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Identification of suitable dyes for dyeing dried Chincherinchee (*Ornithogalum thyrsoides* Jacq.) cut stems for value-addition

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The study was conducted with the objective of identifying mostly suitable dyes to dye dried plant material for enhancing the quality and to create product diversification through value-addition. Twenty dyes belonging to four categories *i.e.* Textile (Green, Pink, Violet, Yellow), Food (Apple Green, Lemon Yellow, Raspberry Red, Orange Red, Bright Green food powder), Indicator (Brilliant Green, Crystal Violet, Eosin Yellow, Metanil Yellow, Methyl Orange, Methylene Blue) and Organic (coffee powder, turmeric powder, dried flowers of palash, rind of pomegranate, Lilium pollens) were evaluated for dyeing. The concentration of dyes was varied along with addition of mordants (common salt and alum). The experiment was divided into four sub experiments and the data on various quality parameters under each category of dye was recorded. The results revealed that turmeric powder scored maximum (23.37/25) amongst organic dyes; Yellow textile dye scored maximum (22.20/25) amongst textile dyes; in case of food dyes Lemon Yellow food powder scored maximum (17.54/25) and in case of indicator dyes Brilliant Green dye scored maximum (14.60/25). Although, immediately after dyeing turmeric powder as organic dye scored maximum but after subsequent storage of dyed flowers up to 120 days, it can be concluded that Yellow textile dye was overall the best as the flowers remained relatively presentable.

Keywords: Chincherinchee, Dyed flowers, Dyeing, *Ornithogalum thyrsoides*, Product diversification, Value-addition.
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Introduction

Chincherinchee (*Ornithogalum thyrsoides* Jacq.) is a bulbous plant and belongs to family Liliaceae. It produces white coloured cup-shaped flowers in dense racemes (Plate 1a). It is a showy garden or container plant and the flower sticks are used as cut flowers as they remain in presentable condition even after termination of vase life. Drying techniques play an important role in the overall quality of the dried produce and the colouring/dyeing enhances their value. According to Director General of Commercial Intelligence Statistics (2010), out of the total floricultural exports, 71 % that values Rs 260 crores were comprised of dry flowers[1]. The demand for dry flowers has increased manifold in the last decade and is increasing at an impressive rate of 8-10 % annually, thus offering immense opportunities to the Indian entrepreneurs to enter the global floriculture trade[2]. But, there is a dearth of literature on the techniques of drying and value-addition aspects of ornamental flowers, for example, Chincherinchee. Hence, the present study was undertaken with the objective of identification of suitable dyes for dyeing dried *Ornithogalum thyrsoides* Jacq. cut stems for value-addition. Dyes are molecules which absorb and reflect light at specific wavelengths to give human eyes the sense of colour. They can adhere to the surface of material and are used to give colour to paper, food stuffs and various textiles such as cotton, wool, synthetic fiber, silk etc. Natural colour may be intensified or artificial colour may be introduced to dried plant materials by dyeing or colouring. It provides the material with a more uniform colour, enhances the appearance of the material and increases their salability. Mordants are the brightening agents which not only intensify or brighten the colour of the dyes but also increase their fastness properties. Some authors have observed by experience that dried and dyed flowers may be arranged in vases (without water) just as fresh cut flowers are arranged. They may be arranged in bouquets or wall displays after fastening them to decorative bands[3]. They can also be used for making decorative floral crafts, greeting cards and covers, wall hangings, floral designs,

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Plate 1 — a) Natural Chincherinchee flowers, b) Vertical hang drying of dyed chincherinchee flowers

calendars, floral belts, festive decoration and other creative displays[4,5].

Materials and Methods

Dried flowers of Chincherinchee were used for the dyeing purpose.

Dyes used

In total, 20 dyes belonging to four different categories were used for dyeing *O thyrsoides* and the experiment was divided into four sub experiments based on the category of dye used. Specifications of dyes, their source and concentrations used in the experiment are presented in Table 1.

Preparation of dyes

Recently, interest in the use of natural dyes has been growing rapidly due to the result of stringent environmental standards imposed by many countries in response to toxic and allergic reactions associated with synthetic dyes. Therefore, in our study we tried to evaluate the effects of organic dyes too. Extraction of dyes from their raw dyestuffs is basically a solid-liquid extraction operation. When a solid material is brought in contact with a solvent, the soluble components from solid material move to the solvent. The rate of mass transfer decreases as the concentration of dye in the solvent increases, until equilibrium is reached. Thereafter, there is no longer mass transfer of dye from plant material to the solvent. Flowers of *Butea monosperma* and rind of pomegranate (*Punica granatum*) were used for extracting colour by immersing them in water. Lilium pollens were collected from the field and dissolved in acetone and utilized for colouring. Turmeric powder and coffee powder were used as such for the dyeing purpose.

There were two different concentrations of dyes used viz. C_1 (0.2 %) and C_2 (0.3 %), prepared by weighing 2 g and 3 g dye. These dyes were then dissolved into 1000 mL of boiling distilled water. Flowers were either dyed alone in dye solution or with addition of a pinch of mordants *i.e.* common salt or alum. The flowers were allowed to dip for 30-60 seconds until complete colour was taken up by the flowers and then taken out from the boiling solution and shade dried over the blotting sheets and later vertically hang dried (Plate 1b).

Scoring

After complete drying of dyed flowers, various observations on quality parameters of these flowers were taken. Scores were allotted on the basis of five quality parameters from highest to lowest order by visual observation for different dyes under study. The colour was recorded as per the colour chart of Royal Horticulture Society, London. Colour absorption was evaluated by the amount of colour absorbed by the dyed flowers. Consistency or strength of colour was observed based on the uniform and even integration of dyes in the dried flowers. For light fastness test, immediately after shade drying, the dyed flowers were exposed to 6 hrs of sunlight and it was observed whether the flowers had undergone fading or not. Accordingly, faded flowers were given less points and least faded were given more points. For rubbing fastness test, dyed flowers were rubbed against a white paper and highest score was given to the samples which gave least impression on the paper and lowest score to those which gave highest impression of dye on the paper. For wash fastness test, dyed

Table 1 — Specification of dyes and their concentrations used for dyeing dried *Ornithogalum thyrsoides* Jacq. flowers

Category	Specification	Source	Treatments	Concentration used
Textile dye	Green	Vaidya Balmukund and sons, Solan, HP	Green	0.2 % and 0.3 %
	Pink	Vaidya Balmukund and sons, Solan, HP	Pink	0.2 % and 0.3 %
	Violet	Vaidya Balmukund and sons, Solan, HP	Violet	0.2 % and 0.3 %
	Yellow	Vaidya Balmukund and sons, Solan, HP	Yellow	0.2 % and 0.3 %
Food dye	Apple Green Powder IH: 8925	LBN Industries, Industrial Estate Expansion, Chitoor (AP)	Apple Green	0.2 % and 0.3 %
	Bright Green Synthetic Food Colour Preparation Product Code: 16	Ajanta Food Products Company, Parwanoo Indl. Area, District Solan	Bright Green	0.2 % and 0.3 %
	Lemon Yellow Powder IH: 6597	LBN Industries, Industrial Estate Expansion, Chitoor (AP)	Lemon Yellow	0.2 % and 0.3 %
	Orange Red Synthetic Food Colour Preparation Product Code: 002654	Ajanta Food Products Company, Parwanoo Indl. Area, District Solan	Orange Red	0.2 % and 0.3 %
	Raspberry Red Powder IH: 7804	LBN Industries, Industrial Estate Expansion, Chitoor (AP)	Raspberry Red	0.2 % and 0.3 %
Indicator dye	Brilliant Green Indicator CI: 42040	Central Drug House (P) Ltd, 7/28 Vardaan House, Daryaganj, New Delhi	Brilliant Green	0.2 % and 0.3 %
	Crystal Violet for Microscopy Product No: C047699	Qualikems Fine Chem Pvt. Ltd., 124/9, GHDC, Industrial Estate, Vadodra	Crystal Violet	0.2 % and 0.3 %
	Eosin Yellow Indicator disodium salt (ms) water soluble CI: 45380	Central Drug House (P) Ltd, 7/28 Vardaan House, Daryaganj, New Delhi	Eosin Yellow	0.2 % and 0.3 %
	Metanil Yellow CAS No: 587-98-4	Central Drug House (P) Ltd, 7/28 Vardaan House, Daryaganj, New Delhi	Metanil Yellow	0.2 % and 0.3 %
	Methyl Orange Indicator Product No: M029603	Qualikems Fine Chem Pvt. Ltd., 124/9, GHDC, Industrial Estate, Vadodra	Methyl Orange	0.2 % and 0.3 %
	Methylene Blue for microscopy CI: 52015	Central Drug House (P) Ltd, 7/28 Vardaan House, Daryaganj, New Delhi	Methylene Blue	0.2 % and 0.3 %
Organic dye	Coffee powder	Local shop at Nauni, Solan (HP)	*Coffea* spp	0.2 % and 0.3 %
	Turmeric powder	Local shop at Nauni, Solan (HP)	*Curcuma longa*	0.2 % and 0.3 %
	Dried flowers of palash	Lacally grown tree at Nauni, Solan (HP)	*Butea monosperma*	0.2 % and 0.3 %
	Rind of pomegranate	Local shop at Nauni, Solan (HP)	*Punica granatum*	0.2 % and 0.3 %
	Lilium pollens	Floriculture Farm, Nauni, Solan (HP)	*Lilium* pollens	0.2 % and 0.3 %

flowers were washed in distilled water and their impression with a finger was taken from each sample on white paper and points to different samples were given based on how much impression they gave on paper after washing. Dyes which left more impression on paper were scored minimum and those which gave little impression were given maximum points. All these points were divided into different categories according to the score card given in Table 2[6,7] and a total score out of 25 was calculated which was allotted to different dyed flowers for evaluating their quality. The data was analyzed with Completely Randomized Design (Factorial).

Results and Discussion

Dyeing

There was a significant difference in absorption of different dyes by dried flowers of *O thyrsoides* Jacq.

Dyeing of O thyrsoides Jacq. cut stems with textile dyes

Although, all the flowers dyed with textile dyes exhibited good scoring for quality parameters, but in general flowers dyed with Yellow textile dye (D_4) obtained maximum score (22.20). As far as concentration of dye used was concerned; more score (21.31) was obtained when 0.3 % concentration (C_2) of dye was used as compared to 0.2 % concentration of dye (C_1). Amongst the mordants maximum score (22.06) was obtained when the flowers were dyed in

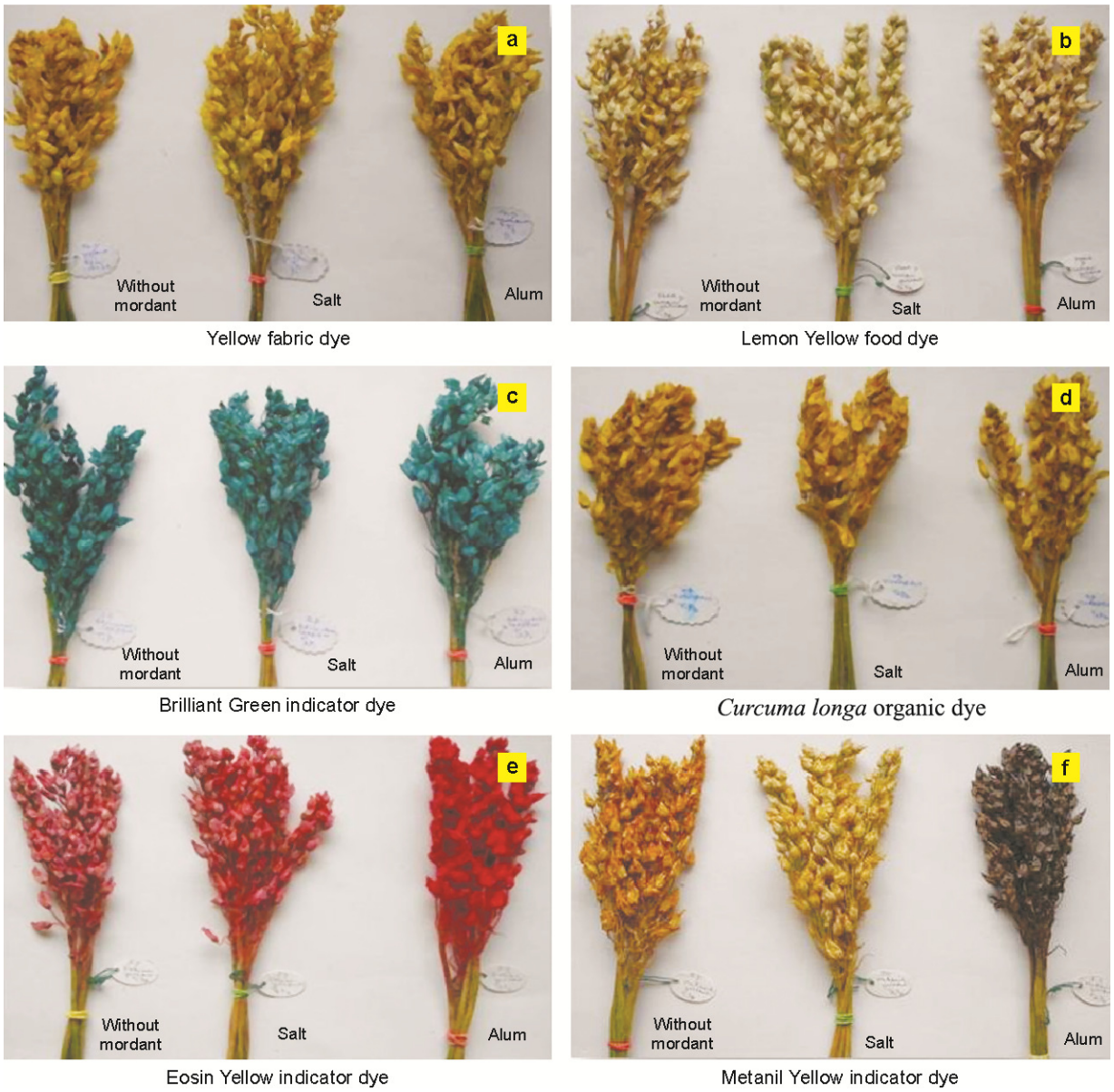

Plate 2— Effect of different dyes (D) and mordants (M) on Chincherinchee

Table 2 — Score card for different quality parameters of dyes (Scoring out of a total of 25)

Light fastness		Wash fastness		Rubbing fastness		Colour absorption		Colour consistency	
Not Faded	5	Low Impression	5	Low Impression	5	Excellent	5	High	5
Moderately Faded	3	Medium Impression	3	Medium Impression	3	Very Good	4	Medium	3
Faded	1	High Impression	1	High Impression	1	Good	3	Low	1
						Poor	2		
						Very Poor	1		

distilled water without any mordant (M_W). Among the interactions; highest score was obtained when the flowers were dyed in Yellow textile dye at a concentration of 0.2 % (D_4C_1) (Plate 2a), Green textile dye without any mordant (D_1M_W) and when a dye concentration of 0.3 % was used without any mordant (C_2M_W). The interaction of textile dyes × concentration × mordant, shows that highest score

was obtained by Yellow textile dye at a concentration of 0.2 % using common salt as a mordant ($D_4C_1M_S$) (Plate 2a), Green textile dye at a concentration of 0.2 % without any mordant ($D_1C_1M_W$) and Green textile dye at a concentration of 0.3 % without any mordant ($D_1C_2M_W$) (Table 3). Colour of textile dye was lightened with the addition of alum but was slightly enhanced by addition of common salt. Dried flowers responded well to different textile dyes. All the fastness properties were well exhibited by those flowers which were dyed with textile dyes. There was practically no or very less loss of colour on exposure of dyed flowers to 6 hrs of sun light. There was very little impression left on paper/cloth in case of textile dyes on rubbing and washing. Therefore, as a whole, textile dyes scored more over other dyes for quality parameters. These results are in agreement with studies on *Lagurus ovatus* (hare tail grass)[8] and *Gomphrena globosa* L. (Globe amaranth)[9] where Yellow dye scored maximum, had excellent colour absorption properties and showed good colour intensity immediately after dyeing (0 hr). It did not fade much even after 10 months of storage. Today, synthetic dyes have dominance because of their varied colours, vast and easy production and very good fastness properties[10].

Dyeing of O thyrsoides Jacq. cut stems with food dyes

In general Lemon Yellow food dye (D_3) obtained maximum score (17.54) for quality parameters. As far as concentration of dye used is concerned more score (12.99) was obtained when 0.3 % (C_2) was used as compared to the score obtained after using 0.2 % concentration (C_1). Effect of mordants was found to be non significant in case of food dyes. Among interactions, highest score was obtained when the flowers were dyed with Lemon Yellow food dye at a concentration of 0.3 % (D_3C_2), Lemon Yellow food dye without any mordant (D_3M_W) (Plate 2b) and when dye concentration of 0.3 % was used with alum as a mordant (C_2M_A). The interaction of food dyes × concentration × mordant, shows that highest score was obtained by Lemon Yellow food dye at a concentration of 0.3 % without mordant ($D_3C_2M_W$) (Table 4). Studies on *Lagurus ovatus* (hare tail grass) showed that colour intensity and colour absorption in case of food dyes were medium to high at the time of dyeing but the colours faded very fast and retention was not good after ten months[8]. Similar results were found in our study too. This is because dyes and pigments work by absorbing certain wavelengths of light and reflecting or transmitting the rest. When a dye molecule absorbs a photon, an electron is excited to a higher energy state. Most of the time (neglecting fluorescence), the molecule de-excites by giving off heat and returns to the ground state intact. However, because the excited state is a high energy state, it has the potential to undergo a chemical reaction, breaking a covalent bond or otherwise irreversibly reacting with another molecule. This changes the electronic structure of the molecule which changes its absorption properties. How likely this kind of destructive chemistry is, depends on the nature of the dye. Some dyes tend to be more susceptible as compared to others[11].

Dyeing of O thyrsoides Jacq. cut stems with indicator dyes

In general, flowers dyed with Brilliant Green indicator dye (D_1) obtained maximum score (14.60) in quality parameters. As far as concentration of dye is concerned; greater score (10.25) was obtained when 0.3 % concentration (C_2) of dye was used as compared to 0.2 % concentration (C_1). Amongst the mordants the highest score (11.15) was obtained when no mordant was used (M_W). Amongst the interactions maximum score was obtained when the flowers were dyed in Brilliant Green indicator dye at a concentration of 0.2 % (D_1C_1), Eosin yellow indicator

Table 3 — Effect of different textile dyes (D), concentration (C), mordants (M) and their interaction on quality parameters of dried flowers of *Ornithogalum thyrsoides* Jacq. (Scoring out of 25)

	C_1				C_2				DxM			
	M_W	M_S	M_A	DxC	M_W	M_S	M_A	DxC	M_W	M_S	M_A	D
D_1	23.65	23.55	19.25	22.15	23.65	21.45	20.50	21.87	23.65	22.50	19.88	22.01
D_2	19.75	15.20	19.35	18.10	19.60	22.10	18.90	20.20	19.68	18.65	19.13	19.15
D_3	21.35	17.90	16.55	18.60	23.55	23.05	17.85	21.48	22.45	20.48	17.20	20.04
D_4	21.40	23.65	23.10	22.72	23.50	22.25	19.30	21.68	22.45	22.95	21.20	22.20
CxM	21.54	20.08	19.56	20.39	22.58	22.21	19.14	21.31	22.06	21.15	19.35	

$CD_{0.05}$ D=0.22 C=0.16 M=0.19 D×C=0.32 D×M=0.39 C×M=0.27 D×C×M=0.55

Where, D_1 =Green, D_2 =Pink, D_3 =Violet, D_4 =Yellow; C_1=0.2%, C_2=0.3%; M_W=water + dye, M_S=water + dye + common salt, M_A=water + dye + alum

Table 4 — Effect of different food dyes (D), concentration (C), mordants (M) and their interaction on quality parameters of dried flowers of *O thyrsoides* Jacq. (Scoring out of 25)

	CD_0											
	C_1				C_2				DxM			
	M_W	M_S	M_A	DxC	M_W	M_S	M_A	DxC	M_W	M_S	M_A	D
D_1	12.65	12.65	13.90	13.07	13.90	12.80	14.05	13.58	13.28	12.73	13.98	13.33
D_2	12.45	13.20	13.00	12.83	14.45	14.70	14.90	14.68	13.45	13.95	13.95	13.78
D_3	17.10	17.75	16.65	17.17	18.45	17.70	17.60	17.92	17.78	17.73	17.13	17.54
D_4	8.95	9.85	8.30	9.03	9.20	9.95	9.30	9.27	9.08	9.90	8.80	9.26
D_5	8.60	9.20	7.30	8.37	9.30	9.00	9.50	9.50	8.95	9.10	8.40	8.94
CxM	11.95	12.53	11.83	12.10	13.06	12.83	13.07	12.99	12.51	12.68	12.45	
$CD_{.05}$	D=0.26		C=0.17		M=NS		D×C=0.37		D×M=0.45		C×M=0.29	D×C×M=0.64

Where, D_1=Apple Green, D_2=Bright Green, D_3= Lemon Yellow, D_4= Orange Red, D_5=Raspberry Red; C_1=0.2 %, C_2=0.3 %; M_W=water + dye, M_S=water + dye + common salt, M_A=water + dye + alum

Table 5 — Effect of different indicator dyes (D), concentration (C), mordants (M) and their interaction on quality parameters of dried flowers of *O thyrsoides* Jacq. (Scoring out of 25)

	C_1				C_2				DxM			
	M_W	M_S	M_A	DxC	M_W	M_S	M_A	DxC	M_W	M_S	M_A	D
D_1	17.30	15.55	13.60	15.18	13.60	14.80	12.75	13.72	15.45	15.18	13.18	14.60
D_2	11.85	9.90	9.65	10.47	12.75	9.05	8.25	10.02	12.30	9.48	8.95	10.24
D_3	7.35	6.85	17.10	10.43	12.75	9.05	8.25	10.27	7.18	7.13	16.75	10.35
D_4	10.70	9.70	5.90	8.77	12.15	5.25	3.80	7.07	11.43	7.48	4.85	7.92
D_5	7.40	8.35	7.90	7.88	9.20	8.85	9.40	9.15	8.30	8.60	8.65	8.52
D_6	8.75	6.45	6.55	7.25	15.75	10.00	8.00	11.25	12.25	8.23	7.28	9.25
CxM	10.56	9.47	10.12	10.05	11.74	9.23	9.77	10.25	11.15	9.35	9.94	
$CD_{0.05}$	D=0.25	C=0.14	M=0.18	D×C=0.35		D×M=0.43		C×M=0.25		D×C×M=0.61		

Where, D_1=Brilliant Green, D_2= Crystal Violet, D_3= Eosin Yellow, D_4= Metanil Yellow, D_5= Methyl Orange, D_6 =Methylene Blue; C_1=0.2 %, C_2=0.3%; M_W=water + dye, M_S=water + dye + common salt, M_A=water + dye + alum

dye was used with alum as a mordant (D_3M_A) and when a dye concentration of 0.3 % was used without any mordant (C_2M_W). The interaction dye × concentration × mordant reveals that the highest score for quality parameters was obtained by Brilliant Green indicator dye at a concentration of 0.2 % without using any mordant ($D_1C_1M_W$) (Table 5) (Plate 2c). There was a significant effect of alum on indicator dyes. In case of Eosin Yellow, the colour of dyed flowers was highly brightened with the addition of alum hence this dye scored similar to Brilliant Green without mordant (Plate 2e). It is often remarked that the addition of a mordant to an appropriate dye solution results in a very sudden, dramatic change in color. This is due to incorporation of the metal atom into the delocalized electron system of the dye. Metals have relatively low energy levels, so their incorporation into a delocalized system results in lowering of the overall energy. The absorbance of the hue and thus its color is related to this phenomenon[12]. Alum showed even and deep shades in *G globosa* L. in comparison to other mordant such as salt in a study by Kumari *et al*[9]. This effect was more profound in case of Eosin Yellow which was similar in our case too. This proved that dyeing can be improved by adding mordants to improve the contact between the dye bath solution and the plant materials as opined earlier[13]. Addition of mordants along with indicator dyes produced some off type of colours in our experiment like in Metanil Yellow (Plate 2f), which is otherwise not acceptable in dyed flowers. It might be possible that the concentration of indicator dye was more in case of our studies.

Dyeing of O thyrsoides Jacq. cut stems with organic dyes

Organic dyes are biodegradable, non toxic and eco-friendly in nature. Prime limitations and technical drawbacks of the natural dyes include low colour yield and inefficient dye extraction methods[14]. Similar problem was also noticed in our experiment. In general, among various organic dyes; flowers dyed with *Curcuma longa* (D_3) obtained maximum score (23.37) for quality parameters. In case of concentration of dyes used more score (15.00) was obtained when 0.3 % concentration of dye was used (C_2), as compared to when 0.2 % concentration was used (C_1). Effect of mordants were found to be non significant in case of organic dyes. The interaction

dye × concentration shows that highest score was obtained when the flowers were dyed with *C longa* at a concentration of 0.2 % (D_3C_1), *C longa* with alum as a mordant (D_3M_A) (Plate 2d) and the interaction concentration × mordant was found to be non - significant in case of organic dyes. The interaction of organic dyes × concentration × mordant used, shows that highest score for quality parameters was obtained when the flowers were dyed with *C longa* at a concentration of 0.2 % without any mordant ($D_3C_1M_W$) (Table 6). Colour fading on exposure to light and washness property was found maximum in organic and food dyes. *C longa* is very susceptible to light because it emits fluorescence and also from the structure of curcumin i.e. the colouring component present in turmeric, one can say that this dye is not able to form metal-complex with the mordants and hence shows poor light fastness properties and the samples are substantially faded within 3-4 h of exposure time in MBTF light fastness tester[15]. Thus we can say that suitability of mordants varied from dye to dye. Wash and Light fastness of many natural dyes, particularly which are extracted from flower parts are found to be poor to medium as compared to synthetic dyes[16]. Poor light fastness of some of the natural dyes is attributable to photooxidation of the chromophore. Natural dyes can be used on most types of material or fibre but the level of success in terms of fastness and clarity of colour varies considerably[17]. Further corroboration comes from investigations of Kashyap *et al*[8]. where bio-colours exhibited very poor colour intensity and colour absorption except for colouring with turmeric and lilium pollen in *Lagarus ovatus*.

Plate 3 — a) Value-added products prepared from Chincherinchee

Plate 3 — b) Value-added products prepared from Chincherinchee

Value-addition

Different value-added products were prepared from dyed flowers of Chincherinchee like: flower arrangements, doll, pen stand, mirror, greeting cards, garlands, hair accessories, napkin holder, pot-pourri, magazine holder, flower basket, wall decoration piece and flower vase (Plate 3a & b). The specific dyes used for the preparation of these value added products are mentioned in the plates.

Conclusion

Different categories of dyes showed different effects when treated with mordants and when the concentration of dyes was varied. But in general, amongst the four group of dyes selected for the experiment; Yellow textile dye, Lemon Yellow food powder, Brilliant Green indicator dye and turmeric powder can be used to dye dried flowers of Chincherinchee. Food dyes had average quality and the colours fade very fast. Among organic dyes except for turmeric powder, all others were very poor in performance, thus cannot be recommended for dyeing. Eosin Yellow indicator dye gave good results when alum was added as a mordant. Colour retention in Yellow textile dye was best even after 120 days of storage, thus, recommended for dyeing dried

Chincherinchee flowers. These techniques can increase the flower quality of dried produce and value-added products thus prepared to create product diversification in the field of floriculture.

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