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RESEARCH ARTICLE

EXTRACTION OF NATURAL DYE FROM SELECTED FLORA FOR TEXTILE COLORATION

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ABSTRACT

Natural dyes are currently in demand not only in textile industry but in cosmetics, leather, food and pharmaceuticals. The rich biodiversity of India has provided the large amount of raw materials for natural dye extraction. Natural dyes show better biodegradability and are generally more used to with the environment. They are derived from natural resources; like plants, animals, minerals, and microbes. The majority of natural dyes need a mordanting agent (metal salt or tannins) to create an attachment between the cloth and dye. In this research paper the effect of mordant in dye extract is studied, which granted various colors to cotton fabrics.

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INTRODUCTION

India has been considered as foremost country in the art of natural dyeing. Natural dyes can be used in the coloring of textiles, drugs, cosmetics, etc. Because of their non toxic effects, they are also used for coloring various food products. More than 450 Indian plants can yield natural dyes (Siva *et al.*, 2007). Plants are able to give out vast array of colors i.e. pigments, but only some of these pigments can be used as dyes. Natural dyes are eco-friendly, biodegradable, non-toxic, such as yellow dye from turmeric and blue dye from indigo (Siva *et al.*, 2007). Natural dyes can be used for coloring almost all types of natural fibers. They can also be used in the coloration of food, medicines, craft articles, and in leather industries (Mansour *et al.*, 2018). There are primarily two sources from which natural dyes are extracted, viz. plants and animals. The rich biodiversity of India has provided the large amount of raw materials, still sustainable linkage must be developed between cultivation, collection and their use (Grover *et al.*, 2011). Most of the natural dyes have no stability on fabrics without the use of a mordant. The majority of natural dyes need a mordanting agent (metal salt or tannins) to create an attachment between the cloth and dye (Geetha and Judia *et al.*, 2013).

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There are two types of mordants: Metallic mordants Ex; Salts of Aluminium, Potassium, Copper, Iron, etc. and Tannins Ex; Myrobalan (from *Terminalia chebula*) and Sumac (from *Rhus coriaria*) (Siva *et al.*, 2007). There are different techniques which can be used for the extraction of dyes such as 1) Aqueous extraction 2) Alkaline or acid extraction 3) Microwave and ultrasonic assisted extraction 4) Fermentation 5) Solvent extraction (Mansour *et al.*, 2018).

Red roses are one of the most attractive and colorful flowers, whose petals are great source of bright red to pink colored dyes, and thus they are studied for its potential in giving natural dye (Patil *et al.*, 2016). Betalain colorants extracted from red Beetroot provide a natural alternative to synthetic dyes (Sivakumar *et al.*, 2009). Beetroot was selected as the plant material in the present study because of the good colorant yield. Turmeric is the plant that has long history of medicinal values. Because of its bright yellow color, turmeric is also known as Indian saffron and it is said to be eco-friendly and biodegradable (Prasad *et al.*, 2011).

MATERIALS

Fresh petals of red rose flower free from diseases were collected from market of Usmanpura, Ahmedabad, Gujarat, India. Fresh beet root and turmeric were bought from local market of Chandkheda, Ahmedabad, Gujarat, India.

METHODOLOGY

Extraction of dye from rose petals (Rose dye) and turmeric with beet root (Cocktail dye).

Extraction of color dye was carried out by three different methods named as

- Aqueous extraction
- Alkaline extraction
- Acidic method

Aqueous extraction method: 20 gm fresh rose petals and crushed turmeric with beet root were boiled separately in a beaker containing 100 ml distilled water at 60°C in water bath for 2 hrs. The materials were filtered and the decolorized residues were taken out from extraction solvent.

Alkaline extraction method: 20 gm fresh rose petals and crushed turmeric with beet root were boiled separately in a beaker containing 100 ml of 1% Sodium hydroxide solution at 60 °C in water bath for 2 hrs. The materials were filtered and the decolorized residues were taken out from extraction solvent.

Acidic method: 20 gm fresh rose petals and turmeric with beet root were boiled separately in a beaker containing 100 ml of 1% acidic solution at 60°C in water bath for 2 hrs. Finally, the materials were filtered and the decolorized residues were taken out from extraction solvent.

Scouring of cotton cloth: Cotton cloths used for dyeing were washed in detergent TWEEN 20 for 10 minutes to remove starch and other impurities. Then the treated cotton cloths were thoroughly washed with cold distilled water.

Dyeing and Mordanting: Dyeing and mordanting were carried out by three different methods which are stated below in detail.

Pre mordanting method: Cotton clothes were first kept with 20 ml (0.5%) of each mordant in different beakers for 30 minutes in water bath at 60°C. After that they were dried normally and directly dipped into their respective dyes inside the water bath for 1 hour at 60°C. Finally all cotton clothes were taken out and allowed to dry, and then dried clothes were kept inside the zip lock bags for further studies.

Simultaneous method: Cotton clothes were dipped into the beaker containing 20 ml of dye with 0.5% of each mordant. Beakers were kept inside the water bath for 1 hour at 60°C. After that clothes were allowed to dry in normal condition. Then dried clothes were kept into the zip lock bags for further analysis.

Post mordanting method: Cotton clothes were kept with 20 ml of each dye in different beakers for one hour in water bath at 60°C, afterward clothes were dried and treated with 20 ml (0.5%) of each mordant solution. For this, set up were kept inside the water bath for 30min. at 60°C. Finally, the clothes were dried and kept inside the zip lock bags till further studied.

Weighing of cotton clothes: The treated cotton clothes were weighted before and after their dyeing process on weighing balance machine. Readings were noted in tabular form.

Testing of cotton clothes: Cotton clothes were tested for the following tests.

- **Washing test;** In this, dyed fabrics were washed in distilled water at 60°C for 30 minutes in water bath.
- **Sunlight test;** In this, dyed fabrics were placed in direct sunlight for 1 hour.
- **Rubbing test;** In this, dyed fabrics were rubbed manually for 10 minutes.

RESULTS AND DISCUSSION

Dye extraction: The extracts show variation in color which is mainly due to the extraction solvents and the mordants. Rose dye gives red color with distilled water, blood red color with 1% HCl and brownish red color with 1% NaOH, while cocktail dye gives dark orange in distilled water, bright orange in 1% HCl and dark brown in 1% NaOH which is shown in table 1.

Dyeing and mordanting: Rose dye when mixed with FeSO₄, CuSO₄ and Alum changes to violet, dark pink and bright pink respectively (Table2) while Cocktail dye, when mixed with FeSO₄, CuSO₄ and Alum changes to brownish yellow, yellow and bright yellow respectively (Table 3). Out of all three mordants, it is found that Alum is the best one to be used for mordanting in dyeing of cotton fabrics, as it did not alter the color of dye and got adheres to the fabric perfectly.

In pre mordanting and simultaneous techniques, Rose dye with FeSO₄, CuSO₄ and Alum gave dark violet, pink and pink color respectively to the fabric in case of distilled water. 1%HCl Rose dye gave violet, bright pink and bright pink color to the fabric with FeSO₄, CuSO₄ and Alum respectively. And 1% NaOH Rose dye solution, turned cotton fabric into pale yellow, light yellow and light-yellow color with FeSO₄, CuSO₄ and Alum respectively. (Figure 1 & 2). But in case of post mordanting technique, Rose dye with FeSO₄, CuSO₄ and Alum gave dark violet, light violet and light grey color respectively to the fabric in case of distilled water. 1% HCl Rose dye also gave dark violet, light violet and light grey color to the fabric with FeSO₄, CuSO₄ and Alum respectively. And 1% NaOH Rose dye solution, turned cotton fabric into pale yellow, light grey and white color with FeSO₄, CuSO₄ and Alum respectively (Figure3). Pre mordanting and simultaneous techniques for cocktail dye, in distilled water provided pale yellow, yellow and bright yellow color on fabric when treated with FeSO₄, CuSO₄ and Alum respectively. In 1% HCl solution cocktail dye turned cotton fabrics into yellow, bright yellow and bright yellow color with FeSO₄, CuSO₄ and Alum respectively. In 1% NaOH cocktail dye gave light brown, light brown and pale brown color to the fabric with FeSO₄, CuSO₄ and Alum respectively. (Figure 4 & 5). But in case of post mordanting techniques, cocktail dye, in distilled water gave pale yellow, pale yellow and bright yellow colors to the fabrics with FeSO₄, CuSO₄ and Alum respectively. In 1% HCl solution cocktail dye turned cotton fabrics into yellow, bright yellow and bright yellow color with FeSO₄, CuSO₄ and Alum respectively.

Table 1. Color of dyes with respective solvents

Sr.No.	Extraction	Distilled water	1%HCl solution	1%NaOH solution
1.	Rose dye	Red	Blood red	Brownishred
2.	Cocktail dye	Dark orange	Bright orange	Dark brown

Table 2. Color of dye with mordants. (Rose dye)

Sr.No.	Solvents	Mordants	Color	Color on fabric
1.	Distilled water	FeSO ₄	Violet	Dark Violet
		CuSO ₄	Dark pink	Pink
		Alum	Bright pink	Pink
2.	1% HCl	FeSO ₄	Dark violet	Violet
		CuSO ₄	Dark red	Bright Pink
		Alum	Bright red	Bright Pink
3.	1%NaOH	FeSO ₄	Brownish yellow	Pale Yellow
		CuSO ₄	Yellow	Light yellow
		Alum	Bright yellow	Light yellow

Table 3. Color of dye with mordants. (Cocktail dye)

Sr. No.	Solvents	Mordants	Color of dye	Color on fabric
1.	Distilled water	FeSO ₄	Brownish yellow	Pale yellow
		CuSO ₄	Yellow	Yellow
		Alum	Bright yellow	Bright yellow
2.	1% HCl	FeSO ₄	Brown	Yellow
		CuSO ₄	Yellow	Bright yellow
		Alum	Bright yellow	Bright yellow
3.	1% NaOH	FeSO ₄	Dark brown	Light brown
		CuSO ₄	Brownish yellow	Light Brown
		Alum	Dark yellow	Pale brown

**Figure 1. Cotton fabric treated under pre mordanting technique (Rose dye)**



Figure 2. Cotton fabric treated under simultaneous technique (Rose dye)



Figure 3: Cotton fabric treated under post mordanting technique (Rose dye)



Figure 4: Cotton fabric treated under pre mordanting technique (Cocktail dye)

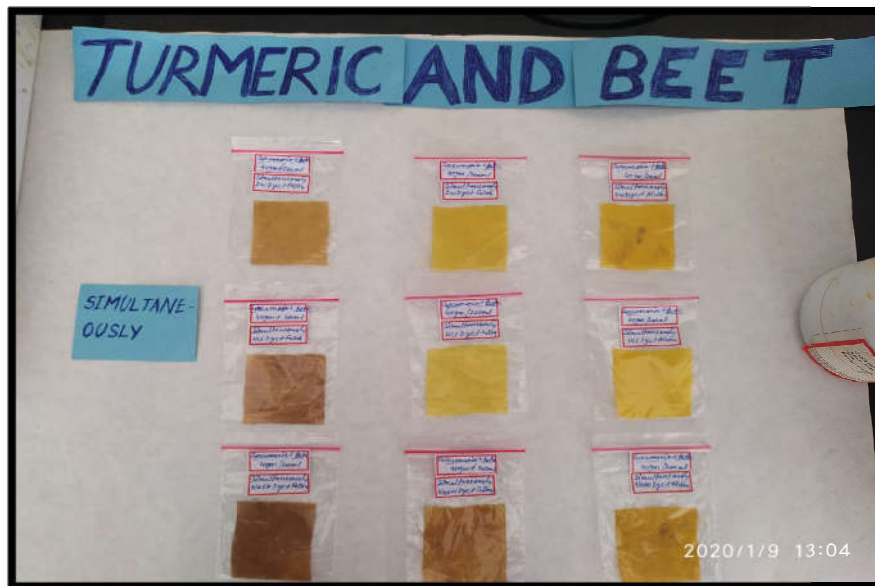


Figure 5: Cotton fabric treated under simultaneous technique (Cocktail dye)



Figure 6: Cotton fabric treated under post mordanting technique (Cocktail dye)

Table 4. Weighing results of cotton fabric with different techniques (Rose dye)

Sr No.	Technique	Solvent	Mordant	Weight of cotton fabric in gm		Difference in weight (gm)
				Before dyeing	After dyeing	
1.	Pre mordanting	Distilled water	FeSO ₄	.155	.160	0.005
			CuSO ₄	.155	.176	0.021
			Alum	.155	.172	0.017
		1% HCl	FeSO ₄	.155	.174	0.019
			CuSO ₄	.155	.171	0.016
			Alum	.155	.170	0.015
		1% NaOH	FeSO ₄	.155	.180	0.025
			CuSO ₄	.155	.184	0.029
			Alum	.155	.180	0.025
2.	Simultaneous	Distilled water	FeSO ₄	.155	.170	0.015
			CuSO ₄	.155	.181	0.026
			Alum	.155	.176	0.021
		1% HCl	FeSO ₄	.155	.170	0.015
			CuSO ₄	.155	.174	0.019
			Alum	.155	.174	0.019
		1% NaOH	FeSO ₄	.155	.184	0.029
			CuSO ₄	.155	.190	0.035
			Alum	.155	.185	0.030
3.	Post mordanting	Distilled water	FeSO ₄	.155	.180	0.025
			CuSO ₄	.155	.161	0.006
			Alum	.155	.160	0.005
		1% HCl	FeSO ₄	.155	.171	0.016
			CuSO ₄	.155	.180	0.025
			Alum	.155	.180	0.025
		1% NaOH	FeSO ₄	.155	.172	0.017
			CuSO ₄	.155	.190	0.035
			Alum	.155	.185	0.030

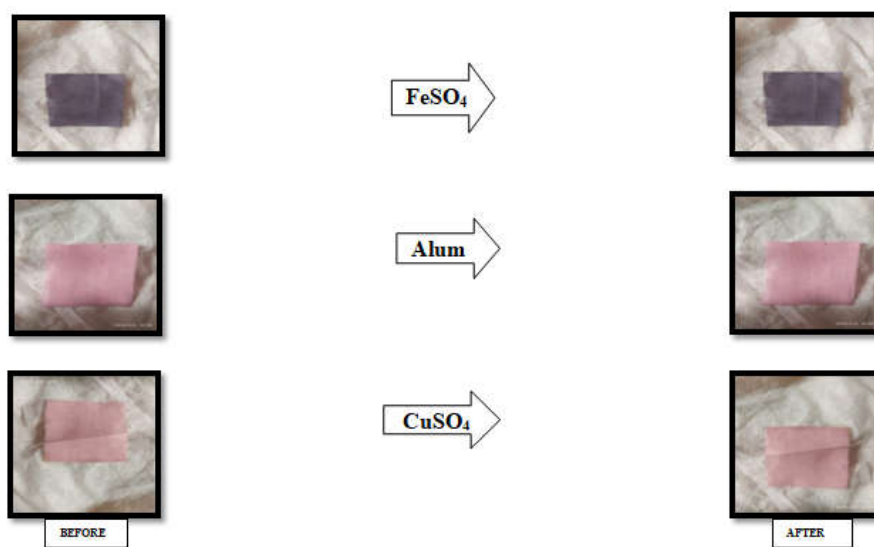


Figure 7: Rubbing test results (Rose dye)

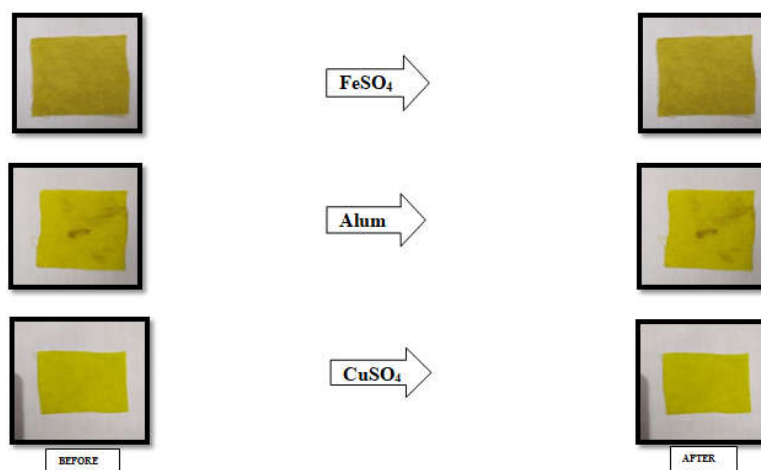


Figure 8: Rubbing test results (Cocktail dye)

Table 5. Weighing resultsof cotton fabric with different techniques (Cocktail dye)

Sr No.	Technique	Solvent	Mordant	Weight of cotton fabric in gm		Difference in weight (gm)
				Before dyeing	After Dyeing	
1.	Pre mordanting	Distilled water	FeSO ₄	.155	.164	0.009
			CuSO ₄	.155	.180	0.025
			Alum	.155	.176	0.021
		1% HCl	FeSO ₄	.155	.178	0.023
			CuSO ₄	.155	.175	0.02
			Alum	.155	.180	0.025
		1% NaOH	FeSO ₄	.155	.184	0.029
			CuSO ₄	.155	.188	0.033
			Alum	.155	.190	0.035
2.	Simultaneous	Distilled water	FeSO ₄	.155	.174	0.019
			CuSO ₄	.155	.185	0.03
			Alum	.155	.180	0.025
		1% HCl	FeSO ₄	.155	.174	0.019
			CuSO ₄	.155	.176	0.021
			Alum	.155	.178	0.023
		1% NaOH	FeSO ₄	.155	.188	0.033
			CuSO ₄	.155	.192	0.037
			Alum	.155	.186	0.031
3.	Post mordating	Distilled water	FeSO ₄	.155	.184	0.029
			CuSO ₄	.155	.165	0.01
			Alum	.155	.164	0.009
		1% HCl	FeSO ₄	.155	.175	0.02
			CuSO ₄	.155	.182	0.027
			Alum	.155	.180	0.025
		1% NaOH	FeSO ₄	.155	.176	0.021
			CuSO ₄	.155	.175	0.02
			Alum	.155	.188	0.033

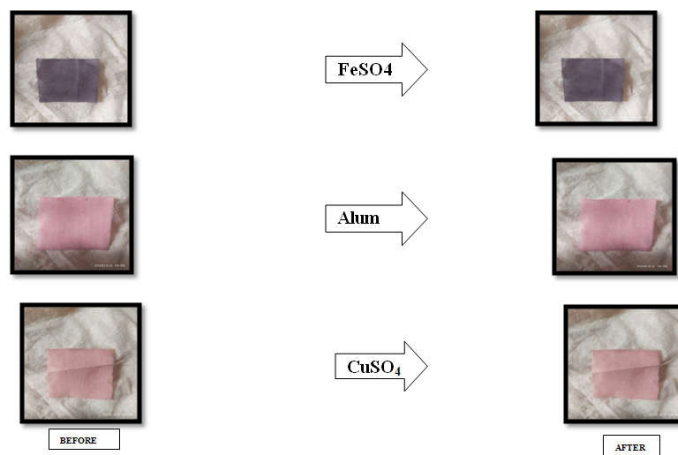


Figure 9: Sunlight test results (Rose dye)

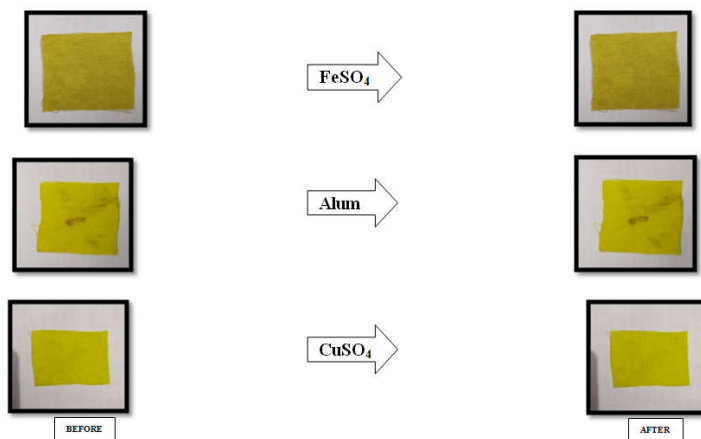


Figure 10: Sunlight test results (Cocktail dye)

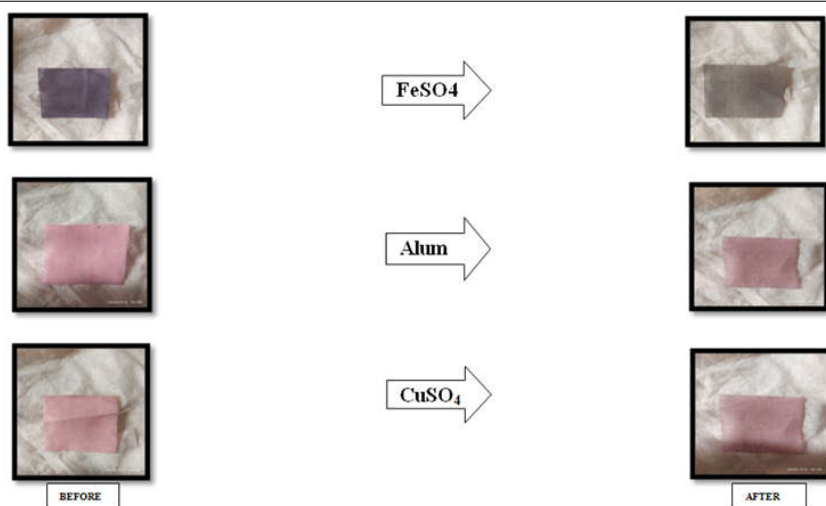


Figure 11. Washing test results (Rose dye)

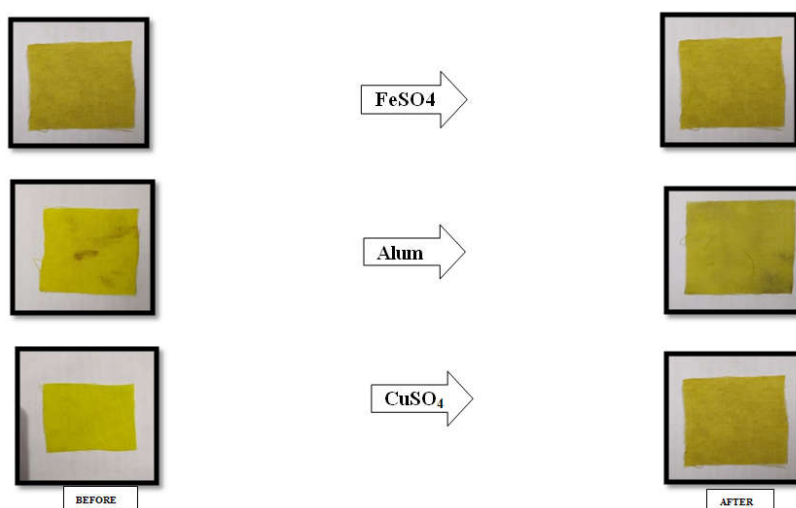


Figure 12: Washing test results (Cocktail dye)

In 1% NaOH turmeric dye gave pale yellow, light yellow and whitish yellow color to the fabric with FeSO_4 , CuSO_4 and Alum respectively (Figure 6). In case of both the dyes, under pre mordanting and simultaneous techniques, results for color on fabrics were almost same but in post mordanting technique color starts to fade and became pale on fabrics.

Weighing results: In case of both the dyes, out of all three techniques, the technique of dyeing and mordanting simultaneously was found to be more effective as the absorption of dyes were greater of all in that technique which is shown in the table 4 and 5.

Testing of cotton clothes results

- Rubbing test: Rubbing test did not affect the dyed fabrics in both the cases. Figure 7 & 8.
- Sunlight test: Dyed cotton clothes were not affected by sunlight at all. Figure 9 & 10.
- Washing test: Washing affected the fabrics in both the cases, as because after washing, the cotton fabrics turned pale. Figure 11 & 12.

CONCLUSION

The present work shows that, colors can be extracted from the flower petals of *Rosa indica* and *Curcuma longa* with *Beta vulgaris* and can be used as a natural dye for cotton fabric. Different colored dyes were obtained in different solvents like distilled water, 1% HCl and 1% NaOH solution. Color fastness property can be obtained by incorporating a mordant such as Alum, CuSO_4 and FeSO_4 in the pre-mordanting, simultaneous and post mordanting techniques as studied. Overall, the Alum and CuSO_4 mordanted fabric gave the best color fastness property without altering the actual color in simultaneous technique. Whereas FeSO_4 mordanted fabrics were found to be dyed with different shades of color with good fastness property. On the basis of weighing of cotton clothes, the maximum absorption of the dyes was found in simultaneous method. In washing, rubbing and daylight test, clothes remained as it is when treated with FeSO_4 and Alum. From all the above experiments, it can be concluded that natural dyes are eco friendly, safe and are easy to get extracted from natural sources, hence can be utilized to color the fabrics naturally.

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