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Utilisation of waste flowers as a potential source of natural dyeing on Bamboo fabric using Natural mordants

Amita Singh[1] and Charu Swami[2]

[2] *Assistant Professor,* [1] *Research Student, Department of Home Science, Dayalbagh Educational Institute, (Deemed University), Agra*

Abstract - The scenario of increasing awareness of environmental ecology, bio – degradability and pollution controls throughout the world, natural dyes and utilization of waste appear to be the emerging choice amongst the populace. However, the sources of natural dye extraction are depleting gradually. As a result there is a need to explore some innovative sources of natural dyeing which are more sustainable and also environment friendly. On these lines, the present research was planned, which was based on the utilization of waste flowers as a potential source of natural dyeing on bamboo fabric using natural mordants. Bamboo fabric is considered to be important eco-friendly fabric for various applications in textile because of its unique properties. Abundance of *Tagetes erecta* and *Rosa centifolia*, used in idol worship forms a temple waste and there is tremendous potential to use this waste as a good source of natural dye. In order to facilitate fully eco-friendly natural dyeing, the possibility of using natural mordants extracted from Amla (*Indian gooseberry*), Harda (*Myrobalan*), Mango bark (*Mangifera Indica*) was investigated. The dyeing of bamboo fabric was carried out using aqueous extracts of these two waste flowers. Consequently different fashion hues were obtained from these dyes extracts using different natural mordants. For colorimetric evaluations, *K/S* values and *CIE L*a*b*, C, H* values were calculated. The effect of natural mordants and three different mordanting techniques was studied. The mordanting process resulted into varied values of colour depth, chroma (C) and hues (H) with significant changes in lightness values (L), and mordant dependent K/S values. Colour fastness properties to light and washing ranged from fair to good, suitable for textile application.

Keywords - Natural dyeing, Natural mordants, Aqueous extraction, Colorimetric evaluation

1. INTRODUCTION

The use of natural dyes and colourants has become an important and essential part of the world's ecological system due to the increased environmental awareness in order to avoid harmful effects synthetic dyes. Natural dyes are considered to be eco-friendly as these are obtained from renewable resources as compared to synthetic dyes which are derived from non-renewable petroleum resources. Most natural dyes are obtained from plants and these dyes are extracted from roots, wood, bark, berries, lichens, leaves, flowers, nuts, and seeds. Other dyes are obtained from insects, shellfish and mineral compounds (Adeel, 2009). However, these are not the sustainable sources, since the exploitation of natural resources to obtain natural dyes may result in de-forestation and threaten endangered species. For these reasons, the efforts are being made to reuse the resources for obtaining the natural dyes. Also, most of the natural dyes are non- substantive and hence mordants are required (Gulrajani, 2001). Mordants are usually derived from metallic salts, but the use of metallic mordants during natural dyeing often puts a question mark on the eco-friendliness of natural dyes. Consequently, wide spread interest has emerged in the dyeing of textile fibres using natural colourants and mordants on account of their better biodegradability and higher compatibility. Natural mordants are free from metals and also known as herbal or bio mordants obtained from fruit peel, leaves, dry seeds, fruit, barks etc. Natural mordants are essential for natural dyes to increase the fastness property and these mordant are free from toxic and carcinogenic substances (Samanta & Agarwal, 2009). The present research aims to fulfill the objective of exploring the feasibility of inclusive eco-friendly dyeing.

Fig:1 Flower wastage

The dyeing material source for the research was flower waste generated from temples, hotels, and various cultural and religious ceremonies.

This portion of community waste is generally neglected and required due consideration.

Hence, the two most commonly available temple flower waste petals , ' *Tagetes erecta'*, commonly known as marigold and ' *Rosa centifolia'* , commonly known as rose, were chosen. The natural dyeing properties were investigated by using natural mordants obtained from natural sources, since chemical mordants are toxic; irritative therefore bio mordants should be used. The natural mordants were extracted from Amla (*Indian gooseberry*), Harda (*Myrobalan*), Mango bark (*Mangifera Indica*) was examined. Additionally the dyeing was carried out on eco-friendly bamboo fabric.

Bamboo is a naturally occurring composite material as it consists of cellulosic fibres. Bamboo fabrics are made of world's fastest growing grass, characterized as eco – friendly & organic. Bamboo fibers have antibacterial, hypo – allergenic and sustainable properties. Bamboo fabric is an excellent organic choice and it has many benefits and advantages in compare to other natural and synthetic fibers. Bamboo is a product which grown without the use of chemicals or pesticide. It quickly absorbs moisture; therefore it keeps dry and odour free. Pure bamboo clothes can be worn for all season because they keep cool in summer and warm in winter. There are many environmental benefits of bamboo clothing. Bamboo plants grows very quickly and do not require fertilisers or pesticides for a successful crop. These plants require very little water and they can survive in drought conditions as well as in flooding. Another benefit of bamboo is that it releases a significant amount of oxygen into the atmosphere, which is more than to other trees. Planting bamboo can help reduce the level of carbon dioxide in the air and also reduces soil erosion (Satindar, 2012).

To summarize, we used flower waste for dyeing along with natural mordants on natural bamboo fabric; thus, effectively completing the eco-friendly cycle.

2. EXPERIMENTAL

2.1Dye material

The samples of waste flowers; *Tagetes erecta & Rosa centifolia,* locally known as Marigold and Rose respectively were collected from various temples and ceremonies in Agra city.

Tagetes erecta belongs to the family of *Asteraceae,* (Sunflower family). It is an ornamental plant belonging to the composite family, has a rich source of natural antioxidant-Lutein, an oxycarotenoid. The main coloring component is quercetagetol, a flavonol along with two of its glycosides and lutein. It dyes wool and silk in deep yellow colors with good fastness properties.

Fig 2: *Tagetes erecta (Marigold)*

Marigold is among the very popular flowers commonly found in India and other countries. They can be easily cultivated, are widely adaptable to varying soils and climatic conditions and have a good flowering duration. This bushy plant with around 20 to 30 species, have a long flowering period and the colours range from orange, yellow, gold, cream to apricot. They are very much used in making garlands and makes excellent beds and pot decorations (Jothi, 2008).

Rosa centifolia belongs to the family of *Rosaceae.* The important chemical constituents present in its flower petals include Phenyl ethanol, Geraniol and citronellol. It is cultivated as an ornamental plant throughout India. It is one of the herbs mentioned in all ancient scriptures of Ayurveda. It has divers' pharmacological used including asthma, hypertension and bronchitis. It is widely cultivated for its fragrance, clear & sweet with light notes of honey.

Fig: 3 *Rosa Centifolia* (Rose)

The plant is shrubby and grows up to 1.5-2 meters in height. Leaves are grayish green in colour, compound, imperipinnate, with 5-7 leaflets. Flowers are varying in colour, usually pink, fragrant, with many petals. They are fleshy hip enclosing small and pendulous seeds. They are round shape, globular with their overlapping petalsm (Jena et. al., 2012).

The present research, thus extends this stream of applications and shows the utilisation of waste flowers of *Tagetes erecta* and *Rosa centifolia* as a natural dye. As compared to the other natural dyes based on vegetable and fruit sources,usage of these in making the natural dye does not result in any wastage of an otherwise commercial product.

2.2 Fabric and mordants

For the present experimental study, 100 % bleached bamboo fabric was used. Bamboo has emerged as one of the eco-friendly fibre in recent times.

The mordants used in the study were Amla *(Phyllanthus emblica)*, Mango bark (*Mangifera indica*), Myrobalan *(Terminalia chebula*). These mordants were applied during pre-mordanting, simultaneous-mordanting and post-mordanting methods.

2.3 Preparation of the fabric

The preparation of the fabric requires removal of added impurities during its processing and production through scouring. Towards this end, the bamboo fabric samples were scoured at 95° C with a solution containing 5 g/l mild detergent for 1 hour. They were then washed, rinsed thoroughly and dried in air to remove the impurities and starch present.

2.4 Dye Extraction

In the present study, the dye was extracted in aqueous medium by boiling in water for dyeing. The petals were seperated from the flowers; buds and other material like threads of garlands were seperated. Petals of *Tagetes erecta* and *Rosa centifolia* were dipped in distilled water for two days. *Rosa centifolia* and *Tagetes erecta*'s flowers petals (100 gms) was dissolved in distilled water (1000 ml.) and soaked for 48 hours. Then, these were grinded to make fine mixture and then boiled in a big pan for extraction for one hour at temperature ranging between 65-70° C. The entire colour was extracted from the soaked and grind petals of *Tagetes erecta* and *Rosa centifolia* by the end of one hour. The solution was filtered and the extract obtained was used for dyeing purpose.

Fig: 4 Aqueous extractions of *Tagetes erecta & Rosa centifolia* flowers

2.5 Mordanting

The treated bamboo fabric selected for the present study was mordanted by three different mordants, namely, Amla *(Phyllanthus emblica)*, Mango bark (*Mangifera indica*), Myrobalan *(Terminalia chebula*). These mordants were applied during pre-mordanting, simultaneous-mordanting and post-mordanting methods.

In case of pre-mordanting method, the mordanting process was carried out before the dyeing of the samples. During simultaneous-mordanting method, the fabrics were dyed in the same bath with dye and mordant put together. In post-mordanting method**,** the fabrics were first dyed and subsequently mordanting was done.

2.6 Dyeing

The bamboo fabric samples were dyed with the dye extract keeping M: L ratio as 1:30. The dye extract was prepared by adding 10 gms of *Tagetes erecta* and *Rosa centifolia* of extracts in 100 ml. of water. The dyeing process was carried out in a dye bath with for 1 hour at temperature ranging from 65°- 90° C. A step wise dyeing of pre-treated, post-treated and simultaneous-mordanted fabrics with three different mordants was carried out for the aqueous dye extracts separately. For fixation of the dyed fabric, the samples were kept in 2% sodium chloride solution at room temperature for 1 hour. The dyed material was washed thoroughly in cold water to remove the extra dye.

2.7 Fastness testing

Colour Fastness can be defined as the resistance of a material to change in any of its colour characteristics, to transfer its colourant to adjacent materials, or both, as a result of the exposure of the material to any environment that might be encountered during the processing, testing, storage or use of the material.
The dyed bamboo fabrics were tested for wash, rub and light fastness. Fastness testing of the dyed samples was carried out according to AATCC (American Association of Textile Chemists and Colorists) standards and methods.

2.8 Colour Measurements

The colour measurements Dyed samples were analyzed by measuring the reflectance curve of both dyed and mordanted samples using Premier Color scan Machine.
The color strength (*K/S* value) was assessed using the following Kubelka – Munk Equation-

$K / S = (1- R)^2 / 2R$ (where R is the decimal fraction of the reflectance of dyed fabric).

The colour coordinates of the dyed samples were also determined based on the CIELab system to investigate color quality. The CIE *L*a*b** values were ascertained for three mordants and three different mordanting conditions.

3. RESULTS AND DISCUSSION

3.1 Optimization of extraction and dyeing conditions

The optimization of extraction and dyeing conditions of *Tagetes erecta & Rosa centifolia* were carried out using their aqueous extracts. Several trials as shown in the Table 1 were carried out on the various parameters for the optimization of the extraction and dyeing conditions. After different combinations and permutations, the best conditions were selected (Swami, 2012).

Parameters for optimization for dyeing samples with *Tagetes erecta & Rosa centifolia flowers*	**Experimental/ trial settings**	**Selected**
1. Mass to liquor ratio	100, 200, 500ml.	**10gm/100 ml.**
2. Material to liquor ratio	1:20, 1:30, 1:40, 1:50	**1:40**
3. Dye extraction time	1, 1.5, 2 hours	**1 hours**
4. Dye extraction temperature	60, 70, 80 ° C	**70° C**
5. Dyeing time	0.5, 1, 2, hours	**1 hours**
6. Dyeing temperature	60, 65- 70 , 80, 90 ° C	**80° C**
7. Mordanting time	30, 45, 60, 90 minutes	**60 min.**

3.2 Shades obtained from dyeing with waste flowers of Tagetes erecta* and *Rosa centifolia

After dyeing the bamboo fabric under selected experimental setting, different shades were obtained on bamboo fabric using different mordants and mordanting conditions.
The shade obatined through *Tagetes erecta* waste petals under controlled conditions i.e without using mordants was yellow. Varied hues were obtained from pre, simultaneous and post-mordanted bamboo fabrics with amla, mango bark myrobalan as natural mordants.

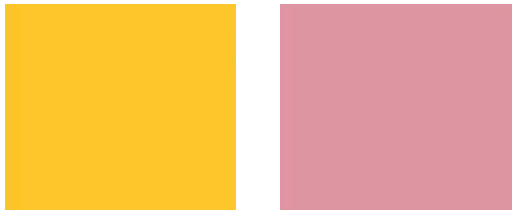

Fig: 5 Shades from *Tagetes erecta and Rosa centifolia* without mordants

The shades achieved varied from light brown to dark brown with variations of browns and mustards reflecting a tinge of yellowness.
Whereas, the shades obtained from waste petals of *Rosa centifolia* without mordant was pink. With mordants the shades obtained varied from brownish pink, lavender purple to grey and brown tints.

The different shades obtained on bamboo fabric by *Tagetes erecta* with three different mordants using three mordanting techniques as obtained on Premier Colour Scan Spectrophotometer, are shown as in Figure 6 (a), (b) and (c).

The different shades obtained on bamboo fabric by *Rosa Centifolia* with three different mordants using three mordanting techniques as obtained on Premier Colour Scan Spectrophotometer, are shown as in Figure 7 (a), (b) and (c).

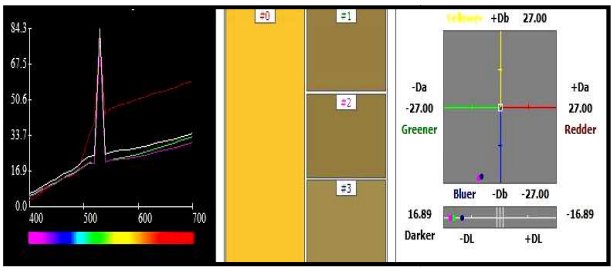

Fig: 6 (a) Colourimetric values of Pre mordanting bamboo fabric with (1) Amla (2) Mango bark (3) Myrobalan using *Tagetes erecta* aqueous extract

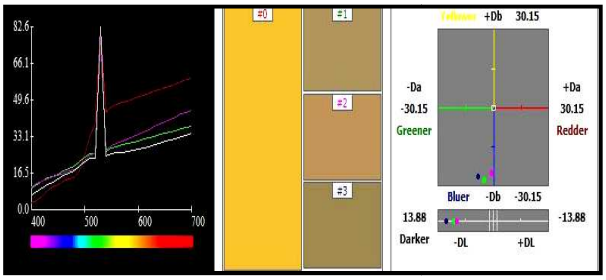

Fig: 6 (b) Colourimetric values of Simulataneous mordanted bamboo fabric with (1) Amla (2) Mango bark (3) Myrobalan using *Tagetes erecta* aqueous extract

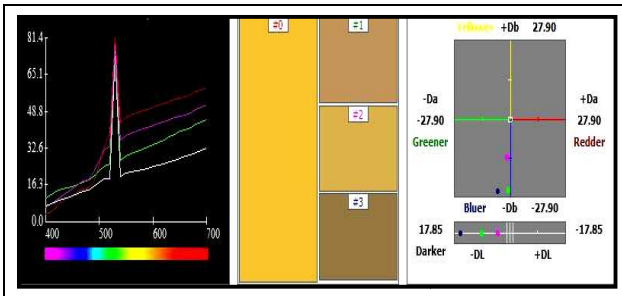

Fig: 6 (c) Colourimetric values of Post mordanted bamboo fabric with (1) Amla (2) Mango bark (3) Myrobalan using *Tagetes erecta* aqueous extract

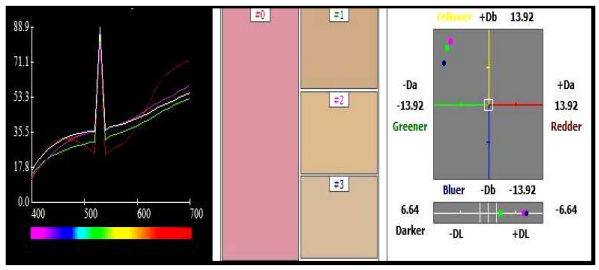

Fig: 7 (a) Colourimetric values of Pre mordanted bamboo fabric with (1) Amla (2) Mango bark (3) Myrobalan using *Rosa Centifolia* aqueous extract

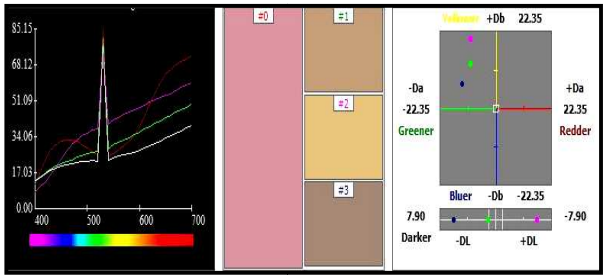

Fig: 7 (b) Colourimetric values of Simultaneous mordanted bamboo fabric with (1) Amla (2) Mango bark (3) Myrobalan using *Rosa Centifolia* aqueous extract

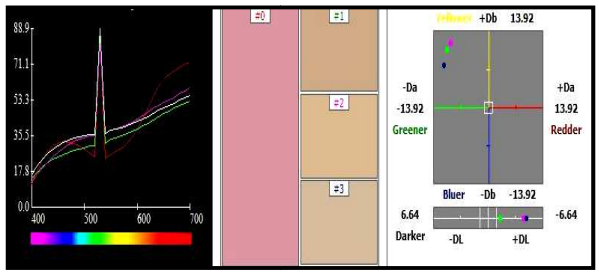

Fig: 7 (c) Colourimetric values of Post mordanted bamboo fabric with (1) Amla (2) Mango bark (3) Myrobalan using *Rosa Centifolia* aqueous extract

The above figure 6 shows that the maximum colourmetric values fall within the - *Da* and - *Db* sections. This indicates the yellowness and brown hue of the shades obtained with *Tagetes erecta* aqueous extract. Whereas figure 7 shows the maximum values fall between - *Da* and + *Db* sections showing the red tinge in the shades obtaines with *Rosa Centifolia* aqueous extract. However, the shades and tones obtained through simultaneous mordanting, were more intense and varied as compared to the other two methods with both the extracts.

3.3 Measurement of K/S values and color hue changes

Different natural mordants (Amla, Mango bark and Myrobalan) were used. The change in *K/S* value shows the reaction of the mordant and the dye extract on the fabric. This also varies with the type and chemical constitutents of the mordant applied. The change in the *K/S* and *L* a* b** values with different mordants is shown below in Table 2.

The above Tables 3 & 4 shows that simultaneous mordanting showed good results on dyeing of bamboo fabric with aqueous extract of waste *Tagetes erecta* and *Rosa Centifolia* using three mordants. This method also indicated high K/S values in comparison with other mordanting methods. Similar results were obtained by (Teli 2013), on dyeing of soya bean protein fabric using waste flowers from temples.

3.4 Fastness of the dyed samples

The dyed samples were further tested for the wash fastness. The grey scale rating was done on a scale from 1 to 5. Good wash fastness was achieved in case of both the dye extracts of *Tagetes erecta* and *Rosa Centifolia.* The acceptable fastness limits set by the AATCC standards are between 3-4 for wash fastness, 3-4 for dry rubbing, 2-3 for wet rubbing and 2-3 for light fastness (Vankar, 2009). The table shows an increase in the fastness properties with the use of mordants. Significant improvement could be noticed in the case of washing and dry rubbing fastness.

Table 4 & 5 shows that in case of dyeing with waste flowers of *Tagetes erecta* and *Rosa Centifolia* using different mordants, good wash, rub and light fastness were obtained during pre, post and simultaneous methods Dry fastness was better than to wet fastness in all three methods of mordanting. Amla as a mordant showed good results in all three mordanting methods compared than to myrobalan and mango bark. Post mordanting method in general showed beer fastness properties on bamboo fabrics dyed with *Tagetes erecta* and *Rosa Centifolia.*

Pre-mordanting	**K/S**	**L***	**a***	**b***	**C***	**H***
Control	16.17	72.88	-5.09	54.39	54.63	95.38
Amla	12.70	57.99	-15.31	29.40	33.14	117.53
Mango Bark	7.23	61.45	-14.09	29.80	32.97	115.32
Myrobalan	9.70	58.93	-14.75	29.91	33.35	116.28
Simultaneous-mordanting	**K/S**	**L***	**a***	**b***	**C***	**H***
Control	16.17	62.88	-5.09	54.39	54.63	95.38
Amla	15.47	38.93	-14.75	29.91	33.35	116.28
Mango Bark	14.23	41.45	-14.09	29.80	32.97	115.32
Myrobalan	11.23	37.99	-15.31	29.40	33.14	117.53
Post-mordanting	**K/S**	**L***	**a***	**b***	**C***	**H***
Control	16.17	72.88	-5.09	54.39	54.63	95.38
Amla	8.47	48.93	-7.75	29.91	29.09	110.42
Mango Bark	7.23	51.45	-7.09	38.80	22.97	95.77
Myrobalan	6.23	47.999	-11.31	28.46	28.04	101.22

Table 2: L a* b* C* H* values for pre, simultaneous and post-mordanted bamboo fabric dyed with Tagetes erecta*

Pre-mordanting	**K/S**	**L***	**a***	**b***	**C***	**H***
Control	9.33	66.78	5.426	8.752	10.298	58.179
Amla	13.33	71.42	-6.04	16.585	17.625	110.051
Mango Bark	12.99	71.10	-4.34	0.673	21.125	101.909
Myrobalan	13.66	68.23	-5.16	19.427	20.102	104.924
Simultaneous-mordanting	**K/S**	**L***	**a***	**b***	**C***	**H***
Control	9.33	76.58	5.42	8.75	10.29	58.17
Amla	14.33	74.79	-5.45	15.02	15.98	110.00
Mango Bark	13.82	75.90	-5.41	22.03	22.69	103.82
Myrobalan	15.56	77.50	-3.02	19.55	19.79	98.81
Post-mordanting	**K/S**	**L***	**a***	**b***	**C***	**H***
Control	3.33	66.78	5.42	8.75	10.29	58.17
Amla	11.99	60.88	-8.30	15.90	17.94	117.58
Mango Bark	9.38	72.64	-4.97	29.10	29.52	109.72
Myrobalan	10.99	65.75	-4.95	21.76	22.32	102.86

Table 3: L a* b* C* H* values for pre, simultaneous and post-mordanted bamboo fabric dyed with Rosa Centifolia*

FASTNESS PROPERTIES				
Tagetes erecta	**Wash**	**Dry Rubbing**	**Wet Rubbing**	**Light**
Un- mordanted	4	3.5	3	4.5
PRE-MORDANTING	**Wash**	**Dry Rubbing**	**Wet Rubbing**	**Light**
Amla	4.5	4.5	3.5	4
Mango bark	4	3	3	3
Myrobalan	4	4	3	3.5
SIMULTANEOUS MORDANTING	**Wash**	**Dry Rubbing**	**Wet Rubbing**	**Light**
Amla	4	4	4	3.5
Mango bark	3.5	3.5	3	4.5
Myrobalan	4.5	4	3	4
POST-MORDANTING	**Wash**	**Dry Rubbing**	**Wet Rubbing**	**Light**
Amla	4.5	4	4	4.5
Mango bark	4	3	3.5	4.5
Myrobalan	4.5	3.5	3.5	4

Table 4: Fastness properties of bamboo dyed with aqueous extract of Tagetes erecta

FASTNESS PROPERTIES				
Rosa Centifolia	**Wash**	**Dry Rubbing**	**Wet Rubbing**	**Light**
Un- mordanted	4	3.5	3	4.5
PRE-MORDANTING	**Wash**	**Dry Rubbing**	**Wet Rubbing**	**Light**
Amla	4.5	4.5	3.5	4
Mango bark	4	3	3	3
Myrobalan	4	4	4	3.5
SIMULTANEOUS MORDANTING	**Wash**	**Dry Rubbing**	**Wet Rubbing**	**Light**
Amla	4	4	4	3.5
Mango bark	3.5	3.5	3	4.5
Myrobalan	4.5	4	3	4
POST-MORDANTING	**Wash**	**Dry Rubbing**	**Wet Rubbing**	**Light**
Amla	4.5	4	4	4.5
Mango bark	4	3.5	3.5	4.5
Myrobalan	4.5	3.5	4	4

Table 5: Fastness properties of bamboo dyed with aqueous extract of Rosa Centifolia

4. CONCLUSIONS

Natural dyes are an important dyeing method and have a long history. The use of natural dye is "2E" friendly which means economic and environmental. The large amounts of chemical dyes have been used by all over the world but environmental activists are supportive of using natural dyes and substances which can be reused or recycled as they are seen to be exploiting renewable resources, causing minimum pollution and having less risk to human health. Hence, this study of reusing the waste flowers of *Tagetes erecta* and *Rosa Centifolia* for dyeing of bamboo fabric using natural mordants like amla, mango bark and myrobalan shows potential source of natural dye. The use of waste flowers will help to reduce environmental pollution and will provide an eco-friendly product. The use of different natural mordant can help produce more colour range with diverse colour range. The different natural mordants used not only changed the hue color and significant changes in *K/S* values. The post-mordanting method gave the best shades and fastness properties. The wash fastness was found to vary from good to excellent. Thus, usage of waste flowers as dye source, with natural mordants on bamboo fabric will contribute significantly in making possible a green environment.

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