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# APPLICATION OF ECO-FRIENDLY FLORAL DYES ALONG WITH MORDANTS AND DYE ASSISTANTS ON DRY FLOWER

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**ABSTRACT**

Dye extraction was performed using fifteen floral sources: *Beta vulgaris, Bixa orellana, Bougainvillea* spp., *Capsicum annuum, Carthamus tinctorius, Celosia argentea, Cosmos bipinnatus, Curcuma longa, Euphorbia pulcherrima, Lilium hybrids, Peltophorum pterocarpum, Punica granatum, Rosa hybrida, Tagetes erecta* and *Woodfordia fruticosa*. Two solvents, water and acetone, were used for dye extraction, combined with two mordants, alum and ferric chloride. Additionally, three dye assistants' sodium chloride, acetic acid, and hydrochloric acid were employed. The effectiveness of these combinations on dye absorption was assessed using *Lagurus ovatus* grass. Among all the sources, marigold, rose, and turmeric exhibited the highest overall acceptability scores for biocolours in combination of colour and shape retention properties.

***Key words :*** Dye, Dye assistants, Extraction, Mordants, Overall acceptability.

## Introduction

The process of natural dyeing is followed since ancient times. Nowadays due to the use of various chemical dyes we almost have lost the touch of natural dye yielding plants. Due to increased environmental awareness people are slowly shifting towards the use of natural dyes obtained from plant sources. During past few years synthetic dye was being used by some important industries like textile, food processing, pharmaceutical, dry flowers etc. Synthetic dyes are easily available and are manufactured from petrochemical based intermediates but cause air and environmental pollution. Synthetic dyes produce certain chemicals that are harmful for both human as well as environment. With the advent of growing global environmental awareness, the use of natural plant bio-colour has increased (Bharati *et al.*, 2017; Samantha *et al.*, 2009 and Kashyap *et al.*, 2017). Because of consumer awareness, interest in natural dyes has grown rapidly (Singh and Srivastava, 2015). Bio-colours are in demand due to their several benefits over synthetic colours. They are renewable, easily available, biodegradable, economical, non-carcinogenic, non- toxic and sustainable. Shades produced by natural dyes are lustrous, soft and soothing to human eye (Ramprasath *et al.*, 2017). Dyeing with natural dyes produce poor colour and have inadequate fastness properties, hence certain mordants are being used to overcome this problem (Baishya *et al.*, 2012). Natural dyes need an element to create a bond between the dye and the substrate called mordant. Dyes are substantive and fugitive and need a mordant for fixing the colour and enhancing their fastness properties, thereby preventing colour fading with exposure to light or washing. To enhance the colour pre and simultaneous post mordanting techniques of dyeing are used. Many horticultural dye yielding plants have immense utilization for value addition. Meagre attention has been paid towards these plants and still remain unexplored but these are excellent dye sources which find application in pharmaceuticals, textiles and other allied industries. There is a need to understand the potential of the less known flowers that have dye yielding potential. Novel research techniques must be carried out in order to get through the vast knowledge and potential of the less known dye yielding plant sources.

## Materials and Methods

### Experimental location

The present investigation was conducted in the Department of Floriculture and Landscape Architecture Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during May 2019-2020. The research farm is located at an elevation of 1275 m above mean sea level. The geographical coordinates of this site lie as: latitude $30.8600^0$ N and longitude $77.1730^0$ E, which furthermore falls under mid hill agro-climatic zone of Himachal Pradesh.

### Plant material

Fifteen different plant species were used for dye extraction *viz.*; $D_1$: *Beta vulgaris* L. (Beetroot), $D_2$: *Bixa orellana* L. (Bixa) $D_3$: *Bougainvillea* spp (Bougainvillea), $D_4$: *Capsicum annuum* L. (Capsicum), $D_5$: *Carthamus tinctorius* L. (Carthamus), $D_6$: *Celosia argentea* L. (Celosia), $D_7$: *Cosmos bipinnatus* C. (Cosmos), $D_8$: *Curcuma longa* L. (Turmeric), $D_9$: *Euphorbia pulcherrima* (Willd. ex Klotzsch) (Poinsettia), $D_{10}$: *Lilium* hybrids (Hybrid lily), $D_{11}$: *Peltophorum pterocarpum*, $D_{12}$: *Punica granatum* L.(*cv*.Nana) (Punica), $D_{13}$: *Rosa hybrida* L. (Rose), $D_{14}$: *Tagetes erecta* L. (Marigold), $D_{15}$: *Woodfordia fruticosa* L. (Kurz) (Woodfordia) along with two extraction methods using solvents (water and acetone), three dye assistants ($B_1$: Sodium chloride, $B_2$: Acetic acid, $B_3$: Hydrochloric acid) and two mordants (aluminium sulphate and ferric chloride) were used.

### Experimental details

Plant samples were weighed using electronic balance. 50 g of the plant part was immersed in 500 ml acetone solution and kept overnight. Secondly plant samples were weighed and then were allowed to boil in 1000 ml distilled water for about one hour at $40^0$ C optimum temperature and the solution was strained to remove residues. Two mordants aluminium sulphate and ferric chloride were used. 2 g sample of each mordant was dissolved in 200 ml of distilled water was taken and was added separately. *Lagurus ovatus* bunches were individually dipped in the prepared mordant solution. Pre mordanting technique was followed in which prior to dyeing the grass samples were dipped in mordant solutions for 15 minutes. Three different dye assistants namely sodium chloride, acetic acid and hydrochloric acid were used. In the extracted dye 1 ml of hydrochloric acid and acetic acid each were added in 20 ml of dye solution separately. 2 g of salt i.e. sodium chloride was added in 20 ml dye solution. These dye assistants were mixed properly. *Lagurus ovatus* bunches were allowed to dip for 30-60 seconds until complete colour was absorbed and air dried by vertically hanging them down a hanger for 1-2 days. The observations were recorded for colour retention, shape retention and overall acceptability parameters.

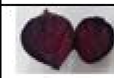
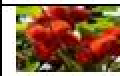
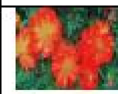
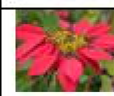
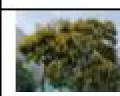
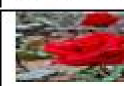
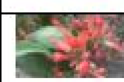
### Statistical analysis

The data recorded was analyzed using MS-excel and OPSTAT as per the design of experiment completely randomized design (CRD) (Sheoran *et al.*, 1998). The mean values of data were subjected to analysis of variance as described by Gomez and Gomez (1984) for using Completely Randomized Design (three-way factorial).

## Results and Discussion

Different shades of colour were obtained by extracting dye and recorded using R.H.S (Royal Horticultural Society) colour chart. Data in Table 1 elucidates the effects of various mordants and dye assistants after extraction of biocolour and dyeing on Lagurus grass. In general; alum produced brighter shades (pinkish red) in dye obtained from rose, celosia, bougainvillea, woodfordia and beetroot as compared to ferric chloride which produced dull shades of colour. Whereas, colour extracted from poinsettia and punica produced darker shade (blackish blue) with ferric chloride as a mordant and dull shades with alum. In general; in all the dye sources; brighter colour shades were produced with hydrochloric acid as a dye assistant. Orange colour dye obtained from bixa and capsicum produced brighter shades (orange). In bixa dull shades (dull green) of colour with ferric choride and vice versa with capsicum were obtained. All the three dye assistants helped in producing brighter colour shades with capsicum and hydrochloric acid in bixa. Yellow colour dye obtained from carthamus, cosmos, turmeric, lilium pollens and marigold produced darker shades (bright yellow) with alum as a mordant and caused dulling with ferric chloride (dull green colour). Whereas; in peltophorum ferric chloride produced darker shades whereas, alum produced dull shades of colour. In these, sodium chloride or acetic acid produced darker colour shades. In all the bio-colours different shades of colour have been produced when dyeing was done with the help of mordants. Yellow colour dye obtained from carthamus, cosmos, turmeric, lilium pollens and marigold produced darker shades (bright yellow) with alum as a

**Table 1 :** Description of plant material (dye sources) used for extracting bio- colour.

| S. No. | Botanical Name | Plant part used | Image |
|---|---|---|---|
| 1) | *Beta vulgaris* L. | Roots |  |
| 2) | *Bixa orellana* L. | The waxy arils covering its seeds |  |
| 3) | *Bougainvillea* spp | Bracts |  |
| 4) | *Capsicum annuum* L. | Fruit |  |
| 5) | *Carthamus tinctorius* L. | Flower petals |  |
| 6) | *Celosia argentea* L. | Flower petals |  |
| 7) | *Cosmos bipinnatus* C. | Flower petals |  |
| 8) | *Curcuma longa* L. | Rhizomes |  |
| 9) | *Euphorbia pulcherrima* | Red coloured bracts |  |
| 10) | *Lilium* hybrids | Pollens |  |
| 11) | *Peltophorum pterocarpum* | Flower petals |  |
| 13) | *Rosa hybrida* L. | Red coloured flower petals |  |
| 14) | *Tagetes erecta* L. | Flower petals |  |
| 15) | *Woodfordia fruticosa* L.(Kurz) | Flowers |  |

mordant and caused dulling with ferric chloride (dull green colour). Whereas; in peltophorum ferric chloride produced darker shades whereas, alum produced dull shades of colour. In these, sodium chloride or acetic acid produced darker colour shades. In all the bio-colours different shades of colour have been produced when dyeing was done with the help of mordants. Mordant is a substance used to fix the dye to the substrate which helps to intensify

**Table 2 :** Colour of different dye sources absorbed on *Lagurus ovatus* after addition of various mordants and dye assistants.

| S. no. | $D_s$ | B | Name of mordants | | | |
|---|---|---|---|---|---|---|
| | | | **Aluminium sulphate** | | **Ferrous chloride** | |
| | | | **Water** | **Acetone** | **Water** | **Acetone** |
| 1. | $D_1$ | $B_1$ | 64(A) Red Purple Group | 58(A) Red Purple Group | 61(A) Greyed Brown Group | 199(A) Greyed Brown Group |
| | | $B_2$ | 58(A) Red Purple Group | 58(A) Red Purple Group | 177(A)Greyed Orange Group | 64(A) Red Purple group |
| | | $B_3$ | 79(A) Red Purple Group | 70(A) Red Purple Group | 176(C)Greyed Orange Group | 177(D) Greyed Orange Group |
| 2. | $D_2$ | $B_1$ | 165(B) Greyed Orange Group | 170(A) Greyed Orange Group | 147(A) Yellow Green Group | 164(A) Greyed Orange Group |
| | | $B_2$ | 164(C) Greyed Orange Group | 168(B) Greyed Orange Group | 147(A) Yellow Green Group | 164(A) Greyed-Orange Group |
| | | $B_3$ | 164(B) Greyed Orange Group | 168(C) Greyed Orange Group | 167(A) Greyed Orange Group | 164(A) Greyed Orange Group |
| 3 | $D_3$ | $B_1$ | 162(A) Greyed Yellow Group | 48 (B) Red Group | 162(A) Greyed Yellow Group | 147(A) Yellow Green Group |
| | | $B_2$ | 162(C) Greyed Yellow Group | 51(A) Red Group | 162(C) Greyed Yellow Group | 147(A) Yellow Green Group |
| | | $B_3$ | 162(A) Greyed Yellow Group | 48 (A) Red Group | 162(A) Greyed Yellow Group | 147(A) Yellow Green Group |
| 4 | $D_4$ | $B_1$ | 167(B) Greyed Orange Group | 170(C) Greyed-Orange Group | 167(A) Greyed Orange Group | 166(B) Greyed Orange Group |
| | | $B_2$ | 167(B) Greyed Orange Group | 170(B) Greyed-Orange Group | 167(A) Greyed Orange Group | 166(B) Greyed Orange Group |
| | | $B_3$ | 167(B) Greyed Orange Group | 170(C) Greyed Orange Group | 164(A) Grey Orange Group | 164(A) Greyed Orange Group |
| 5 | $D_5$ | $B_1$ | 163(A) Greyed Orange Group | 20(B) Yellow Orange Group | 148(A) Yellow Green Group | 199(A) Greyed Brown Group |
| | | $B_2$ | 163(B) Greyed Orange Group | 162(A)Greyed Yellow Group | 148(A) Yellow Green Group | 199(A) Greyed Brown Group |
| | | $B_3$ | 163(B) Greyed Orange Group | 152(B)Yellow Green Group | 148(A) Yellow Green Group | 199(A) Greyed Brown Group |
| 6 | $D_6$ | $B_1$ | 182(B) Greyed Red Group | - | 148(A) Yellow Green Group | - |
| | | $B_2$ | 182(C) Greyed Red Group | - | 148(A) Yellow Green Group | - |
| | | $B_3$ | 182(B) Greyed Red Group | - | 148(A) Yellow Green Group | - |
| 7 | $D_7$ | $B_1$ | 165(B) Greyed-Orange Group | 21(A)Yellow Orange Group | 147(A) Yellow Green Group | 199(A) Greyed Brown Group |
| | | $B_2$ | 20 (A)Yellow Orange Group | 17(A)Yellow Orange Group | 147(A) Yellow Green Group | 199(A) Greyed Brown Group |
| | | $B_3$ | 163(B) Greyed Orange Group | 13(A)Yellow Group | 164(B)Greyed Orange Group | 199(A) Greyed Brown Group |
| 8 | $D_8$ | $B_1$ | 17(A) Yellow Orange Group | 23(A)Yellow Orange Group | 166(B)Greyed Orange Group | 165(A) Greyed Brown Group |
| | | $B_2$ | 17(B) Yellow Orange Group | 23(A)Yellow Orange Group | 166(B) Greyed Orange Group | 165(A) Greyed Brown Group |
| | | $B_3$ | 163(B) Greyed-Orange Group | 23(A) Greyed Orange Group | 164(A)Greyed-Orange Group | 165(A) Greyed Brown Group |

***Table 2 continued...***

*Table 2 continued...*

| S. no. | $D_S$ | B | Name of mordants | | | |
|---|---|---|---|---|---|---|
| | | | Aluminium sulphate | | Ferrous chloride | |
| | | | Water | Acetone | Water | Acetone |
| 9 | $D_9$ | $B_1$ | 48 (B) Red Group | 37(B) Red Group | 187(A) Greyed Purple Group | 38(A) Red Group |
| | | $B_2$ | 51(A) Red Group | 37(A) Red Group | 187(A) Greyed Purple Group | 197(A) Grey Green Group |
| | | $B_3$ | 48 (A) Red Group | 39(B) Red Group | 51(A) Red Group | 38(A) Red Group |
| 10 | $D_{10}$ | $B_1$ | 152(A) Yellow Orange Group | 23(A)Yellow Group | 152(A) Yellow Green Group | 161(A) Greyed Yellow Group |
| | | $B_2$ | 21(B) Yellow Orange Group | 24(A)Yellow Group | 152(B) Yellow Green Group | 163(B) Greyed Yellow Group |
| | | $B_3$ | 33(A) Orange Red Group | 153(A)Yellow Group | 33(B) Orange Red Group | 148(A) Yellow Green Group |
| 11 | $D_{11}$ | $B_1$ | - | 153(A)Yellow Green Group | - | 152(A) Yellow Green Group |
| | | $B_2$ | - | 152(B)Yellow-Green Group | - | 152(A) Yellow Green Group |
| | | $B_3$ | - | 153(C)Yellow-Green Group | - | 152(A) Yellow Green Group |
| 12 | $D_{12}$ | $B_1$ | 164(A) Greyed Orange Group | 33(A) Red Group | 202(A) Black Group | 202(A) Black Group |
| | | $B_2$ | 199(A) Greyed Orange Group | 41(A) Red Group | 202(A) Black Group | 202(A) Black Group |
| | | $B_3$ | 165(B) Greyed Orange Group | 46(A) Red Group | 202(A) Black Group | 202(A) Black Group |
| 13 | $D_{13}$ | $B_1$ | 64(A) Red Purple Group | 53(C) Red Group | 59(A) Red Purple Group | 59(C) Red Purple Group |
| | | $B_2$ | 60(C) Red Purple Group | 53(C) Red Group | 59(A) Red Purple Group | 59(C) Red Purple Group |
| | | $B_3$ | 63 (A) Red Purple Group | 53(C) Red Group | 52(B) Red Purple Group | 53(C) Red Purple Group |
| 14 | $D_{14}$ | $B_1$ | 12(B) Yellow Group | 17(A)Yellow Orange Group | 147(A)Yellow Green Group | 152(A)Yellow Green Group |
| | | $B_2$ | 8(A) Yellow Orange Group | 13(A)Yellow Orange Group | 152(B) Yellow Green Group | 148(A)Yellow Green Group |
| | | $B_3$ | 5(A) Yellow Orange Group | 13(B)Yellow Orange Group | 152(C) Yellow Green Group | 153(A) Yellow Green Group |
| 15 | $D_{15}$ | $B_1$ | 176(C) Greyed-Orange Group | - | 200(A) Brown Group | - |
| | | $B_2$ | 176(B) Greyed-Orange Group | - | 200(A) Brown Group | - |
| | | $B_3$ | 166(B) Greyed-Orange Group | - | 200(A) Brown Group | - |

$D_1$: *Beta vulgaris* L. (Beetroot), $D_2$: *Bixa orellana* L. (Bixa) $D_3$: *Bougainvillea spp* (Bougainvillea), $D_4$: *Capsicum annuum* L. (Capsicum), $D_5$: *Carthamus tinctorius* L. (Carthamus), $D_6$: *Celosia argentea* L. (Celosia), $D_7$: *Cosmos bipinnatus* C. (Cosmos), $D_8$: *Curcuma longa* L. (Turmeric), $D_9$: *Euphorbia pulcherrima* Willd. ex Klotzsch (Poinsettia), $D_{10}$: *Lilium* hybrids (Hybrid lily), $D_{11}$: *Peltophorum pterocarpum* $D_{12}$. (Peltophorum), $D_{12}$: *Punica granatum* L. (*cv*.Nana) (Punica), $D_{13}$: *Rosa hybrida* L. (Rose), $D_{14}$: *Tagetes erecta* L. (Marigold), $D_{15}$: *Woodfordia fruticosa* L. (Kurz) (Woodfordia); $B_1$: Sodium chloride, $B_2$: Acetic acid, $B_3$: Hydrochloric acid.

**Table 3 :** Scoring for colour, shape and overall acceptability.

| Colour | Score(5) | Shape Retention | Score(5) | Overall Acceptability | Score(5) |
|---|---|---|---|---|---|
| Excellent | 5 | Excellent | 5 | Excellent | 5 |
| Very good | 4 | Very good | 4 | Very good | 4 |
| Good | 3 | Good | 3 | Good | 3 |
| Poor | 2 | Poor | 2 | Poor | 2 |
| Very poor | 1 | Very poor | 1 | Very poor | 1 |

**Table 4 :** Effect of mordant (A), dye assistants (B) and method of extraction (C) on scoring for overall acceptability in *Lagurus ovatus* after dyeing with Marigold (Score out of 5).

| | $A_1$ | | | $CxA_1$ | $A_2$ | | | $CxA_2$ | CxB | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | | $B_1$ | $B_2$ | $B_3$ | | $B_1$ | $B_2$ | $B_3$ | |
| $C_1$ | 3.30 | 3.30 | 3.20 | 3.26 | 4.90 | 4.90 | 4.20 | 4.60 | 4.10 | 4.10 | 3.70 | **3.96** |
| $C_2$ | 1.70 | 1.60 | 1.60 | 1.63 | 3.00 | 3.00 | 2.70 | 2.90 | 2.35 | 2.30 | 2.15 | **2.26** |
| **AxB** | 2.50 | 2.45 | 2.40 | **2.45** | 3.95 | 3.95 | 3.45 | **3.78** | **3.22** | **3.20** | **2.92** | |

**$CD_{0.05}$** Extraction methods (A) :0.06; Dye Assistants(B): 0.08; Mordants (C): 0.06; Extraction methods x Dye Assistants: 0.11; Extraction methods x Mordants: NS; Dye Assistants x Mordants: 0.11; Extraction methods x Dye Assistants x Mordants: NS

**Table 5 :** Effect of mordant (A), dye assistants (B) and method of extraction (C) on scoring of overall acceptability in *Lagurus ovatus* after dyeing with Rose (Score out of 5).

| | $A_1$ | | | $CxA_1$ | $A_2$ | | | $CxA_2$ | CxB | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | | $B_1$ | $B_2$ | $B_3$ | | $B_1$ | $B_2$ | $B_3$ | |
| $C_1$ | 3.50 | 3.90 | 4.00 | 3.80 | 4.70 | 4.60 | 4.70 | 4.66 | 4.10 | 4.25 | 4.35 | **4.23** |
| $C_2$ | 3.90 | 3.90 | 3.80 | 3.86 | 4.40 | 4.40 | 4.30 | 4.36 | 4.15 | 4.15 | 4.05 | **4.11** |
| **AxB** | 3.70 | 3.90 | 3.90 | **3.83** | 4.55 | 4.50 | 4.50 | **4.51** | **4.12** | **4.20** | **4.20** | |

**$CD_{0.05}$** Extraction methods (A): 0.06; Dye Assistants(B): NS; Mordants (C): 0.06; Extraction methods x Dye Assistants: 0.11; Extraction methods x Mordants: 0.06; Dye Assistants x Mordants: 0.11; Extraction methods x Dye Assistants x Mordants: 0.16

or bring dullness in colour shades.

Similar results have earlier been reported by Karim *et al*. (2019) and Jothi (2008) during their studies where mordant alum gave golden colour to silk while bright yellow colour was retained on cotton cloth using marigold biocolour. Whereas, with the use of ferrous sulphate the dull brown coloured shade was obtained for cotton cloth while silk gave black colour. Similar results have also been reported by Arora *et al*. (2017), who opined that the colour fastness properties of the dyed fabric are dependent not only on the dye but are also determined by the concentration and type of mordants used. Common mordants alum brightened the colour slightly. Whereas, iron or copper saddens or darken the colours, bringing out green shades. Various kinds of shades like black to brown and green to yellow and orange can be obtained by application of varied mordants; as in case of our study.

Different scores were observed for overall acceptability on the basis of colour and shape retention one day prior to dyeing as per the score card followed after Sharma (2015). A scale was developed as evident in Table 2 where maximum score of 5 points were allocated for this parameter whereas 1 point as minimum. Table 4 shows that maximum score for overall acceptability was obtained when extraction was done in acetone with sodium chloride or acetic acid as a dye assistant (3.95). Minimum score for overall acceptability was obtained when extraction was done in water using hydrochloric acid as a dye assistant (2.40). Maximum score (4.10) was obtained when either sodium chloride or acetic acid were used as dye assistant with alum as mordant. Whereas minimum score (2.15) was obtained with hydrochloric acid as dye assistant when ferric chloride was used as a mordant. Interaction amoung extraction method, dye assistants and mordant were found to be non-significant. The results are in accordance with the findings of Chavan and Ghosh (2015) in which during extraction of colour from marigold with water; and alum with ferrous sulphate were used as mordants. Different shades of colour i.e. brown with alum and black with


**Fig. 1 :** Effect of extraction methods, mordants and dye assistants from dye of beetroot, bixa, bougainvillea, capsicum and carthamus absorbed on dry flower *Lagurus ovatus*.

ferrous suphate were obtained. Similar results have earlier been reported by Jothi (2008) and Chavan and Ghosh (2015) during their studies where mordant alum gave golden colour to silk while bright yellow colour was retained on cotton cloth using marigold bio-colour. Whereas, with the use of ferrous sulphate the dull brown


**Fig. 2 :** Effect of extraction methods, mordants and dye assistants from dye of celosia, cosmos, turmeric, poinsettia and lilium absorbed on dry flower *Lagurus ovatus*.

coloured shade was obtained for cotton cloth while silk gave black colour.

Maximum score (4.70) for overall acceptability in *Lagurus ovatus* after dyeing with rose was obtained when extraction was done in acetone using alum as a mordant with either sodium chloride or hydrochloric acid as dye assistants. Table 5 depicts that minimum score was obtained in extraction with water when alum was used as a mordant and sodium chloride as dye assistant (3.50). The results are in accordance with the results of

**Table 6 :** Effect of method of extraction (A), dye assistants (B) and mordant (C) on scoring for overall acceptability in *Lagurus ovatus* after dyeing with Turmeric (Score out of 5).

| | $A_1$ | | | $CxA_1$ | $A_2$ | | | $CxA_2$ | CxB | | | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $B_1$ | $B_2$ | $B_3$ | | $B_1$ | $B_2$ | $B_3$ | | $B_1$ | $B_2$ | $B_3$ | |
| $C_1$ | 3.70 | 3.70 | 3.20 | 3.53 | 4.90 | 4.90 | 4.40 | 4.73 | 4.30 | 4.30 | 3.80 | **4.13** |
| $C_2$ | 2.00 | 2.00 | 3.00 | 2.33 | 4.40 | 4.50 | 4.20 | 4.36 | 3.20 | 3.20 | 3.60 | **3.35** |
| AxB | 2.85 | 2.85 | 3.10 | **2.93** | 4.65 | 4.70 | 4.30 | **4.55** | **3.75** | **3.77** | **3.70** | |

**$CD_{0.05}$ Extraction** methods (A): 0.06; Dye Assistants(B): NS; Mordants (C): 0.06; Extraction methods x Dye Assistants: 0.11; Extraction methods x Mordants: 0.97; Dye Assistants x Mordants: 0.11; Extraction methods x Dye Assistants x Mordants: 0.16
$A_1$ = Water; $A_2$ = Acetone; $B_1$ = Sodium chloride; $B_2$ = Acetic acid; $B_3$ = Hydrochloric acid
$C_1$ = Alum; $C_2$ = Ferric chloride

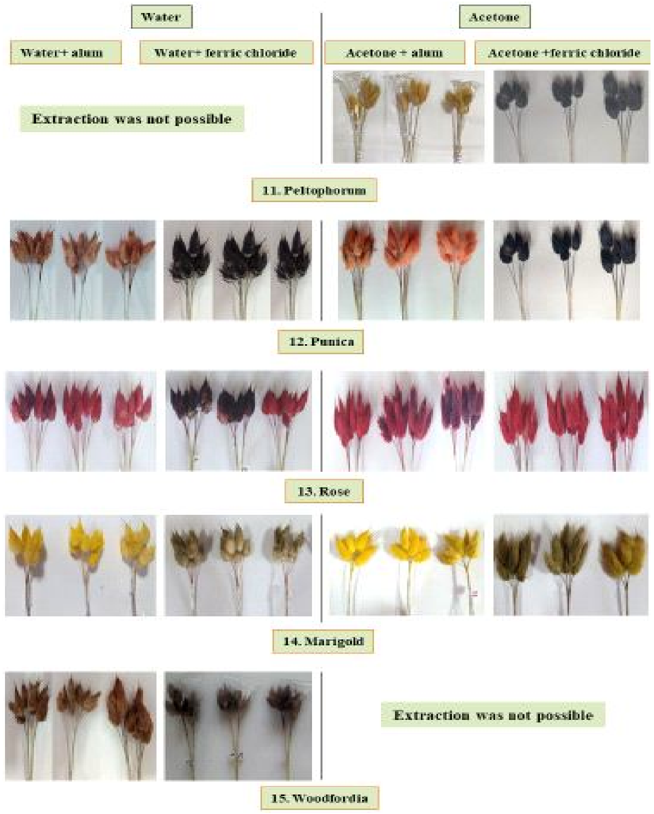



**Fig. 3 :** Effect of extraction methods, mordants and dye assistants from dye of peltophorum, punica, rose, marigold and woodfordia absorbed on dry flower *Lagurus ovatus*.

Kale *et al*. (2005) in Cosmos and Patil *et al*. (2016), who reported that natural dye could be extracted from red coloured rose. The different colour shades were obtained from various mordants like salts of iron and alum. The extracts showed variation in colour and which was mainly dependent on type of mordant used. Results revealed that, the red rose flower was good source of natural dye.

Table 6 explains maximum score for overall acceptability in *Lagurus ovatus* was obtained when extraction of bio-colour from turmeric was done in acetone using alum as a mordant and either of sodium chloride or acetic acid as a dye assistant (4.90). Minimum score was obtained in extraction with water when ferric chloride was used as a mordant and sodium chloride or acetic acid was used as dye assistant (2.00). Mordants form metal complexes between fabric or substrate and the dye. On application of mordant, the metal salts anchoring to the fibres, attracts the dye/organic pigment and creates the bridging link between the dye molecules and the fibre by forming coordinating complexes. Similar findings were reported by Grover and Patni (2011) in Woodfordia and Chavan and Ghosh (2015) for textile dyeing from turmeric where yellow colour shades were observed with the use of alum as a mordant.

## Conclusion

The study suggested that biocolour was successfully extracted using acetone as a solvent, alum as a mordant and sodium chloride or acetic acid as dye assistants in case of turmeric and marigold, whereas; sodium chloride or hydrochloric acid were found to be suitable dye assistants for rose. Significant differences w.r.t. colour, shape retention and overall acceptability were observed on dry flower after the absorption of the colour or dye obtained in general.

Overall acceptability scores of marigolds, rose and turmeric that stood best out of all crops that were utilized justifying the best extraction method, mordants are discussed in Table 4.

## References

Arora, J., Agarwal P. and Gupta G. (2017). Rainbow of natural dyes on textiles using plants extracts: Sustainable and eco-friendly processes. *Green Sustain Chem*., **7**, 35-47.

Baishya, D., Talukdar J. and Sandhya S. (2012). Cotton dyeing with natural dye extracted from flower of bottlebrush (*Callistemon citrinus*). *Univers. J. Environ. Res. Technol*., **2**, 377-382.

Bharati, K.T., Gujarathi D.B. and Argade B.U. (2017). Extraction of eco-friendly dye from red colour flowers of *Caesalpinia pulcherima* for dyeing cotton fabrics. *Int. J. Sci. Res*., **6**, 418-419.

Chavan, S. and Ghosh E. (2015). Cotton and silk dyeing with Natural dye extracted from floral parts of African marigold (*Tagetes erecta* L). *Int J. Res Advent Technol*., 16-19.

Gomez, K.A. and Gomez A.A. (1984). *Statistical procedures for agricultural research*. John wiley & sons Inc, New York. 680p.

Grover, N. and Patni V. (2011). Extraction and application of natural dye preparations from the floral parts of *Woodfordia fruticosa* (Linn.) Kurz. *Indian J Nat Prod Resour*., **2**, 403-408.

Jothi, D. (2008). Extraction of natural dyes from African marigold flower (*Tagetes erecta* L) for textile coloration. *Autex. Res. J*., **8**, 49-53.

Kale, S., Naik S. and Deodhar S. (2005). Utilization of *Cosmos sulphureus* Cav. flower dye on wool using mordant combinations. *Indian J Nat Prod Resour*., **5**, 19-24.

Karim, R., Islam T. and Mamun A.A. (2019). Effect of different mordanting agents on the fastness properties of cotton knitted fabric dyed with marigold extracted dyes. *J Text. Sci. Engin.*, **9**, 1-4.

Kashyap, B., Gupta Y.C., Sharma M. and Sharma R. (2017). Effect of biocolours and inorganic dyes on ornamental dry flower grasses. *J Ecol.*, **44**, 837-842.

Kulkarni, S.S., Gokhale A.V., Bodake U.M. and Pathade G.R. (2011). Cotton dyeing with natural dye extracted from pomegranate (*Punica granatum*) peel. *Univers. J.*

*Environ. Res. Technol.,* **1**, 135-139.

Patil, D.B., Patil K.N., Gaikwad P.V., Patil P.J., Shewale U.L. and Bhamburdekar S.B. (2016). Extraction of natural dye from rose flower for dyeing cotton fabrics. *Int J. Innov Res Multidis Field,* **2**, 135-137.

Ramprasath, R., Kavi G.G. and Rathi T.S. (2017). Isolation of natural dyes from *Hibiscus rosa sinensis* and marigold flower and dyeing properties of the dyes on cotton cloth. *J. Appl. Chem.,* **10**, 74-79.

Samanta, A.K. and Agarwal P. (2009). Application of natural dyes on textiles. *Indian J. Fibre Text.*, **34**, 384-99.

Sharma, G. (2015). Studies on dyeing and drying of Chincherinche (*Ornithogallum thrysoides* Jacq.) for value-addition. *MSc. Thesis*. Department of Floriculture and Landscape Architecture. Dr. Y.S. Parmar University of Horticulture and Forestry, Solan. 50p.

Sharma, G., Kashyap B., Sharma B.P., Gupta Y.C. and Gupta R. (2017). Identification of suitable dyes for dyeing dried Chincherinche (*Ornithogallum thrysoides Jacq*.) cut stems for value-addition. *Indian J. Nat. Prod. Resour*., **8**, 282-290.

Sheoran, O.P., Tonk D.S., Kauhik L.S., Hasija R.C. and Pannu R.S. (1998). Statistical Software Package for Agricultural Research Workers. In: *Recent Advances in Information Theory, Statistics and Computer Application* (Hooda, D.S. and Hasija R.C. eds). Department of mathematics statistics, CCS HAU, Hisar. 139-43p.

Singh, R. and Srivastava S. (2015). Exploration of flower based natural dyes- A Review. *Res. J. Recent Sci*., **4**, 6-8.