STUDY OF DEHYDRATION TECHNIQUES FOR ZINNIA

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SUMMARY

Dehydration is an important post harvest technique for enhancing ornamental keeping quality of flowers as it quickly reduces the moisture content of flowers to a point wherein growth of microorganisms can be prevented and bio-chemical changes can be minimized or brought to a standstill. The study of the phenomena of dehydration with respect to petal shape, colour and longevity, revealed 8 to 11.5% moisture content as an optimum level of dehydration for maintaining six months longevity and good flower shape. Dehydration at low temperature (40°C) or flower drying at ambient temperature with sand or silica gel as embedding media, exhibited better quality with good petal-texture, colour and low degradation of carotenoids and anthocyanins.

***Key words*: Dehydration, embedding media, moisture content, pigment, temperature, *Zinnia*.**

INTRODUCTION

Dry flowers have great export potential as nearly 70% of total export of floricultural commodities consists of dried products (Singh 2000). Yet, systematic and organized research on various aspects of flower dehydration technology is meager. Hence, with a view to exploit dehydration technology to enhance the keeping quality of zinnia flowers, along with an effort towards value addition to this ornamental crop, this research problem was undertaken. While employing this technology, the main emphasis was given to colour for maintaining aesthetic appearance of flowers. Besides this, how dehydration affects the flower physiology and how the dehydration methods influence the chloroplast and vacuolar pigments, the flower tissue integrity and correlation of moisture content with dry flower shape and keeping quality were also examined and their influence on success of dehydration technology was studied.

MATERIALS AND METHODS

The study was conducted in the Department of Floriculture and Landscaping, ASPEE College of Horticulture and Forestry, Gujarat Agricultural University, Navsari. Two experiments were conducted during the research work, experiment A [under different drying conditions- room (D1) and sun (D2)] and experiment B [at different temperatures, viz. 40°C (T1), 45°C (T2) and 50°C (T3)], along with three embedding media for both the experiments viz; sand (M1), Borax (M2) and silica gel in powder form (M3). The experimental design was completely randomized block with factorial concept. Treatments were replicated four times. Observations were recorded at an interval of one day for experiment A and six h. for experiment B. The orangish-yellow flowers of *Zinnia linearis* were harvested at full bloom stage, in the morning hours before 11 a.m., required observations with respect to flower weight, size, shape, colour and texture were taken and embedded in different media carefully in

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aluminum trays and kept for drying at different temperatures (oven) and different conditions (room and sun). Observations on quantitative and qualitative parameters were recorded daily. The pigment analysis of fresh and after optimum dehydration was also carried out. The chloroplast pigments chlorophylls; carotenes and xanthophylls were extracted using extraction method given by Machlis and Torrey (1956) while the vacuolar pigment anthocyanins were extracted and estimated according to the analysis procedure described by Lees and Francis (1972).

RESULTS AND DISCUSSION

Temperature influenced quantitative and qualitative parameters where drying at higher temperature resulted into rapid drying of flowers with higher moisture loss (Table 1). At higher temperature, as proposed by Mayak and Halevy, (1980) rate of transpiration is higher. This can be attributed to higher respiration rate with more ethylene release, modifying permeability of cell membrane by weakening cell membrane integrity through cellulase and phospholipase enzyme that causes cell leakage and thus, maximum moisture is liberated from cellls at higher temperature. Simillarly, at higher temperature, surface evaporation of water is also higher. With increase in temperature, diffusion pressure deficit (DPD) of air increases *i.e.* saturation point of air is raised due to decreased relative humidity. This stimulates diffusion of internal moisture to surface and further increases its vaporization rate. Thus, leading to higher moisture loss at higher temperature. Similar results of rapid drying at higher temperature have also been reported in rose and carnation by Chen *et al.* (2000), in coriander and fenugreek

Table 1. Effect of different dehydration treatments on per cent moisture cotnent in the flowers of *Zinnia linearis* Benth.

Experiment A.

Drying Condition	After 3 days Embedding media				After 5 days Embedding media			
	M1	M1	M3	Mean	M1	M2	M3	Mean
D1 (room)	15.1	12.3	10.8	12.73	9.8	9.2	5.8	8.27
	(22.87)	(20.5)	(19.2)	(20.9)	(18.2)	(17.6)	(13.7)	(16.5)
D2 (sun)	12.2	11.35	9.8	11.11	8.6	5.9	4.6	6.35
	(20.4)	(19.7)	(18.2)	(19.4)	(17.1)	(13.9)	(12.3)	(14.43)
Mean	513.65	11.83	10.3		9.2	5.53	5.2	
	(21.7)	(20.1)	(18.7)		(17.6)	(15.8)	(13.01)	

(Figures in paranthesis are arc sine transformed values)
CD at 5% for: D=0.2820, M=0.3458 and DxM=.4885D=0.5085, M=0.6225 and DxM=.8808

Experiment B.

Drying Temp.	After 24 hours Embedding media				After 30 hours Embedding media			
	M1	M2	M3	Mean	M1	M2	M3	Mean
T1	12.26	11.53	10.6	11.46	8.9	8.6	6.3	7.93
	(20.26)	(19.8)	(19.1)	(17.8)	(17.4)	(17.1)	(14.6)	(16.9)
T2	11.8	11.1	9.8	10.9	8.2	6.3	5.86	6.79
	(20.1)	(19.4)	(18.3)	(19.3)	(16.6)	(14.5)	(13.9)	(15.01)
T3	11.4	8.2	6.2	8.6	7.7	6.25	3.9	5.96
	(19.8)	(16.6)	(14.4)	(16.9)	(16.1)	(14.4)	(11.3)	(13.94)
Mean	11.82	10.28	8.86		8.3	7.06	5.4	
	(20.1)	(18.6)	(17.2)		(16.7)	(15.3)	(13.26)	

(Figures in paranthesis are arc sine transformed values)
CD at 5% for: T=0.908, M=0.908 and TxM=1.573T=1.573, M=1.573 and TxM=NS

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drying (Pandey *et al.* 2000) and in spice and condiments by Pandey (2001).

Drying of flowers at higher temperature caused more degradation of all pigments, viz. chlorophylls, carotenes, xanthophylls and anthocyanins (Table 2). All these pigments except anthocyanins, are located in grana (memberance of thylakoids) in the chloroplast. Bartley and Hallam (1979), working with *Coleochloa setifer* observed that chloroplast looses thylakoids and contains only vesicles and plastoglobuli after drying. Thus, clearly indicating degradation of pigments on drying and higher temperature might have aggravated the effect. Similar results have been reported by Levin (1989) in conifer foliage, Ramus *et al.* (1993) in spinach and Minquez *et al.* (1994) in *Capsicum annum*. Besides, Sharma *et al.* (2000) have reported high susceptibility of carotenoids to auto oxidative degradation during processing and storage, that causes discolouration.

Anthocyanins are water soluble, located in vacuoles. At higher temperature, moisture loss and ethylene release might have caused disintegration of tonoplast, thus, affecting anthocyanin pigments. Quantitative studies by Mescheter (1953) on the effect of heat on degradation of anthocyanins showed exponential increase in pigment destruction with increase in temperature. Similarly, Sistrunk and Morris (1978) in strawberry preserves and Khafaga and Kock (1980) in *Hibiscus sabdariffa* var. sabdariffa recorded higher degradation in anthocyanins at higher temperature. Anthocyanin being phenylpropanoid may show browning effect on oxidation and the effect may be more at higher temperature. Mackinney *et al.* (1955) reported linear relationship between pigment loss and browning. This browning effect in orangish-yellow colour tone might provide darker colour tone. Similar effect has been reported by Sistrunk and Morris (1978) and Feenestra (1960). Sanders *et al.* (1989) also reported increased colour intensity in peanut curing at higher temperature. Besides, media also influenced flower colour, where bleaching property of borax resulted into fading effect while no such effect was observed with sand and silica gel. Similar results have been reported by Pamela (1992) and Bhutani (1995). Accordingly, the effect of temperature and drying media on degradation of pigments and change in flower colour is outlined in Fig 1.

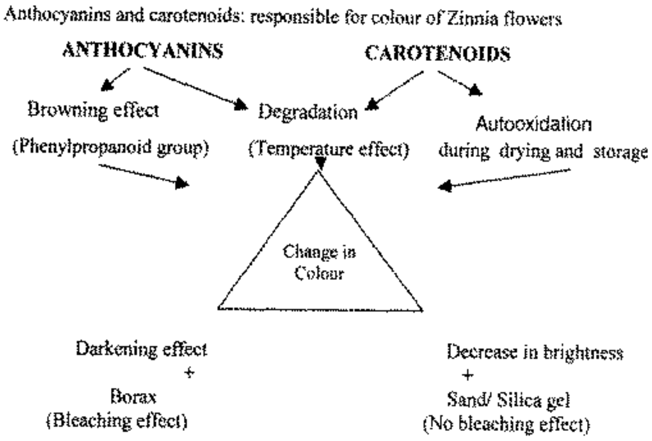

Fig. 1. Effect of drying on colour in zinnia

Moisture content in the flowers after drying influenced flower shape; lower moisture content provided rigidity and uniform cell-contraction in the flower while at higher moisture content dried flowers appeared flaccid as illustrated

Table 2. Effect of drying on pigment cotnent in the flowers of *Zinnia linearis* Benth.

Sample	Chlorophylls (mg g^{-1}fw)	Carotenes (mg g^{-1}fw)	Xanthophylls (mg g^{-1}fw)	Anthocyanins (mg g^{-1}fw)
Fresh flowers	0.1259	0.0248	0.0231	0.3513
Room dried flowers	0.0784	0.0198	0.0196	0.2431
Sun dried flowers	0.0377	0.0163	0.0195	0.2004
40°C (Cabinet drying)	0.0421	0.0122	0.0107	0.2303
45°C (Cabinet drying)	0.0370	0.0049	0.0104	0.2181
50°C (Cabinet drying)	0.0251	0.0049	0.0049	0.1839

in Fig 2. This finding was further supported by Chen Wei *et al.* (2000) who reported stronger and stiffer petals in dried flowers having low moisture content. Mechanical support provided by the media throughout the drying process ensured well-maintained flower shape in the flowers having moisture content below 11.5%. Embedding media also influenced petal texture. Drying with sand provided smooth petal texture while with silica gel slight roughness and with borax more roughness was recorded. This might be influenced by mode of moisture liberation from the flowers and physical pressure applied by the embedding media.

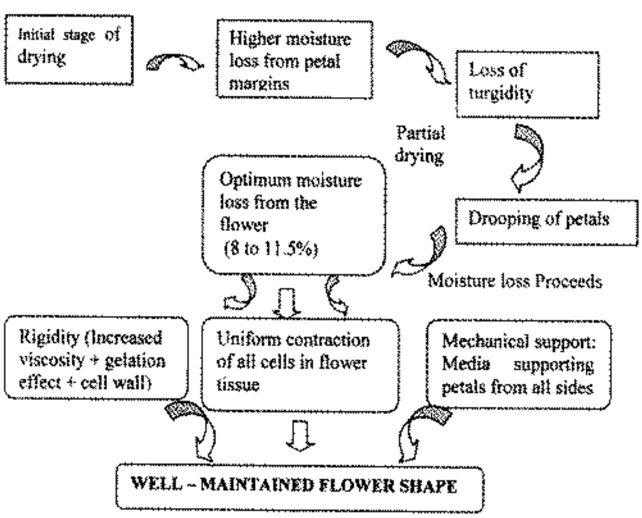

Fig. 2. Effect of drying on flower shape in zinnia

Moisture content in dried flowers influenced longevity. Lower moisture content showed higher longevity as also reported by Brandenburg *et al.* (1961) and Pandey (2001). A range of 8 to 11.5% moisture content in the dried flowers provided optimum drying with good quality, firmness and maintained keeping quality for more than six months. Excessive drying of flowers resulted into petal shedding during handling. Drying below 8% moisture content showed shedding effect. This may be attributed to excessive loss in moisture, which may have resulted into weakened adhesion and cohesion forces in flower tissue, which might have caused softening of middle lamella leading to abscission. Sanders *et al.* (1981) reported increased vulnerability of peanuts to mechanical damage during commercial shelling due to excessive shrinkage below 6.5% moisture content. Further, Papparozzi and Mc Callister (1988) observed rapid tissue dessication in microwave dried statice flowers and Wilkins and Desborough (1986) observed vulnerability of flowers to breakage in vacuum dried dianthus flowers.

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