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Effect of different levels of embedding media and traditional drying methods on production of quality dry flowers in chrysanthemum cv. local yellow

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Abstract
An experiment was laid out to study the "Effect of different levels of embedding media and traditional drying methods on production of quality dry flowers in chrysanthemum cv. local yellow" was carried out in the Department of Floriculture and Landscape Architecture, College of Horticulture, Venkataramannagudem, West Godavari district, Andhra Pradesh during the year 2021-22. The minimum dry weight (0.42 g), minimum moisture content (12.78%), minimum time taken for drying of flowers (4 days) and maximum per cent age of weight loss (85.21%), maximum percentage of moisture loss (85.61%) was recorded in the flowers embedded in silica gel under sun drying conditions and the maximum dry weight (0.81 g), maximum moisture content (23.66%) and maximum time taken for drying of flowers (7 days) and minimum per cent age of weight loss (70.22%), minimum percentage of moisture loss (72.94%) was recorded in flowers embedded in sand under shade drying conditions. Maximum xanthophyll retention (48.76%) was recorded in flowers embedded in silica gel under shade drying conditions and minimum xanthophyll retention (24.29%) was recorded in flowers embedded in sand under sun drying conditions. From the above findings it could be concluded that flowers embedded in silica gel under sun drying conditions showed good results with respect to dry weight, moisture content, time taken for drying, per cent age of weight loss and percentage of moisture loss compare to flowers embedded in sand under shade drying conditions.

Keywords: Chrysanthemum, sun drying, silica gel, moisture content

Introduction
Drying and preserving flowers and plant material is a form of artistic expression that has been very popular during the Victorian age and is gaining popularity in recent time. Dried or dehydrated flowers or plant parts (roots, leaves, stem, bark or whole plant) have tremendous potential to substitute fresh flowers and foliage for interior decoration and other aesthetic and commercial uses.

In global floriculture trade, Netherlands (51.20%) contributes maximum export of dry flowers to different countries followed by Israel (14.20%), Nigeria (5.60%) and India (4.80%). The UK is the largest importer of dry flowers accounting for 65 million US$ import, amounting to 40.7% of the total, followed by France and Japan. The demand for dry flowers has increased in the last decades, thus offering immense opportunities to the Indian entrepreneurs to enter the global Floriculture trade (Nair and Singh, 2011) [1]. Netherlands ranks first in export of dried flowers to the American market followed by Columbia, Mexico, India and Israel. In the recent years, Australia is emerging as a leader in dry flower export with Japan, Germany and the United States of America as their prime markets (Mathapathi *et al.* 2015) [2]. In India, Maharashtra, Karnataka, Andhra Pradesh, Hyderabad and Kolkata have emerged as major dry flower industries in recent times. This industry showed a growth rate of 15% annually (Murugan *et al.* 2007) [3].

Material and Methods
The present investigation was carried out on "Effect of different levels of embedding media and traditional drying methods on production of quality dry flowers in chrysanthemum cv. local yellow" during 2021-22 at Department of Floriculture and Landscape Architecture, College of Horticulture, Venkataramannagudem, West Godavari district, Andhra Pradesh. Chrysanthemum flowers immediately after brought to the laboratory embedded in different

media (sand, silica gel, sand: silica gel (50:50 v/v). Flowers kept in face up position and dried in sun and shade conditions. The experiment was laid out in a Factorial Completely Randomized Design.

Treatments combinations are T_1- M_1Dm_1: Sand + Shade drying, T_2- M_1Dm_2: Sand + Sun drying, T_3- M_2Dm_1: Silica gel + Shade drying, T_4- M_2Dm_2: Silica gel + Sun drying, T_5- M_3Dm_1: Sand: Silica gel (50:50 v/v) + Shade drying, T_6- M_3Dm_2: Sand: Silica gel (50:50 v/v) + Sun drying. M_1: Sand, M_2: Silica gel, M_3: Sand: Silica gel (50:50 v/v); Dm_1: Shade drying, Dm_2: Sun drying.

Results and Discussion

The data was recorded for the following parameters.

Dry weight of flowers (g)

The data pertaining to dry weight of flowers (g) due to influence of embedding media and traditional drying methods in chrysanthemum cv. Local Yellow are presented in Table 1. Clearly revealed that mean dry weight of flowers as influenced by different embedding media and drying methods decreased gradually from 2.30 g to 0.62 g from day 1 to day 7.

Table 1: Effect of different embedding media and traditional drying methods on dry weight of flowers (g) in chrysanthemum cv. Local yellow

Media (M)	Traditional drying methods (Dm)																							
	Days taken for drying																							
	Initial weight			Day 1			Day 2			Day 3			Day 4			Day 5			Day 6			Day 7		
	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean
M_1	2.72	2.65	2.68	2.44	2.27	2.36	2.14	1.87	2.00	1.81	1.43	1.62	1.46	1.00	1.23	1.19	0.59	0.89	0.97	0.56	0.76	0.81	0.55	0.68
M_2	2.61	2.84	2.72	2.29	2.23	2.26	1.95	1.60	1.77	1.61	1.02	1.31	1.26	0.51	0.88	0.92	0.45	0.68	0.68	0.43	0.55	0.67	0.42	0.54
M_3	2.58	2.77	2.67	2.29	2.28	2.29	2.00	1.82	1.91	1.70	1.40	1.55	1.42	0.96	1.19	1.14	0.58	0.86	0.89	0.53	0.71	0.72	0.52	0.62
Mean	2.63	2.75	2.69	2.34	2.26	2.30	2.03	1.76	1.90	1.70	1.28	1.50	1.38	0.82	1.10	1.08	0.54	0.81	0.84	0.50	0.68	0.73	0.49	0.62
Factor	S.Em (±)	CD @ 5%	S.Em (±)	CD @5%	S.Em (±)	CD @ 5%	S.Em(±)	CD @5%	S.Em (±)	CD @ 5%	S.Em (±)	CD @5%	S.Em (±)	CD @ 5%										
Media (M)	-	-	0.02	0.07	0.02	0.06	0.01	0.05	0.01	0.03	0.01	0.03	0.01	0.02										
Drying method (Dm)	-	-	0.02	0.06	0.02	0.04	0.01	0.04	0.01	0.03	0.01	0.02	0.01	0.02										
M × Dm	-	-	0.03	N.S	0.03	0.08	0.02	0.06	0.02	0.05	0.02	0.04	0.02	0.03										

M_1: Sand, M_2: Silica gel, M_3: Sand: Silica gel (50:50 v/v); Dm_1: Shade drying, Dm_2: Sun drying

The differences in dry weight of flowers as influenced by different embedding media were found significant. Among the different embedding media, dry weight of flowers significantly decreased during drying period from day 1 to day 7. The minimum dry weight of flowers was recorded in flowers embedded in silica gel (M_2) from day 1 (2.26 g) to day 7 (0.54 g) followed by flowers embedded in sand: silica gel (50:50 v/v) (M_3) from day 1 (2.29 g) to day 7 (0.62 g) whereas maximum dry weight of flowers was recorded in flowers embedded in sand (M_1) from day 1 (2.36 g) today 7 (0.68 g).

The differences in dry weight of flowers as influenced by drying methods were found significant. Among the drying methods, dry weight of flowers significantly decreased during drying period from day 1 to day 7. The minimum dry weight of flowers was recorded under sun drying (Dm_2) from day 1 (2.26 g) to day 7 (0.49 g) and the maximum dry weight of flowers was recorded under shade drying (Dm_1) from day 1 (2.34 g) to day 7 (0.73 g).

The interaction effect between different embedding media and drying methods on dry weight of flowers was found non-significant during day 1, whereas from day 2 to day 7 significant differences were observed between interactions. The minimum dry weight of flowers was noticed in flowers embedded in silica gel under sun drying (M_2Dm_2) from day 2 (1.60 g) to day 7 (0.42 g) followed by flowers embedded in sand: silica gel (50:50 v/v) under sun drying (M_3Dm_2) from day 2 (1.82 g) to day 7 (0.52 g) whereas the maximum dry weight of flowers was noticed in flowers embedded in sand under shade drying (M_1Dm_1) from day 2 (2.14 g) to day 7 (0.81 g).

From the above findings it was revealed that flowers embedded in silica gel under sun drying (M_2Dm_2) recorded minimum dry weight, which may be due to properties of silica gel which act as a quick dehydrating agent and rapid drying under sun due to high temperature. Similar results were reported in calendula, coreopsis and cosmos by Parmar *et al.* (2018) [4] and chrysanthemum var. marigold by Chithira (2017) [5].

Per cent weight loss (%)

The data pertaining to per cent weight loss due to influence of embedding media and traditional drying methods in chrysanthemum cv. Local Yellow are presented in Table 2. Clearly revealed that mean per cent weight loss as influenced by different embedding media and drying methods increased gradually from 14.55% to 77.05% from day 1 to day 7.

Table 2: Effect of different embedding media and traditional drying methods on per cent weight loss (%) in chrysanthemum cv. Local yellow

Media (M)	Traditional drying methods (Dm)																							
	Days taken for drying																							
	Day 1			Day 2			Day 3			Day 4			Day 5			Day 6			Day 7					
	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean
M_1	10.29 [3.36]	14.34 [3.91]	12.31 [3.63]	21.32 (27.48)	29.43 (32.84)	25.37 (30.16)	33.45 (35.32)	45.04 (42.71)	39.74 (39.01)	46.32 (42.87)	62.26 (52.08)	54.29 (47.47)	56.25 (48.57)	77.73 (61.84)	66.99 (55.20)	64.34 (53.31)	78.86 (62.63)	71.60 (57.97)	70.22 (57.00)	79.24 (62.84)	74.73 (59.92)			
M_2	12.26 [3.64]	21.47 [4.74]	16.87 [4.19]	25.28 (30.17)	43.66 (41.34)	34.47 (35.75)	38.31 (38.22)	64.08 (53.16)	51.19 (45.69)	51.72 (45.97)	82.04 (64.93)	66.88 (55.45)	64.75 (53.56)	84.15 (66.56)	74.45 (60.06)	73.94 (59.29)	84.85 (67.12)	79.40 (63.21)	74.33 (59.55)	85.21 (67.54)	79.77 (63.48)			
M_3	11.24 [3.49]	17.69 [4.32]	14.46 [3.91]	22.48 (28.29)	34.29 (35.83)	28.38 (32.06)	34.11 (35.71)	49.45 (44.67)	41.78 (40.19)	44.96 (42.09)	65.34 (53.91)	55.15 (48.00)	55.81 (48.32)	79.06 (62.76)	67.43 (55.54)	65.50 (54.01)	80.86 (64.06)	73.18 (59.04)	72.09 (58.20)	81.22 (64.39)	76.65 (61.30)			
Mean	11.26	17.83	14.55	23.03	35.79	29.41	35.29	53.19	44.24	47.66	69.88	58.78	58.94	80.31	69.63	67.93	81.53	74.73	72.21	81.89	77.05			

	[3.50]	[4.32]	(28.65)	(36.67)	(36.42)	(46.84)	(43.64)	(56.97)	(50.15)	(63.72)	(55.54)	(64.60)	(58.18)	(64.92)
Factor	SEm (±)	CD @ 5%	SEm (±)	CD @ 5%	SEm (±)	CD @ 5%	SEm (±)	CD @5%	SEm (±)	CD @5%	SEm (±)	CD @ 5%	SEm (±)	CD @ 5%
Media (M)	0.02	0.06	0.19	0.58	0.27	0.83	0.40	1.20	0.50	1.50	0.54	1.63	0.56	1.70
Drying method (Dm)	0.02	0.05	0.16	0.48	0.22	0.68	0.32	0.98	0.41	1.22	0.44	1.33	0.46	1.39
M × Dm	0.03	0.08	0.27	0.83	0.39	1.18	0.56	1.69	0.71	2.15	0.77	2.33	0.80	2.40

Figures in parentheses () are arc sign transformed values; Figures in parentheses [ ] are square root transformed values

M_1: Sand, M_2: Silica gel, M_3: Sand: Silica gel (50:50 v/v); Dm_1: Shade drying, Dm_2: Sun dryin The differences in per cent weight loss as influenced by different embedding media were found significant. Among the different embedding media, per cent weight loss significantly increased during drying period from day 1 to day 7. The maximum per cent weight loss was recorded in flowers embedded in silica gel (M_2) from day 1 (16.87%) to day 7 (79.77%) followed by flowers embedded in sand: silica gel (50:50 v/v) (M_3) from day 1 (14.46%) to day 7 (76.65%) whereas minimum per cent weight loss was recorded in flowers embedded in sand (M_1) from day 1 (12.31%) to day 7 (74.73%).

The differences in per cent weight loss as influenced by drying methods were found significant. Among the drying methods, per cent weight loss significantly increased during drying period from day 1 to day 7. The maximum per cent weight loss was recorded under sun drying (Dm_2) from day 1 (17.83%) to day 7 (81.89%) and the minimum per cent weight loss was recorded under shade drying (Dm_1) from day 1 (11.26%) to day 7 (72.21%).

The interaction effect between different embedding media and drying methods on per cent weight loss was found significant from day 1 to day 7 during drying period. The maximum per cent weight loss was noticed in flowers embedded in silica gel under sun drying (M_2Dm_2) from day 1 (21.47%) to day 7 (85.21%) followed by flowers embedded in sand: silica gel (50:50 v/v) under sun drying (M_3Dm_2) from day 1 (17.69%) to day 7 (81.22%) whereas, the minimum per cent weight loss was noticed in flowers embedded in sand under shade drying (M_1Dm_1) from day 1 (10.29%) to day 7 (70.22%).

From the above data, it is concluded that flowers embedded in silica gel dried under sun drying (M_2Dm_2) recorded maximum percentage of weight loss. From the above results, It was evident that the weight loss during drying was caused by the loss of moisture. At a higher temperature, the rate of moisture loss or liberation of moisture from flower tissue (transpiration) was increased due to increased conduction and convection of heat to the flower tissue, and its evaporation from the surface was also accelerated due to an increase in DPD (diffusion pressure deficit) and a decrease in relative humidity in the outside conditions, which causes drying. Similar results were recorded by Singh *et al.* (2004) [6] in Zinnia and Varu (2014) [7] in rose, gerbera and gomphrena.

Silica gel has a great capacity to absorb moisture up to 30-50% of its own weight. Silica gel (60-120 mesh) was found to be the best absorbent for removing moisture from the flowers and foliage. Similar line of work was reported by Meman *et al.* (2006) [8] in China aster flowers and Parmar *et al.* (2018) [4] in calendula, coreopsis and cosmos.

Per cent moisture content (%)

The data pertaining to per cent moisture content due to influence of embedding media and traditional drying methods in chrysanthemum cv. Local Yellow are presented in Table 3. Clearly revealed that mean moisture content (%) as influenced by different embedding media and drying methods decreased gradually from 73.12% to 18.62% from day 1 to day 7.

Table 3: Effect of different embedding media and traditional drying methods on per cent moisture content (%) in chrysanthemum cv. Local yellow

Media (M)	**Traditional drying methods (DM)**											
	Days taken for drying											
	Initial moisture content			**Day 1**			**Day 2**			**Day 3**		
	Dm_1	**Dm_2**	**Mean**	**Dm_1**	**Dm_2**	**Mean**	**Dm_1**	**Dm_2**	**Mean**	**Dm_1**	**Dm_2**	**Mean**
M_1	87.43 [9.40]	89.67 [9.52]	88.55 [9.46]	76.27 (60.84)	74.71 (59.80)	75.49 (60.32)	66.45 (54.59)	60.99 (51.33)	63.72 (52.96)	55.94 (48.40)	46.30 (42.86)	51.12 (45.63)
M_2	88.21 [9.44]	88.78 [9.47]	88.49 [9.45]	75.22 (60.14)	67.54 (55.25)	71.38 (57.69)	63.66 (52.91)	47.66 (43.64)	55.66 (48.28)	52.06 (46.16)	29.60 (32.95)	40.83 (39.56)
M_3	86.91 [9.37]	87.88 [9.42]	87.39 [9.40]	75.02 (60.01)	69.98 (56.76)	72.50 (58.38)	65.24 (53.86)	55.43 (48.10)	60.34 (48.10)	55.01 (47.86)	42.32 (40.57)	48.66 (44.21)
Mean	87.51 [9.40]	88.77 [9.47]	88.14	75.50 (60.33)	70.74 (57.27)	73.12	65.12 (53.79)	54.69 (47.69)	59.91	54.34 (47.47)	39.41 (38.79)	46.87
Factors	SEm (±)	CD @ 5%	SEm (±)	CD @ 5%	SEm (±)	CD @ 5%	SEm (±)	CD @ 5%				
Media (M)	-	-	0.49	1.48	0.37	1.11	0.28	0.86				
Drying method (Dm)	-	-	0.40	1.21	0.30	0.90	0.23	0.70				
M × Dm	-	-	0.70	2.10	0.52	1.57	0.40	1.21				

Media (M)	Traditional drying methods (DM)											
	Days taken for drying											
	Day 4			Day 5			Day 6			Day 7		
	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean
M_1	44.62 (41.90)	31.55 (34.16)	38.08 (38.03)	35.99 (36.85)	17.58 (24.78)	26.78 (30.81)	29.08 [5.48]	17.26 [4.27]	23.17 [4.88]	23.66 [4.97]	17.03 [4.25]	20.34 [4.61]
M_2	40.29 (39.39)	13.62 (21.65)	26.96 (30.52)	28.72 (32.39)	13.34 (21.41)	21.03 (26.90)	20.89 [4.68]	13.02 [3.74]	16.95 [4.21]	20.71 [4.66]	12.78 [3.71]	16.75 [4.19]
M_3	43.93 (42.39)	28.31 (32.13)	36.11 (38.81)	34.89 (36.18)	16.14 (23.68)	25.51 (29.93)	27.88 [5.37]	15.87 [4.11]	21.88 [4.74]	21.87 [4.78]	15.66 [4.08]	18.76 [4.43]
Mean	42.94 (41.49)	24.49 (29.31)	33.71	33.20 (35.14)	15.69 (23.29)	24.42	25.95 [5.18]	15.38 [4.04]	20.67	22.08 [4.80]	15.16 [4.01]	18.62
Factors	SEm (±)	CD @ 5%		SEm (±)	CD @ 5%		SEm (±)	CD @ 5%		SEm (±)	CD @ 5%	
Media (M)	0.22	0.66		0.17	0.52		0.02	0.06		0.02	0.06	
Drying method (Dm)	0.18	0.53		0.14	0.43		0.01	0.05		0.01	0.05	
M × Dm	0.31	0.93		0.24	0.74		0.03	0.09		0.03	0.09	

Figures in parentheses () are arc sign transformed values; Figures in parentheses [] are square root transformed values

M_1: Sand, M_2: Silica gel, M_3: Sand: Silica gel (50:50 v/v); Dm_1: Shade drying, Dm_2: Sun drying.

The differences in per cent moisture content as influenced by different embedding media were found significant. Among the different embedding media, percentage of moisture content significantly decreased during drying period from day 1 to day 7. The lowest moisture content (%) was recorded in flowers embedded in silica gel (M_2) from day 1 (71.38%) to day 7 (16.75%) followed by flowers embedded in sand: silica gel (50:50 v/v) (M_3) from day 1 (72.50%) to day 7 (18.76%) whereas highest moisture content (%) was recorded in flowers embedded in sand (M_1) from day 1 (74.71%) to day 7 (20.34%).

The differences in per cent moisture content as influenced by drying methods were found significant. Among the drying methods, percentage of moisture content significantly decreased during drying period from day 1 to day 7. The lowest moisture content (%) was recorded under sun drying (Dm_2) from day 1 (70.74%) to day 7 (15.16%) and the highest moisture content (%) was recorded under shade drying (Dm_1) from day 1 (75.50%) to day 7 (22.08%).

The interaction effect between different embedding media and drying methods on per cent moisture content was found significant from day 1 to day 7 during drying period. The lowest moisture content (%) was noticed in flowers embedded in silica gel dried under sun (M_2Dm_2) from day 1 (67.54%) to day 7 (12.78%) followed by flowers embedded in sand: silica gel (50:50 v/v) dried under sun (M_3Dm_2) from day 1 (69.98%) to day 7 (15.66%) whereas, the highest moisture content (%) was noticed in flowers embedded in sand under shade drying (M_1Dm_1) from day 1 (76.27%) to day 7 (23.66%).

From the above results it was observed that flowers embedded in silica gel dried under sun (M_2Dm_2) record minimum per cent moisture content. Similar results were reported in rose, gerbera and gomphrena by Varu (2014) [7].

Per cent moisture loss (%)

The data pertaining to per cent moisture loss due to influence of embedding media and traditional drying methods in chrysanthemum cv. Local Yellow are presented in Table 4. Clearly revealed that mean per cent moisture loss as influenced by different embedding media and drying methods increased gradually from 17.03% to 78.85% from day 1 to day 7.

Table 4: Effect of different embedding media and traditional drying methods on per cent moisture loss (%) in chrysanthemum cv. Local yellow

Media (M)	Traditional drying methods (Dm)																				
	Days taken for drying																				
	Day 1			Day 2			Day 3			Day 4			Day 5			Day 6			Day 7		
	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean	Dm_1	Dm_2	Mean
M_1	12.76 [3.71]	16.69 [4.21]	14.73 [3.96]	23.99 (29.32)	31.99 (34.43)	27.99 (31.87)	36.01 (36.86)	48.37 (44.05)	42.19 (40.46)	48.96 (44.39)	64.82 (53.60)	56.89 (49.00)	58.83 (50.07)	80.40 (63.73)	69.62 (56.90)	66.74 (54.77)	80.75 (63.98)	73.75 (59.38)	72.94 (58.65)	81.01 (64.17)	76.98 (61.41)
M_2	14.73 [3.96]	23.93 [4.99]	19.33 [4.48]	27.83 (31.83)	46.32 (42.87)	37.07 (37.35)	40.98 (39.79)	66.65 (54.71)	53.82 (47.25)	54.32 (47.46)	84.65 (66.96)	69.49 (57.21)	67.44 (55.19)	84.97 (67.22)	76.21 (61.21)	76.32 (60.88)	85.34 (67.51)	80.83 (64.19)	76.52 (61.01)	85.61 (67.73)	81.06 (64.37)
M_3	13.68 [3.83]	20.37 [4.62]	17.03 [4.23]	24.93 (29.94)	36.93 (37.41)	30.93 (33.67)	36.71 (37.28)	51.84 (46.04)	44.28 (41.66)	49.44 (44.66)	67.79 (55.41)	58.61 (50.03)	59.85 (50.66)	81.63 (64.63)	70.74 (57.64)	67.92 (55.49)	81.94 (64.86)	74.93 (60.17)	74.84 (59.89)	82.18 (65.04)	78.51 (62.46)
Mean	13.72 [3.83]	20.33 [4.61]	17.03	25.58 (30.36)	38.41 (38.23)	32.00	37.90 (37.98)	55.62 (48.27)	46.76	50.90 (45.50)	72.42 (58.66)	61.66	62.04 (51.97)	82.34 (65.19)	72.19	70.33 (57.04)	82.68 (65.45)	76.50	74.77 (59.85)	82.93 (65.65)	78.85
Factor	SEm (±)		CD @ 5%	SEm (±)		CD @ 5%	SEm (±)		CD @ 5%	SEm (±)		CD @ 5%	SEm (±)		CD @ 5%	SEm (±)		CD @ 5%	SEm (±)		CD @ 5%
Media (M)	0.02		0.06	0.20		0.62	0.29		0.88	0.43		1.29	0.53		1.59	0.57		1.70	0.59		1.77
Drying method (Dm)	0.01		0.05	0.17		0.51	0.24		0.72	0.35		1.05	0.43		1.30	0.46		1.39	0.48		1.45
M × Dm	0.03		0.08	0.29		0.88	0.41		1.24	0.61		1.83	0.75		2.25	0.80		2.40	0.84		2.52

Figures in parentheses ( ) are arc sign transformed values; Figures in [ ] are square root transformed values

M_1: Sand, M_2: Silica gel, M_3: Sand: Silica gel (50:50 v/v); Dm_1: Shade drying, Dm_2: Sun drying

The differences in per cent moisture loss as influenced by different embedding media were found significant. Among the different embedding media, per cent moisture loss significantly increased during drying period from day 1 to day 7. The maximum per cent moisture loss was recorded in flowers embedded in silica gel (M_2) from day 1 (19.33%) to day 7 (81.06%) followed by flowers embedded in sand: silica gel (50:50 v/v) (M_3) from day 1 (17.03%) to day 7 (78.51%) whereas minimum per cent moisture loss was recorded in flowers embedded in sand (M_1) from day 1 (14.73%) to day 7 (76.98%).

The differences in per cent moisture loss as influenced by drying methods were found significant. Among the drying methods, per cent moisture loss significantly increased during drying period from day 1 to day 7. The maximum per cent moisture loss was recorded under sun drying (Dm_2) from day 1 (20.33%) to day 7 (82.93%) and the minimum per cent moisture loss was recorded under shade drying (Dm_1) from day 1 (13.72%) to day 7 (74.77%).

The interaction effect between different embedding media and drying methods on per cent moisture loss was found significant from day 1 to day 7 during drying period. The maximum per cent moisture loss was noticed in flowers embedded in silica gel under sun drying (M_2Dm_2) from day 1 (23.93%) to day 7 (85.61%) followed by flowers embedded in sand: silica gel (50:50 v/v) under sun drying (M_3Dm_2) from day 1 (20.37%) to day 7 (82.18%) whereas, the minimum per cent moisture loss was noticed in flowers embedded in sand under shade drying (M_1Dm_1) from day 1 (12.76%) to day 7 (72.94%).

From the above results it was observed that flowers embedded in silica gel under sun drying (M_2Dm_2) recorded maximum per cent moisture loss. This could be due to strong hygroscopic nature of silica gel and higher temperature under sun drying. Under sun drying both temperature and wind velocity were high than the shade drying. At higher temperatures, rate of moisture loss or liberation of moisture from flower tissues was more due to higher transfer of heat by conduction and convection. Similar results were reported by Meman *et al.* (2006) [8] in China aster.

The maximum moisture loss in silica gel may be due to its superior hydrosorbent properties when compared to other desiccants used. The better hydrosorbent properties of silica gel could be attributed to the fact that it is made of sodium silicate and is composed of a vast network of interconnected microscopic pores that attract and hold moisture through a process known as physical absorption and capillary condensation Safeena *et al.* (2006) [9]. The present results were conformity with Dahiya (2003) [10] in chrysanthemum and Yadlod *et al.* (2016) [11] in rose cv. Gold Strike and Bordo.

Time taken for drying of flowers (days)

The data pertaining to time taken for drying of flowers (days) as influenced by different embedding media and traditional drying methods in chrysanthemum cv. Local Yellow are presented in Table 5.

Table 5: Effect of different levels of embedding media and traditional drying methods on time taken for drying (days) in chrysanthemum cv. Local yellow

Treatment combinations	Drying time
T_1 - M_1Dm_1	7 days
T_2 - M_1Dm_2	5 days
T_2 - M_1Dm_2	6 days
T_4 - M_2Dm_2	4 days
T_3 - M_2Dm_1	7 days
T_6 - M_3Dm_2	5 days

T_1 - M_1Dm_1 – Sand + Shade drying
T_2 - M_1Dm_2 – Sand + Sun drying
T_3 - M_2Dm_1 – Silica gel + Shade drying
T_4 - M_2Dm_2 – Silica gel + Sun drying
T_5 - M_3Dm_1 – Sand: Silica gel (50:50 v/v) + Shade drying
T_6 - M_3Dm_2 – Sand: Silica gel (50:50 v/v) + Sun drying

Among the treatment combinations, flowers embedded in silica gel under sun drying (M_2Dm_2) has recorded least time for drying (4 days) and flower embedded in sand and sand:silica gel (50:50 v/v) under sun drying (M_1Dm_2, M_3Dm_2 registered 5 days for drying followed by flowers embedding in silica gel under shade drying (M_2Dm_1) has taken 6 days for drying. While flowers embedding in sand:silica gel (50:50 v/v) under shade (M_3Dm_1) and sand embedding flowers under shade drying (M_1Dm_1) has recorded maximum time (7 days) for drying of flowers.

From the above findings it can be concluded that flowers embedded in silica gel under sun drying recorded less time for drying. This may be due to under sun drying temperature was comparatively higher than shade drying temperature, Therefore drying under shade was slow as compared to sun drying. Similar finding were reported by in gerbera.

Drying time was found to be more under shade drying this might be due low ambient temperature which causes addition of supplemented heat to vaporize the free water presented in the floral parts was very small and rate of evaporation was also controlled by the saturation prevailed in the room. Similar results were reported by Kumpavat *et al.* (2015) [12] in gerbera.

Xanthophyll retention (%)

The data pertaining to Xanthophyll retention (%) due to influence of embedding media and traditional drying methods in chrysanthemum cv. Local yellow are presented in table 7.

Table 6: Effect of different embedding media and traditional drying methods on xanthophyll retention (%) in chrysanthemum cv. Local yellow

Media (M)	Drying method (Dm)		
	Dm_1	**Dm_2**	**Mean**
M_1	30.24 (33.34)	24.29 (29.51)	27.26 (31.43)
M_2	48.76 (44.27)	44.19 (41.64)	46.47 (42.95)
M_3	38.47 (38.31)	35.97 (36.83)	37.22 (37.57)
Mean	39.15 (38.64)	34.81 (35.99)	36.98
Factor	S.Em(±)	CD @ 5%	
Media (M)	0.23	0.70	
Drying method (Dm)	0.19	0.57	
M × Dm	0.33	0.98	

Figures in parentheses ( ) are arc sign transformed values; Xanthophyll retention (%) of fresh flower - 56.21%
T1 - M1Dm1 – Sand + Shade drying
T2 - M1Dm2 – Sand + Sun drying
T3 - M2Dm1 – Silica gel + Shade drying
T4 - M2Dm2 – Silica gel + Sun drying
T5 - M3Dm1 – Sand: Silica gel (50:50 v/v) + Shade drying
T6 - M3Dm2 – Sand: Silica gel (50:50 v/v) + Sun drying

The xanthophyll retention in fresh flowers was 56.21% and decreased significantly in dried flowers. Among the different embedding media, significantly the maximum xanthophyll retention (46.47%) was recorded in flowers embedded in silica gel (M_2) whereas minimum xanthophyll retention (27.26%) was recorded in flowers embedded in sand (M_1).

Among the drying methods, significantly the maximum xanthophyll retention (39.15%) was recorded under sun drying (Dm_2) and the minimum xanthophyll retention (34.81%) was recorded under shade drying (Dm_1).

The interaction effect between different embedding media and drying methods on xanthophyll retention was found significant. The maximum xanthophyll retention (48.76%) was noticed in flowers embedded in silica gel under shade drying (M_2Dm_1) followed by silica gel under sun drying (M_2Dm_2, 44.19%) and the minimum xanthophyll retention (24.29%) was observed in flowers embedded in sand under sun drying (M_1Dm_2).

The above data reveals that the flowers embedded in silica gel under shade drying exhibited maximum xanthophyll retention. It could be due to high hygroscopic nature of silica gel and also less temperature effect in shade drying conditions compared to sun drying. Similar results were observed by Chithira (2017) [5] in chrysanthemum var. marigold.

Conclusion

In traditional drying of chrysanthemum cv. Local yellow, flowers embedded in silica gel under sun drying has recorded minimum dry weight, maximum per cent weight loss, minimum moisture content, maximum per cent of moisture loss, maximum change in diameter and minimum time for drying (days). Whereas, maximum xanthophyll retention was observed in flowers embedded in silica gel under shade drying condition. Economics analysis revealed that high benefit cost ratio was recorded in flowers embedded in silica gel under sun drying in chrysanthemum cv. Local yellow.

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