordent are main causes of the pollution. The synthetic dyes can be replaced by the natural plant based dyes, scoring can be done by soft soaps mixed with natural surfactants, chlorine for bleaching is replaced by hydrogen peroxide and metal mordents are replaced or minimized by use of enzymes. The enzymes are extracted from natural sources to make the process economical. The present work deals with the dying of cotton and silk using plant based dyes as pomegranate, babool and Manjishtha. The enzymes used are Amylase, cellulase, protease and pectinase. Dye uptake and fastness study has also been carried out.

Keywords:natural dye, enzyme binding, metal mordenting.

INTRODUCTION

The textile dyeing industry has created a huge pollution problem as it is one of the most chemically intensive industries and the No. 1 polluter of clean water. More than 3600 textile dyes are being manufactured by the Industry today. The World Bank estimates that 17 to 20 percent of industrial water pollution comes from textile dyeing and finishing treatment given to fabric. Some 72 toxic chemicals have been identified in water solely from textile dyeing, 30 of which cannot be removed1. Taking into consideration all above ill effects of synthetic dye industry and dyeing processes we need to produce luxurious, sensuous fabric in ways that are non-toxic, ethical and sustainable. We can see the growing consumer consciousness to purchase eco-friendly clothing. Historical records of the use of natural dyes extracted from vegetables, fruits, flowers, certain insects and fish dating back to 3500 BC have been found. Fabric was earlier being dyed with natural dyes. These however gave a limited and a dull range of colors. Besides, they showed low color fastness when exposed to washing and sunlight. Enzymes are gaining an increasing role in textile wet processing3 due to their proven flexibility, reliability, and concerns about safety, energy and water conservation, and environmental responsibility. Unlike chemicals, enzymes are very specific with their actions as each type can only affect one chemical bond and they achieve their specific effects in a cost-effective manner. The dying of cotton and wool with some natural enzymes has been reported by Tsatsaroni, E and Liakopoulou-kyriakids,M.4H.S.El-khateeb3 has reported the dyeing of Wool/Nylon Blend Fabric with Camphor Plant After Bio-Treatment with Brewers 'Yeast Suspension. Enzymes can be used to improve the dying properties and controls the fiber shrinkage 5We here by present the work done in the direction of effective, fast, lustrous and bright dyeing with nearly zero pollution using plant based dyes, minimum amount of metal mordents and enzyme fixing.

MATERIALAND METHODS:

To make the process economical we adopted the use of plant material containing the dye in the proportion 20% of the weight of cloth (traditional dyer's thumb rule). The fabric material is first washed with soft soap solution to remove dirt and oily material from the surface. Then it is passed over a cylinder above the bath for bleaching by hydrogen peroxide solution (10%). after soaking through fresh water the fabric is dried and dipped in dye bath

containing 0.1% enzyme, 20% dye material, 2% tannic acid and metal mordent to adjust the color shade.

The chemicals required are purchased Loba chemicals and are 99% pure. The plant material was collected from local area and authenticated by botany department. The dyeing material along with fabric and enzyme solution was heated for two hours at 45 0C. Removed, dried and subjected to fastness tests.

The treatment with natural silk

Wt. of the fabric (mg)	Dye & Wt (20%) (mg)	Enzyme & wt (0.1%) (mg)	1% Tannic Acid (mg)	Water (1:20 Ratio) (ml)	Temperature (^{0}C)	pH		Alum 2 gm /lit	Effect Of treatment
						Dye solu^n	Fixer solu^n		
2050	pomegranate 410	Amylase 2.05	20.50	41	30.5	5	5.6	82	Deep and smooth
2050	pomegranate 410	Cellulase 2.05	20.50	41	30.5	5	5.6	82	Deep and smooth
2050	pomegranate 410	Protease 2.05	20.50	41	30.5	5	5.6	82	Deep and smooth
2050	Anar 410	Pectinase 2.05	20.50	41	30.5	5	5.6	82	Deep and smooth
2100	Babool 420	Amylase 2.1	21	42	30	7	6.5	84	Deep and smooth
2150	Babool 430	Cellulase 2.150	21.5	43	30	6.95	6.5-6.2	86	Deep and smooth
2150	Babool 430	Protease 2.150	21.5	43	30	7-7.4	6	86	Deep and smooth
2150	Babool 430	Pectinase 2.150	21.5	43	30	6.8	6-6.2	86	Deep and smooth
2200	Manjishtha 440	Amylase 2.2	22	44	30	7.5	7	88	Deep and smooth
2200	Manjishtha 440	Cellulase 2.2	22	44	30	7.5	7	88	Deep and smooth
2200	Manjishtha 440	Protease 2.2	22	44	30	7.5	7	88	Deep and smooth
2200	Manjishtha 440	Pectinase 2.2	22	44	30	7.5	7	88	Deep and smooth

RESULTS AND DISCUSSION

It may be also suggested that the formation of dye–enzyme complexes is increased by increasing the enzyme conc. resulting in diminishing the rate and degree of dye exhaustion leading to final lower colour strength on cotton fabric6. The enzymes contain true active centers in the form of three- dimensional structures as fissures, holes, pockets, and cavities or hollows. The active site is a part of the enzyme molecule that combines with the substrate. The number of active sites per enzyme molecule is very small. To catalyze a reaction, the enzyme molecule makes a complex adsorbed onto the surface of substrate in lock and key fashion7. It has been observed that the enzyme does not affect the fastness properties of the dye but the dye intake capacity of the fabric is improved to a large extent. In case of the cotton the dye intake capacity increases up to 20% with the enzyme cellulase while in case of the silk the protease and pectinase improve the dye intake capacity for all the dyes studied. The enzyme amylase induces special softness in the dyed fabric silk and cotton. In case of the dyes pomegranate (Anar), manjishtha and babool the enzyme gives deepness to the color. Probably the enzymes might be biting to the fabric creating required rough texture and dye absorbing sites on surface of the fabric. Therefore it is observed that cellulase and amylase are more effective on cotton and protease and pectinase on silk fabric. The increase in concentration of enzyme up to 0.4 % increases the deepening of the color. The denaturation of enzymes by heating the dye bath above 800C is necessary to avoid the further degradation of fiber. The amount of mordent required for fixing and color deepening decreases considerably by use of enzyme. Instead of using the commercially available enzymes natural sources like raw milk, toor dal extract, soyabean extract, fungus from mango tree also give same results and decreases the cost of dying considerably.

The results with pomegranate, manjistha and babool with urease, cellulase, amylase are shown bellow

Fabric	Enzyme	Colour Pigment	Maximum Color fastness- as per Test	Mordents used	Physical observation & feel
Cotton	Urease	pomegranate	3-4	$FeSO_4$, $CuSO_4$ Alum and $SnCl_2$	Dark, Soothing; Faint, bright
Cotton	Urease	Manjishtha	2	Faint	**Soft**; Bright; Shine
Cotton	Urease	Babool	3-4	$FeSO_4$, Alum and $SnCl_2$	Dark and soft Faint Lustrous; Bright;
Cotton	cellulase	pomegranate	4	$FeSO_4$, $CuSO_4$ Alum and $SnCl_2$	Deep, soothing Faint and smooth
Cotton	cellulase	Manjishtha	4	Faint	Deep, soothing Faint and smooth
Cotton	cellulase	Babool	3-4	$FeSO_4$, Alum and $SnCl_2$	Deep, soothing Faint and smooth
Cotton	amylase	pomegranate	3-4	$FeSO_4$, $CuSO_4$ Alum and $SnCl_2$	Deep, soothing Faint Deep, soothing
Cotton	amylase	Manjishtha	4	$FeSO_4$, $CuSO_4$ $K_2Cr_2O_7$ and $SnCl_2$	dark, soothing Faint and smooth
Cotton	amylase	Babool	4	$FeSO_4$, Alum and $SnCl_2$	Deep, soothing Faint and smooth

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