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Original Research Paper

Effect of edible dyes on value addition and post-harvest life of tuberose spikes

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ABSTRACT

Tuberose is one of the most imperative bulbous crops with white fragrant florets, used for loose as well as cut flowers. All the commercial varieties have white colour flower only which is limiting factor in its popularity and marketing. By using edible dyes this issue may be solved for getting higher price in market as well as consumers satisfaction. An investigation was carried out to study the effect of food dyes on value addition and post harvest life of cut spikes of tuberose cv. Local Double in completely randomized design with factorial concept consisting thirty-six treatment combinations and one absolute control. Different treatments of food dyes and immersion time considerably induced colour in tuberose spikes without affecting postharvest life. The results revealed that 4% lemon yellow food dye with one hour immersion of tuberose cut spikes was found best in improving vase life (6.02 days), floret diameter (3.29 cm), opening of florets (49.66%) and visual appearance with minimum physiological loss in weight (16.91 % and 34.04 % at second and fourth day, respectively). Tinted tuberose cut spikes aids higher net return than white flowers, which will benefit farmers in fetching good prices.

Keywords: Cut spike, food dyes, immersion duration, postharvest life, tinting, tuberose

INTRODUCTION

Tuberose (*Polianthes tuberosa* Linn.) belonging to the family Asparagaceae, is one of the important bulbous flower crops of tropical and sub-tropical regions and popularly known as '*Rajanigandha*' or '*Nishigandha*'. Tuberose, both single and double types, are highly demanded for their waxy white spikes, which have a longer keeping quality; fill the air with their pleasant aroma, and used for loose flowers, cut flowers and oil extraction. The double-flowered tuberose form is highly prized for their usage in floral arrangements and as table decorations. Value addition refers to the process of increasing the value of a raw product by making modifications to the processes or diversifying the product line. Therefore, to make tuberose colourful, tinting is simple and farmer friendly approaches fetch remunerative prices. Dyes can be used for tinting to get a desired colour as they travel through the xylem or veins of a flower, because of its capillary action. This is a vital value-adding technique in flower crops to add colours especially in white cut flowers (Safeena et al., 2016). Inflorescences coloured with edible dyes are more attractive, have a wider colour palette for embellishment, and fetch a higher price. Farmers can increase their earnings by selling tinted tuberose spikes at a premium price over white spikes. In view of this, the present study involved use of several food dyes to transfer varying shades of colour on the petals of aromatic spikes of tuberose cv. Local Double.

MATERIAL AND METHODS

The experiment was conducted at Laboratory, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, NAU, Navsari during 2017-18, which is located at 20º 572 N latitude, 72º 542 E longitude, and an elevation of about 11.83 meters above mean sea level. The goal of the study was to determine the impact of food dyes on the postharvest life of tuberose spikes cv. Local Double. The experiment was laid out in completely randomised design with factorial concept (FCRD) consisting twelve levels of food dyes with different concentrations *viz*., lemon yellow 4% (C_1), lemon yellow 8% (C_2), kesar yellow 4% (C_3), kesar yellow 8% (C_4), kalakatta 4% (C_5), kalakatta 8% (C_6), orange red 4% (C_7), orange red 8 % (C_8), rose pink 4% (C_9), rose pink 8% (C_{10}), raspberry red 4% (C_{11}) and raspberry red 8% (C_{12}) and three levels of

Table 1 : Effect of food dyes and immersion period on vase life and quantity of dye uptake of tuberose

Treatment	Vase life (days)				Dye solution uptake (mL/spike)			
	1 hour (I_1)	2 hours x(I_2)	3 hours (I_3)	Mean	1 hour (I_1)	2 hours (I_2)	3 hours (I_3)	Mean
Lemon yellow 4% (C_1)	6.02	5.69	5.60	5.77	3.16	3.58	5.69	4.14
Lemon yellow 8% (C_2)	5.78	5.73	5.51	5.67	2.67	3.58	5.13	3.79
Kesar yellow 4% (C_3)	5.80	5.73	5.24	5.59	3.18	3.62	4.71	3.84
Kesar yellow 8% (C_4)	5.53	5.42	5.42	5.46	3.18	3.33	4.09	3.53
Kalakatta 4% (C_5)	5.38	5.00	5.04	5.14	3.18	3.64	5.07	3.96
Kalakatta 8% (C_6)	5.13	4.96	4.89	4.99	3.22	3.53	4.44	3.73
Orange red 4% (C_7)	5.29	5.09	4.80	5.06	3.24	3.60	5.38	4.07
Orange red 8 % (C_8)	5.02	4.87	4.89	4.93	3.04	3.31	4.38	3.58
Rose pink 4% (C_9)	5.80	5.56	5.24	5.53	3.51	4.13	4.62	4.09
Rose pink 8% (C_{10})	5.47	5.33	5.29	5.36	2.93	2.91	4.62	3.49
Raspberry red 4% (C_{11})	5.40	5.22	5.27	5.30	3.42	3.42	4.93	3.93
Raspberry red 8% (C_{12})	5.51	5.22	4.91	5.21	2.76	3.11	4.13	3.33
Mean	5.51	5.32	5.18	5.34	3.12	3.48	4.77	3.79
Control	6.09	-	-	-	0.00	-	-	-
	C	I	C x I	-	C	I	C x I	-
S. Em±	0.07	0.04	0.12	-	0.10	0.05	0.18	-
CD at 5%	0.20	0.10	NS	-	0.28	0.14	0.49	-
Cont. v/s rest								
S. Em±	0.09	-	-	-	0.12	-	-	-
CD at 5%	0.25	-	-	-	0.35	-	-	-

immersion periods *viz*., 1 hour (I_1), 2 hours (I_2) and 3 hours (I_3) along with one absolute control (distilled water). The experiment was repeated thrice to confirm the results. Dye solutions 4% and 8% were prepared by dissolving 40 g/L and 80 g/L of edible dyes in one litre of distilled water, respectively. Five freshly cut spikes of tuberose were dipped in the different dye solution and placed in a container.

To test the impact of food dye and immersion period on the post-harvest longevity of tuberose, cut spikes were dipped to the dye solutions at ambient conditions as per immersion period and then placed in vases with distilled water. During the time of experimentation, average maximum temperature (28 ºC, 27 ºC and 29 ºC), minimum temperature (20 ºC, 21 ºC and 12 ºC) and relative humidity (55.40 %, 84.35 % and 56.80 %) were recorded in laboratory during March 2017, September 2017 and February 2018, respectively. Throughout the experiment, data were recorded on vase life, physiological weight loss, dye uptake quantity, bud opening, floret diameter and colour intensity. Weight loss due to normal physiological processes was measured on second and fourth day. A digital Vernier calliper was used to measure the diameter of the third set of florets from the base, and the percentage of opened florets on each cut spike was estimated on third day of the experiment. The colour acquired by cut spikes was recorded by using RHS colour chart. Analysis of variance and critical difference (5 %) was used as reported by Gomez and Gomez (1984) to conduct statistical analysis of the data.

RESULTS AND DISCUSSION

Data presented in Table 1 showed impact of various food dyes and immersion period on the vase life and solution uptake of tuberose spikes cv. Local Double. The vase life of control spikes was recorded maximum (6.09 days), while, in dyed tuberose spikes, it was recorded 5.77 days in lemon yellow 4% (C_1), whereas, negatively influenced by a higher concentration (8%) of each food colour. The vase life of spikes immersed in dye solution for 1 hour is increased up to 5.51 days compared to 2 and 3 hours of immersion (5.32 and 5.18 days, respectively). However, non-significant relationship was observed between immersion time and types of food colour used. The poor cell turgidity and water loss linked with the shift in osmotic pressure may account for the shorter vase life as observed with coloured spikes compared to the control. Upon examination of a cross section of the cut spike of coloured tuberose, it was found that the dye

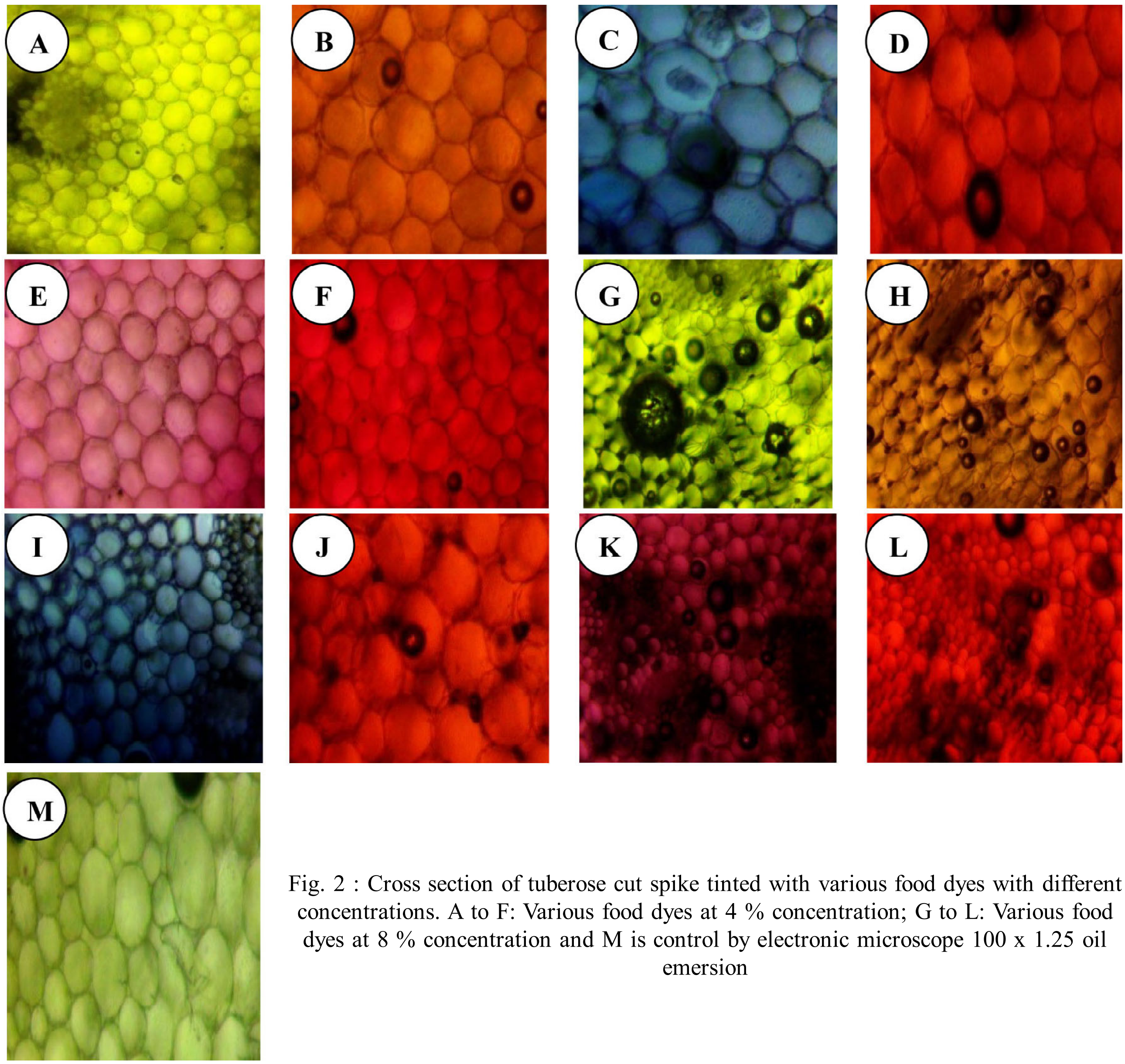

Fig. 2 : Cross section of tuberose cut spike tinted with various food dyes with different concentrations. A to F: Various food dyes at 4 % concentration; G to L: Various food dyes at 8 % concentration and M is control by electronic microscope 100 x 1.25 oil emersion

concentration 4% caused significantly less blockage than 8% (Fig. 2). Wilted florets and reduction in vase life was due to lack of nutrition since the dye particles clogged xylem and phloem vessels, disrupting the movement of water and food components. These findings are consistent with the previous studies on tuberose (Safeena et al., 2016; Kumari & Deb, 2018).

The maximum dye solution uptake (4.14 mL/spike) was recorded in spikes dipped in 4% lemon dye solution. Equally, all food colours showed more solution uptake in 4% solution in comparison to 8%. It is possible that the higher water flow and water balance associated with lower dye concentration may contribute to better uptake of dye solution. Specifically, a 3-hour immersion period resulted in highest dye solution uptake (4.77 mL/spike). Further, substantial findings were observed for interaction of food dyes and immersion period, with maximal dye solution uptake in 4% lemon yellow dye for 3 hours (5.69 mL/spike). The longer time for submerged condition in lower concentration of dye solution is responsible for more vibrant coloration of florets, as it allows for greater water circulation and water balance. The present findings corroborate the studies of Safeena et al. (2016) and Kumari and Deb (2018).

Data presented in Table 2 provides an overview of effects of different food dyes, immersion period, and their interaction on floret diameter and opening of

Table 2 : Effect of food dyes and immersion period on floret diameter and opening of florets of tuberose

Treatment	Floret diameter (cm) at 3rd day				Opening of florets (%) at 3rd day			
	1 hour (I_1)	2 hours x(I_2)	3 hours (I_3)	Mean	1 hour (I_1)	2 hours (I_2)	3 hours (I_3)	Mean
Lemon yellow 4% (C_1)	3.29	3.12	2.88	3.09	49.66	45.32	37.03	44.00
Lemon yellow 8% (C_2)	2.47	2.48	2.56	2.51	41.31	40.15	35.82	39.09
Kesar yellow 4% (C_3)	2.70	2.62	2.65	2.66	41.33	41.53	36.29	39.71
Kesar yellow 8% (C_4)	2.61	2.61	2.66	2.63	36.58	34.68	36.87	36.04
Kalakatta 4% (C_5)	2.91	2.71	2.66	2.76	39.37	38.73	36.18	38.09
Kalakatta 8% (C_6)	2.73	2.66	2.77	2.72	35.51	29.95	32.16	32.54
Orange red 4% (C_7)	2.96	2.84	2.89	2.90	48.22	43.67	36.46	42.78
Orange red 8 % (C_8)	2.91	2.84	2.80	2.85	41.08	37.42	33.93	37.48
Rose pink 4% (C_9)	2.99	2.92	2.95	2.96	41.67	35.67	33.08	36.81
Rose pink 8% (C_{10})	2.92	2.89	2.84	2.88	39.13	33.49	32.26	34.96
Raspberry red 4% (C_{11})	3.01	2.91	2.88	2.93	43.38	40.65	41.28	41.77
Raspberry red 8% (C_{12})	2.75	2.86	2.75	2.79	44.17	37.82	33.68	38.56
Mean	2.85	2.79	2.77	2.81	41.78	38.26	35.42	38.49
Control	3.08	-	-	-	48.52	-	-	-
	C	I	C x I		C	I	C x I	-
S. Em±	0.05	0.03	0.09	-	0.58	0.29	1.00	-
CD at 5%	0.15	NS	NS	-	1.62	0.18	2.80	-
Cont. v/s rest								
S. Em±	0.06	-	-	-	0.71	-	-	-
CD at 5%	0.18	-	-	-	1.99	-	-	-

florets on 3rd day. When flowers were preserved for decoration, such as in vases, flower diameter is an important quality parameter (Kumari and Deb, 2018). The diameter of the florets was noticeably affected by the concentration of the dye solutions. Florets exposed to lower concentrations of each food colour (4 %) were larger than those exposed to higher concentrations (8%) on 3rd day. Significantly, largest floret diameter (3.09 cm) was recorded in 4% lemon yellow colour over the control. However, there was no statistically significant effect of immersion duration as well as interaction of food dyes and immersion time. A sufficient supply of sucrose may have sped up respiration rate required for cell division, cell enlargement, and production of cell constituents, all of which would have contributed to larger size of florets. Kumar *et al.* (2015) have also reported analogous results in gladiolus.

Significant effect of food colouring, immersion period and its interaction as observed on meter and opening of florets (Table 2). On 3rd day, the florets treated with 4 % lemon yellow dye showed highest rate of opening (44.00 %). With comparison of 4 % and 8 % food dye solutions, it was found that 4 % solution of each food dye resulted in the most open florets. When spikes were submerged for 1 hour, the maximum opened florets (41.78%) compared to the other two immersion intervals. Maximum floret opening (49.66%) was recorded after soaking spikes 4% lemon yellow dye solution for 1 hour, demonstrating considerable influence of both food dye and immersion period. The florets opening may due to their improved carbohydrate metabolism, respiration rate, and water balance. The floret opens in part due to the availability of soluble carbohydrate and an increase in osmotic potential for growth of petal cells caused by least stem obstruction (Kumari and Deb, 2018).

On the perusal of data presented in Table 3 indicated the effect of food dyes and immersion period on physiological weight loss on 2nd and 4th days. The least physiological weight loss was recorded in the control (15.20% and 33.33%) on 2nd and 4th days, respectively, for various dyes tested. Spikes dipped in different dyes at 4% recorded least physiological weight loss on 2nd and 4th days, in comparison to cut spikes dipped in 8%. Comparatively, the physiological weight loss in cut spikes receiving 4% lemon yellow dye was lowest on 2nd (19.06%) and 4th (38.45%) day. There was significant temporal effect, with spikes losing 23.34% and 43.51% of their physiological

Table 3 : Effect of food dyes and immersion period on physiological loss of weight (%) of tuberose

Treatment	Physiological loss of weight (%)							
	2nd day				4th day			
	1 hour (I_1)	2 hours x(I_2)	3 hours (I_3)	Mean	1 hour (I_1)	2 hours (I_2)	3 hours (I_3)	Mean
Lemon yellow 4% (C_1)	16.91	19.12	21.15	19.06	34.04	38.38	42.91	38.45
Lemon yellow 8% (C_2)	20.97	24.97	26.47	24.14	37.47	43.77	46.89	42.71
Kesar yellow 4% (C_3)	24.62	25.45	28.52	26.19	40.97	45.31	49.05	45.11
Kesar yellow 8% (C_4)	26.65	29.82	31.76	29.41	46.34	55.86	58.61	53.60
Kalakatta 4% (C_5)	23.42	26.66	28.50	26.19	44.76	49.94	54.36	49.69
Kalakatta 8% (C_6)	29.44	33.14	34.76	32.45	51.06	57.95	60.29	56.43
Orange red 4% (C_7)	23.61	28.45	29.81	27.29	44.95	53.99	55.84	51.59
Orange red 8 % (C_8)	25.86	29.56	30.70	28.71	48.60	55.39	57.02	53.67
Rose pink 4% (C_9)	19.85	24.61	26.06	23.51	42.17	46.83	49.64	46.21
Rose pink 8% (C_{10})	23.29	27.36	29.39	26.68	44.90	51.78	53.64	50.10
Raspberry red 4% (C_{11})	21.66	24.02	25.36	23.68	41.83	47.49	51.25	46.86
Raspberry red 8% (C_{12})	23.79	26.94	29.68	26.80	45.02	50.35	54.23	49.87
Mean	23.34	26.68	28.51	26.18	43.51	49.75	52.81	48.69
Control	15.20	-	-	-	33.33	-	-	-
	C	I	C x I	-	C	I	C x I	-
S. Em±	0.35	0.18	0.61	-	0.49	0.25	0.85	-
CD at 5%	0.98	0.49	NS	-	1.37	0.69	NS	-
Cont. v/s rest								
S. Em±	0.43	-	-	-	0.60	-	-	-
CD at 5%	1.20	-	-	-	1.68	-	-	-

weight on 2nd and 4th day, respectively, when spikes dipped in dye for 1 hour. However, the combined effects of food colouring and immersion time did not have any appreciable impact on spike physiological leanness. There may be less impact on supply of water and food because fewer colour particles can be absorbed by spikes in 1 hour. Therefore, the physiological weight loss could be mitigated by cells potential use of water absorbed by spikes to preserve cell turgidity (Kumar *et al*., 2015).

Table 4 : Effect of food dyes and immersion period on tuberose flower colour intensity (RHS colour chart)

Treatment	1 hour (I_1)	2 hours (I_2)	3 hours (I_3)
Lemon yellow 4% (C_1)	Brilliant yellow, 7(B)	Brilliant greenish yellow, 5(A)	Vivid yellow, 9(A)
Lemon yellow 8% (C_2)	Vivid yellow, 13(A)	Brilliant greenish yellow, 6(A)	Vivid yellow, 14(A)
Kesar yellow 4% (C_3)	Strong orange, N25(C)	Vivid orange yellow, 6(A)	Vivid yellow, 14(A)
Kesar yellow 8% (C_4)	Strong orange, N25(C)	Strong orange, N25(B)	Strong orange, 25(A)
Kalakatta 4% (C_5)	Very pale purplish blue, 101(D)	Very pale purplish blue, 106(D)	Very light purplish blue, 102(D)
Kalakatta 8% (C_6)	Moderate blue, 98(B)	Light blue, 107(D)	Very pale purplish blue, 101(D)
Orange red 4% (C_7)	Strong reddish orange, 32(B)	Vivid orange, N30(D)	Strong orange, N25(B)
Orange red 8 % (C_8)	Vivid reddish orange, 32(A)	Strong reddish orange, 31(A)	Strong orange, N25(A)
Rose pink 4% (C_9)	Very pale purple, N76(C)	Grayish purplish red, N77(D)	Very pale purple, 76(C)
Rose pink 8% (C_{10})	Very light purple, 76(C)	Light purple, 77(D)	Very light purple, 76(B)
Raspberry red 4% (C_{11})	Light purplish pink, 68(D)	Deep purplish pink, 58(D)	Strong purplish red, 58(B)
Raspberry red 8% (C_{12})	Deep purplish pink, N54(B)	Vivid purplish – N57(B)	Vivid purplish red –N57(A)
Control	Pale yellow green, NN155(B)		

Fig. 1 : Colour intensity of various food dyes at 4 % and 8 % concentration for 1 h immersion time. (A) 4% lemon yellow, (B) 4% kesar yellow, (C) 4% kalakatta, (D) 4% orange red, (E) 4% rose pink, (F) 4% raspberry red, (G) 8% lemon yellow, (H) 8% kesar yellow, (I) 8% kalakatta, (J) 8% orange red, (K) 8 % rose pink and (L) 8% raspberry red

RHS colour codes of spikes influenced by various food dyes and immersion periods were recorded (Table 4). After being treated with various dyes, the white tuberose spikes took on diverse hues (Fig. 1). Preferred colour shades can be created by tinting with various food dyes. It was found that the length of the immersion correlated with the colour intensity of the flower. The results corroborate the findings of Viradia *et al.* (2015) & Sowmeya *et al.* (2017) in tuberose, rose and carnation.

Table 4 lists the RHS colour codes of spikes affected by various food dyes and immersion period. The white tuberose spikes took on a variety of colours after being dyed (Fig. 1). By adding various food dyes, one can tint spikes to desired colour tones. It was discovered that the duration of the immersion connected with the flower's colour intensity. The findings are supported by the results of Viradia et al. (2015) and Sowmeya et al. (2017) in in tuberose, rose, and carnation.

Table 5 shows the cost-effectiveness of several food dyes for creating coloured tuberoses. The two treatments that produced the highest net realisation (1.952) were 4% lemon yellow for 1 hour and 4% kesar yellow for 1 hour.

CONCLUSION

Based on the results, it can be concluded that soaking of tuberose spikes in 4% lemon yellow dye solution for 1 hour produce beautiful, natural, and pretty flowers. This is because the dye solution can make flowers more attractive in terms of colour, vase life, floret diameter, dye solution uptake, floret opening,

Table 5 : Economics of tinted tuberose cut spikes with different food dyes

Treatment	Cost of dye/500 g (Rs.)	Cost of dye solution (Rs./L)	Cost of normal spike (Rs./spike)	Cost of dye (Rs/spike)	Total cost (Rs./ spike)	Income of tinted spike (Rs./spike)	Net realization (Rs./spike)
C_1I_1	190	15.2	3	0.048	3.048	5	1.952
C_1I_2	190	15.2	3	0.054	3.054	5	1.946
C_1I_3	190	15.2	3	0.086	3.086	5	1.914
C_2I_1	190	30.4	3	0.081	3.081	5	1.919
C_2I_2	190	30.4	3	0.109	3.109	5	1.891
C_2I_3	190	30.4	3	0.156	3.156	5	1.844
C_3I_1	190	15.2	3	0.048	3.048	5	1.952
C_3I_2	190	15.2	3	0.055	3.055	5	1.945
C_3I_3	190	15.2	3	0.072	3.072	5	1.928
C_4I_1	190	30.4	3	0.097	3.097	5	1.903
C_4I_2	190	30.4	3	0.101	3.101	5	1.899
C_4I_3	190	30.4	3	0.124	3.124	5	1.876
C_5I_1	190	15.2	3	0.048	3.048	5	1.952
C_5I_2	190	15.2	3	0.055	3.055	5	1.945
C_5I_3	190	15.2	3	0.077	3.077	5	1.923
C_6I_1	190	30.4	3	0.098	3.098	5	1.902
C_6I_2	190	30.4	3	0.107	3.107	5	1.893
C_6I_3	190	30.4	3	0.135	3.135	5	1.865
C_7I_1	190	15.2	3	0.049	3.049	5	1.951
C_7I_2	190	15.2	3	0.055	3.055	5	1.945
C_7I_3	190	15.2	3	0.082	3.082	5	1.918
C_8I_1	190	30.4	3	0.092	3.092	5	1.908
C_8I_2	190	30.4	3	0.101	3.101	5	1.899
C_8I_3	190	30.4	3	0.133	3.133	5	1.867
C_9I_1	300	24.0	3	0.084	3.084	5	1.916
C_9I_2	300	24.0	3	0.099	3.099	5	1.901
C_9I_3	300	24.0	3	0.111	3.111	5	1.889
$C_{10}I_1$	300	48.0	3	0.141	3.141	5	1.859
$C_{10}I_2$	300	48.0	3	0.140	3.140	5	1.860
$C_{10}I_3$	300	48.0	3	0.222	3.222	5	1.778
$C_{11}I_1$	250	20.0	3	0.068	3.068	5	1.932
$C_{11}I_2$	250	20.0	3	0.068	3.068	5	1.932
$C_{11}I_3$	250	20.0	3	0.099	3.099	5	1.901
$C_{12}I_1$	250	40.0	3	0.110	3.110	5	1.890
$C_{12}I_2$	250	40.0	3	0.124	3.124	5	1.876
$C_{12}I_3$	250	40.0	3	0.165	3.165	5	1.835
Control	0	0	3	0	3.000	0	0

and physiological weight loss. Additionally, desired colour tones can be achieved by colouring with different food dyes including kesar yellow, kalakatta, orange red, rose pink, and raspberry red at 4% concentration for a 1 hour immersion duration. Thus, tinting could be adopted by the tuberose producers which needs less skill and fetches higher price for beautifully coloured flowers.

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REFERENCES

Gomez, K. A., & Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. John Willey and Sons, New York, USA, p. 680.

Kumar, S. P. B., Lalitha Kameswari, Pratap M., & Venkateswarrao, P. (2015). Studies on vase life of tinted spikes of gladiolus cultivar White Prosperity. *Indian Journal of Agricultural Research*, *49*(1), 71-76.

Kumari S., & Deb, P. (2018). Effect of tinting on value addition of tuberose (*Polianthes tuberosa* L.) cv. Prajwal. *International Journal of Bio-resource and Stress Management*, *9*(3), 314-322.

Safeena S. A., Thangam, M., & Singh, N. P. (2016). Value addition of tuberose (*Polianthes tuberosa* L.) spikes by tinting with different edible dyes. *Asian Journal of Research in Biological and Pharmaceutical Sciences*, *4*(3), 89-98.

Sowmeya, S., Kumaresan, S., & Sanmuga Priya L. (2017). Effect of multi colours in tinting techniques in cut flowers (rose and carnation). *Chemical Science Review and Letters*, *6*(24), 250-253.

Viradia, R. R., Bajad, A., & Polara, N. D. (2015). Value addition through use of dye chemicals and floral preservatives in tuberose (*Polianthes tuberosa* L.) cv. Double. *International Journal of Forestry and Horticulture*, *1*(1), 1-4.

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