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Effect of Varying Levels of pH and Edible Dyes on Tinting and Vase Life of Tuberose

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The objective of this study is to explore how manipulating pH levels and incorporating edible dyes can extend the vase life, enhance the tinting, and improve the overall quality of tuberose flowers (*Polianthes tuberosa*).

Study Design: The experiment was designed as a complete randomized design with three replications and a total of twenty-eight treatments.

Place and Duration of Study: The experiment was conducted at the Horticulture lab in Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab. The study was carried out over a specific duration in 2022.

Methodology: Tuberose (*Polianthes tuberosa*) flowers were obtained from a local supplier. The flowers were carefully selected based on their uniformity in size and maturity. The study followed a completely randomized design (CRD) with 28 combinations of treatments. The pH levels included three treatments (pH 4, pH 5, and pH 6), while the edible dyes consisted of three treatments (Apple green, Lemon yellow, and orange red) at varying concentrations (1%, 2.5%, and 4%).

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Results: This research reveals that the best conditions for attaining the desired tinting effect on tuberose flowers are a slightly acidic pH level (pH 5) and a moderate concentration of lemon-yellow color (2.5%). This treatment combination was suitable for increasing the water uptake, floret opening, percent increase in floret opening and vase life. While the concentration of the dye influences the strength of the coloration, the pH level has a significant impact on how the color solution is taken up and absorbed by the flowers.

Conclusion: The results of this study demonstrate that maintaining a pH level of 5 and using a moderate concentration (2.5%) of lemon-yellow color positively impacted both the tinting process and the longevity of cut tuberose flowers in vases.

Keywords: Tuberose; tinting, food dye; post-harvest life.

1. INTRODUCTION

Owing to a steady increase in demand for flowers, floriculture has become one of the important commercial trades in Agriculture. Hence, commercial floriculture has emerged as a hi-tech activity that takes place under controlled climatic conditions inside the greenhouse. Floriculture in India is viewed as a high growth.

India is one of the emerging countries in the floriculture sector of the world. At present India occupies 0.61 per cent share of the global floricultural industry. As per the National Horticulture Database published by National Horticulture Board, during 2020-21 the area under floriculture production in India was 322 thousand hectares with the production of 2152 thousand tons of loose flowers and 828 thousand tons of cut flowers.

Tinting is considered to be one of the important value-addition techniques in flowers where color pigments in the flowers are absent or in white flowers. It was a good approach for achieving the desired colour at the post-harvest stage by modifying the colours according to the wish [1,2]. Tinting can be done with flowers by adding artificial dyes or food dyes. The visual attractiveness of the fresh flowers is enhanced by tinting. Cut flower inflorescences that are colored with edible dyes improve the arrangement's look and attractiveness. Additionally, it may offer a wide range of hues to enhance aesthetic beauty. As flowers of a certain color with two colors are desired for ornamental purposes, we might think about coloring white flowers [3,4].

Tinting enhances the aesthetic beauty of fresh and dry flowers as single-color limits the flower acceptability and reduces the market value. Tinting is usually done at the retailer level, however, if farmers adopt this technique at the farm level and impart various colors to tuberose spikes it will increase the value of the product and fetch good prices the in market which in turn earn higher returns with this value addition technology [4,5].

Tuberose is commonly known as Rajanigandha or Nishigandha which means„ The Fragrance of the Night'. It is a commercially important cut as well as loose flower crop standing fifth in the international trade after rose, carnations, chrysanthemum, and gladiolus. Tinting enhances the aesthetic beauty of fresh and dry flowers as single-color limits the flower acceptability and reduces the market value. Tinting is usually done at the retailer level, however, if farmers adopt this technique at the farm level and impart various colors to tuberose spikes it will increase the value of the product and fetch good prices the in market which in turn earn higher returns with this value addition technology.

2. MATERIALS AND METHODS

The experiment involved subjecting tuberose flowers to different pH levels ranging from acidic to alkaline, achieved by adjusting the water's acidity using citric acid and sodium bicarbonate. Additionally, edible dyes of various colors and concentrations were applied to the cut stems of the flowers before placing them in the vases. The flowers were monitored daily to assess changes in color intensity, tinting uniformity, and vase life. The site, where the experiment was carried out in the horticulture laboratory of the Department of Horticulture, School of Agriculture, Lovely Professional University, Phagwara, Punjab in the month of February of 2023. The experiment includes different treatments involving pH levels and concentrations of edible dyes. The pH levels tested are 4, 5, and 6, while the concentrations of edible dyes are 1%, 2.5%, and 4%. The edible dyes used in the experiment are apple green, orange-red, and lemon yellow.

Table 1. Details about the treatments and their composition

Treatment Details:	
T_1	pH 4 + 1% of apple green color
T_2	pH 5 + 1% of apple green color
T_3	pH 6 + 1% of apple green color
T_4	pH 4 + 2.5 % of apple green color
T_5	pH 5 + 2.5 % of apple green color
T_6	pH 6 + 2.5 % of apple green color
T_7	pH 4 + 4 % of apple green color
T_8	pH 5 + 4 % of apple green color
T_9	pH 6 + 4 % of apple green color
T_{10}	pH 4 + 1% of orange red color
T_{11}	pH 5 + 1% of orange red color
T_{12}	pH 6 + 1% of orange red color
T_{13}	pH 4 + 2.5 % of orange red color
T_{14}	pH 5 + 2.5 % of orange red color
T_{15}	pH 6 + 2.5 % of orange red color
T_{16}	pH 4 + 4 % of orange red color
T_{17}	pH 5 + 4 % of orange red color
T_{18}	pH 6 + 4 % of orange red color
T_{19}	pH 4 + 1% of lemon-yellow color
T_{20}	pH 5 + 1% of lemon-yellow color
T_{21}	pH 6 + 1% of lemon-yellow color
T_{22}	pH 4 + 2.5 % of lemon-yellow color
T_{23}	pH 5 + 2.5 % of lemon-yellow color
T_{24}	pH 6 + 2.5 % of lemon-yellow color
T_{25}	pH 4 + 4 % of lemon-yellow color
T_{26}	pH 5 + 4 % of lemon-yellow color
T_{27}	pH 6 + 4 % of lemon-yellow color
T_{28}	Tap water

Additionally, there is a control group treated with tap water. Different observations like Initial weight of flower (gm), Final weight of flower (gm), Loss in flower weight (%), Uptake of water (g/cut flower), Loss of water, Water balance (g/cut flower), Number of florets on First day, Final day, Percent floret opening, Time taken for colure changes (Hours) and Vase life of cut flower (days) were taken. Flowers were harvested in the morning between 8.00 and 9.00 am. Flowers were harvested from farmer's field with 2-3 flowers open in each spike. Immediately after harvest, the cut ends of the flower stalks were immersed in water. To prepare 1%, 2.5% and 4% of the color solution powder of Apple green, Lemon yellow, and Orange red color of 1 g, 2.5 g, and 4 g are mixed in 100 ml of filtrated water. The uniform spikes with 60 cm stalk length with 2-3 florets opening with 3 spikes were put in a glass bottle containing 100 ml of edible dye solutions. Each treatment was repeated thrice. The data were analyzed completely randomized block with 28 treatments and 3 replications.

3. RESULTS AND DISCUSSION

Effect of pH and color concertation on initial fresh weight, final fresh weight and Percent weight loss: Different levels of pH and color concentration had a significant effect on initial weight, final weight and percent weight loss of cut flower (Table 2). The maximum fresh weight of flower (59.2 gm) in the initial day was found in treatment T_{26} which was pH 5 + 4 % of lemon yellow color which was found statistically similar with T_{25}, T_{22} and T_{13} . While minimum fresh weight (39.8 gm) of flower reported in T_{28} control Although maximum fresh weight (51.4 gm) in the final day was in the treatment using pH 5 + 4 % of lemon yellow and the minimum weight (28.6 gm) was found in T_{28} in the final day using tap water. The minimum percent the physiological weight loss of the tinted tuberose (10.5%) was observed with the treatment T_{23} (pH 5 + 2.5 % of lemon-yellow color) which was significantly minimum weight loss to all other treatments except T_{22}. while the maximum percent physiological weight loss (28.0%) was observed in the treatment T_{28} (control). This may be due to the fact that original food content of the tuberose contained, and higher pH of the solution helped in retaining the physiological weight. Spike weight shows a significant difference for different food dyes from day one to eight days this statement was given by [6].

Uptake of water: The uptake of water varied across the treatments. Generally, higher levels of pH and edible dyes led to increased water uptake [6]. The treatments T_{27} with pH 6 and 4% of lemon-yellow color, had maximum uptake was 35.6 g/cut flower. On the other hand, *i.e.,* T_2 and T_5 with pH 5 as common and the version in their concentration 1% and 2.5% of apple green color had the lowest uptake of 10.3 g/cut flowers [6].

Loss of water: The loss of water also showed significant variations among the treatments. In some cases, higher levels of pH and edible dyes led to increased water loss. For instance, the treatment with pH 5 and 2.5% of lemon-yellow color had a loss of 51.5 g/cut flowers, which was the highest recorded. Conversely, the treatment with T_2 and T_5 had the lowest loss of 18.6 g/cut flowers.

pH plays a crucial role in the physiology and biochemistry of plants, including water uptake. Different pH levels can affect the ionization and availability of nutrients and water in the surrounding medium. In this study, treatments with higher pH levels (pH 6) generally resulted in increased water uptake compared to lower pH levels (pH 4 and 5). This could be attributed to improved nutrient availability and enhanced physiological processes, such as the opening of stomata for transpiration.

The edible dyes used in the study could have influenced water dynamics in Tuberose cut flowers through various mechanisms. Edible dyes may contain compounds that affect the permeability and osmotic properties of plant tissues, which can impact water uptake and loss. The observed variations in water uptake and loss among different edible dye treatments suggest that the specific composition and concentration of the dyes played a role in altering the water balance of the cut flowers.

The combined effects of pH and edible dyes could have contributed to the observed variations in water dynamics. Different pH levels may interact with the chemical properties of the edible dyes, influencing their behavior and subsequent impact on water uptake and loss. The specific interactions between pH and the edible dyes used in this study might have synergistic or antagonistic effects on the physiological processes involved in water management.

No of florets: Based on these results, it can be observed that the different levels of pH and edible dyes had an impact on the number of florets and percent opening of florets in Tuberose. The treatment with pH 5 and 2.5% of lemon-yellow color exhibited a significantly higher number of florets and a remarkable percent opening of florets (24.5 on the first day, 29.00 on the final day, and 60.3% floret opening). While the minimum floret opening (27.4 %) was recorded on the treatment T_{12} (pH 6 + 1% of orange red color). The treatments with higher concentrations of dyes generally resulted in a higher number of florets and a greater percentage of floret opening compared to the treatments with lower dye concentrations [6]. Combinations of pH and dye concentration yielded more favorable results.

Table 2. Effect of Varying Levels of pH and Edible Dyes on physical parameters of Tuberose

Treat.	Initial weight of flower (gm)	Final weight of flower (gm)	Loss in flower weight (%)	Uptake of water (g/cut flower)	Loss of water
T_1	45.5	35.5	21.9	11.6	20.4
T_2	45.7	35.9	21.5	10.3	18.6
T_3	46.1	35.8	22.3	13.3	22.0
T_4	50.4	41.5	17.8	13.3	21.7
T_5	48.4	39.9	17.6	10.3	18.6
T_6	47.3	38.5	18.5	15.6	23.5
T_7	49.0	40.1	18.0	15.9	23.3
T_8	50.0	41.0	17.9	14.9	23.9
T_9	47.9	39.0	18.7	20.8	29.1
T_{10}	47.2	37.7	20.1	20.5	26.7
T_{11}	48.5	39.0	19.6	22.5	32.1
T_{12}	45.4	36.2	20.2	21.2	31.6
T_{13}	58.0	49.1	15.3	18.6	32.5
T_{14}	55.2	46.6	15.5	20.3	31.2
T_{15}	44.5	34.6	22.4	25.7	33.9
T_{16}	48.9	40.2	17.8	24.7	34.8
T_{17}	55.0	46.2	16.0	27.0	39.3
T_{18}	46.7	37.6	19.5	25.7	34.5
T_{19}	52.4	43.2	17.6	24.4	34.2
T_{20}	54.0	44.6	17.3	31.9	43.4
T_{21}	52.1	43.1	17.4	30.2	40.6
T_{22}	58.3	50.7	12.9	29.5	44.6
T_{23}	55.9	50.1	10.5	31.9	51.5
T_{24}	53.7	44.7	16.7	30.2	41.3
T_{25}	59.0	50.8	13.9	30.2	43.4
T_{26}	59.2	51.4	13.1	33.6	48.5
T_{27}	53.2	44.1	17.2	35.6	47.7
T_{28}	39.8	28.6	28.0	34.2	41.2
Sem$\pm$	0.85	0.70	0.90	4.56	4.31
CD at 5%	2.39	1.99	2.56	12.88	12.17

Table 3. Effect of varying levels of pH and edible dyes of tuberose

Treat.	Number of florets		Percent floret opening	Time taken (Hours)	Vase life of cut flower (days)
	First day	Final day			
T_1	17.7	24.17	35.1	18.0	5.24
T_2	17.3	24.83	40.6	17.7	5.26
T_3	16.5	23.50	37.1	18.0	5.10
T_4	19.3	25.33	37.6	15.0	6.28
T_5	19.7	24.17	31.5	14.7	6.31
T_6	18.3	26.67	48.8	16.0	5.24
T_7	18.0	26.00	48.3	15.7	5.24
T_8	18.5	25.33	42.6	15.7	6.29
T_9	18.0	24.50	38.7	16.3	5.25
T_{10}	18.2	25.17	39.6	16.7	5.23
T_{11}	17.5	23.00	31.0	16.7	5.24
T_{12}	17.0	22.00	27.4	17.0	5.25
T_{13}	20.7	27.17	47.4	12.7	7.34
T_{14}	20.0	27.50	53.6	12.7	7.10
T_{15}	16.0	22.50	34.6	18.0	5.26
T_{16}	18.5	24.00	34.3	15.3	6.30
T_{17}	20.0	26.00	41.9	13.0	6.91
T_{18}	17.5	23.67	34.3	16.3	5.23
T_{19}	19.0	24.50	36.3	14.7	6.29
T_{20}	19.5	27.00	53.2	13.3	6.30
T_{21}	19.0	24.50	36.9	14.0	6.28
T_{22}	22.3	28.83	50.3	11.7	7.97
T_{23}	24.5	29.00	60.3	11.7	7.33
T_{24}	20.0	25.00	35.2	13.0	7.32
T_{25}	21.0	28.00	47.0	12.3	7.23
T_{26}	21.5	28.00	47.1	12.0	7.36
T_{27}	19.5	27.00	50.9	13.3	7.33
T_{28}	16.3	26.17	50.5	00	4.76
Sem±	0.9	0.97	9.5	0.98	0.44
CD at 5%	2.6	2.76	26.9	2.78	1.26

Time taken for color change: The results demonstrated significant variations in the time taken for color change among the different treatments. Tuberose flowers subjected to pH 4 and pH 5 with 2.5% of lemon-yellow color (T_{22} and T_{23}) showed the fastest color change, with a mean time of 11.7 hours. Conversely, Tuberose flowers treated with pH 4 + 1% of apple green color (T_1), exhibited slower color change, with mean times 18.0 hours. Color intensity was recorded using RHS color chart by assigning different codes for flower color as reported by Sravan Kumar et al. [7] and Yamini, [8]. With the increase in the concentration of dye, an increase in the intensity of the color in the flower petals was observed.

Vase life: The results indicated significant differences in the vase life of Tuberose cut flowers among the different treatments. Among the different pH levels and edible dye tested, pH 4 + 2.5 % of lemon-yellow color consistently resulted in the longest vase life, with an average of 7.97 days while Tap water, used as a control, resulted in an average vase life of 4.76 days.

This study highlights the significant influence of pH levels and edible dyes on the vase life of Tuberose cut flowers. pH 4 and the 2.5% concentration of lemon-yellow edible dyes were found to enhance the vase life of the flowers. A similar result was confirmed by Sambandamurthy and Appavu [9], Mekala et al. [10], and Shim et al. (2012).

4. CONCLUSION

This study highlights the significant influence of pH levels and edible dyes on the vase life of

Tuberose cut flowers. pH 5 and the 2.5% concentration of edible dyes were found to enhance the vase life of the flowers. Among the edible dyes tested, orange red at the 2.5% concentration exhibited the longest vase life. These findings provide valuable insights for florists and growers aiming to maximize the vase life of Tuberose cut flowers. Further research is recommended to investigate the underlying physiological mechanisms associated with the observed effects.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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