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Standardization of drying technique and embedding media for annual flowers of Asteraceae family

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Abstract
The present experiment was conducted to study the standardization of drying methods and embedding media for various annual flowers of Asteraceae family *viz.,* Calendula, Coreopsis and Cosmos. Sun drying condition recorded significantly minimum dry weight and maximum weight loss percentage, moisture loss percentage and took minimum days to drying with silica gel as embedding media in sun drying method while, minimum reduction in dried flower diameter was recorded with sand as embedding media in sun drying in Calendula, Coreopsis and Cosmos, respectively. Drying with silica gel embedding in room drying obtained maximum point scale on visual basis of colour, texture and appearance in dried flowers of Calendula, Coreopsis and Cosmos.

Keywords: Asteraceae flowers, sun drying, silica gel, embedding media, quality score

Introduction
In the present era of eco-consciousness, use of natural products like dry flowers and their parts has become the premier choice of the masses in their lifestyles for interior decoration. Future prospects of the dry flower industry are expected to contribute a lot to the country's economy in comparison to the fresh cut flowers and other live plants. Dry flowers and plant materials have tremendous potential as substitute for fresh flowers and foliages for interior decoration as well as for a variety of other aesthetic and commercial uses. Drying and preserving of flowers and plant materials is a form of artistic expression that was very popular during the Victorian age and has once again gained popularity. India is one of the major exporters of dry flowers to the tune of 5% of the world trade. This industry shows a growth rate of 15% annually. Potpourri is a major segment of dry flower industry valued at Rs. 55 crores in India alone. Easy availability of products from forests, possibility of manpower, availability of labours, intensive craft making and availability of wide range of products throughout the year are the reasons for development of dry flower industry in India. This industry provides direct employment to around 15,000 persons and indirect employment to around 60,000 persons. Dried flowers and plant parts are the major segment and constitute 77.1% of the total share of floriculture products export from India. Seasonal flowers are grown easily but doesn't market value. So, drying of some annual flowers draw the potential in this line. But, research on dry flower is merger, hence, the research endeavor was planned for standardization of drying techniques and embedding media for annual flowers of Asteraceae family like Calendula, Coreopsis and Cosmos.

Materials and Methods
Studies were conducted to standardize the drying technique and embedding media for annual flowers of Asteraceae Family *viz.,* Calendula, Coreopsis and Cosmos at Laboratory, Department of Floriculture and Landscape Architecture, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, during 2015-16. Experiment was laid out in a Completely Randomized Design with Factorial Concept (FCRD) with three repetitions. Flowers were harvested in the morning hours before 11.00 am from Floriculture Research Farm. Immediately after harvest, flowers were embedded with different embedding media *viz.,* M_1- Silica gel, M_2- Borax, M_3- Sand and treated with different drying condition *viz.,* room drying (D_1) and sun during (D_2). About 1.5 to 2 cm layer of the desiccant (sand, silica gel and borax) was poured at the bottom of container and the flower stems were pushed into the

medium. The flowers were kept in erect position. Desiccants were then gently and gradually poured all around and over the flower up to 4 to 4.5 cm above, so as to fill all the crevices in between the petals without disturbing the shape of flowers. After embedding the flowers with desiccants, the containers were kept at room temperature in a well-ventilated room for drying while; the trays with flowers in embedding media were kept on terrace of the college building for sun drying. After drying, the containers were tilted for removing the desiccants over and around the flowers. The dried flowers were picked up by hand, cleaned by inverting them and tapping the stems with fingers slowly and gently. Remaining desiccants were finally removed with the help of fine brush. The observation were recorded on different quantitative and qualitative parameters *viz.*, dry weight, weight loss, moisture loss, reduction in flower diameter, time taken for drying, storage life, colour, shape retention, texture, petal intactness of dried flowers and statistically analyzed using standard method as suggested by Panse and Sukhatme (1967) [12].

Result and Discussion

Effect of drying media

The embedding media had significant influence on dry weight of flowers of calendula, coreopsis and cosmos (Table 1). The minimum dry weight was recorded in M_1- silica gel (462.71, 108.48 and 238.52 mg, respectively). Significantly maximum weight loss and moisture loss in flowers of calendula (781.14 mg, 62.80 %), coreopsis (152.41 mg, 58.43%) and cosmos (384.08 mg, 61.69 %) was observed in M_1 *i.e.* silica gel which was followed by flowers embedded in borax. Among all the desiccants, the silica gel (60-120 mesh) has been found to be the best absorbent for removing moisture from the flowers and foliage. The research findings are also similar with that of Desh Raj *et al.* (2006) [4], Nazki *et al.* (2012) [10] and Gupta *et al.* (2005) [6].

Significantly minimum time required for drying was recorded in flowers embedded in silica gel (M_1) *viz.*, 4.30 days for calendula, 2.73 days for coreopsis and 3.37 days for cosmos which might be due to strong hygroscopic nature of silica gel. The other probable reason may also be the hydrosorbant nature of silica gel which has been manufactured from sodium silicate. Silica gel is composed of a vast network of interconnecting microscopic pores, which attract and hold moisture by a phenomenon known as physical adsorption and capillary condensation and thus, it acts as a dehydrating agent, the same has also been explained by Sindhuja *et al.* (2015) [13].

Sand (M_3) embedded flowers shown minimum reduction in diameter (5.43, 4.00 and 4.07 mm, respectively) followed by M_2- borax (5.60 mm and 4.35 mm) for calendula and cosmos while at par for coreopsis (4.20 mm). Higher flower diameter was observed with respect to sand embedding as compared to other embedding media which might be due to the fact that sand does not react with water vapour released during the process of drying as in the case of silica gel and borax. It allows the water vapour to escape in to the air freely thereby, causing minimum loss in size of flowers as explained by Sindhuja *et al.* (2015) [13].

Effect of drying conditions

The minimum dry weight of calendula (476.36 mg), coreopsis (108.92 mg) and cosmos (243.70 mg) was recorded in sun drying condition. In sun drying condition, there was increase in temperature and wind velocity which may have increased the drying rate in embedding method. It may be also due to evaporation of moisture from the material at higher rate (Biswas and Dhua, 2010) [3]. Alka Singh and Dhaduk (2005) [1] had also got similar results with drying at higher temperature (solar-drying) in zinnia flowers.

Significantly maximum weight loss and moisture loss of calendula (768.01 mg, 61.72 %), coreopsis (151.10 mg, 58.11 %) and cosmos (380.60 mg, 60.97 %) flowers was observed in sun drying condition. At higher temperature, rate of moisture loss or liberation of moisture from flower tissues (transpiration) was more due to higher transfer of heat by conduction and convection (Meman *et al.*, 2008) [9]. The minimum time taken for drying (4.60, 2.42 and 2.60 days, respectively) was recorded in flowers dried under sun drying. The time taken for drying in open sun was minimum as compared to room condition and the duration varies according to the size and density of plant materials and it may take four days to three weeks according to Westland (1993) [14].

Significantly minimum reduction in diameter during drying was recorded in room drying (5.48, 3.86 and 4.23 mm,) whereas it was found maximum in sun drying (5.87, 4.84 and 4.64 mm) for calendula, coreopsis and cosmos, respectively. This may be due to exposure of flowers to different day and night temperature in sun drying condition. Nirmala *et al.* (2008) [11] reported that maximum dry flower diameter was observed with quartz sand (3.44 cm) which was on par with silica gel (3.43) in carnation. Kher and Bhutani (1979) [7] and Bhalla *et al.* (2006) [2] also reported same results with regard to flower diameter.

Interaction Effect

It is evident from the data that the dry weight, weight loss, moisture loss, time taken for drying and reduction in diameter of flowers of calendula, coreopsis and cosmos was not influenced significantly by the interaction of drying conditions and embedding media. Moreover, qualitative parameters were recorded form interaction and presented Table 2.

Among all treatments, significantly maximum rating of (18.20, 17.80 and 18.00) points was obtained in the flowers which were embedded in silica gel and dried at room temperature (D_1M_1) followed by the treatment of room drying with sand (17.00, 16.60 and 16.60). Because of silica gel as the best medium for getting excellent dried flowers that retain colour and shape (Alka Singh and Dhaduk, 2005) [1]. Silica gel embedded drying methods has been reported to be provided best quality of dried flowers as reported by (Dhatt *et al.* 2007, and Meman *et al.* 2006) [5, 8]. Flower dried in sun and in borax medium scored minimum quality score owing to shrinkage of flower petals, rough texture and loss in flower shape which caused deterioration of flowers. None of the fungal development was observed up to 6 months in flowers of calendula, coreopsis and cosmos dried in sun and room condition with all desiccants. The combination of media and drying conditions results revealed that silica gel with room drying condition gave maximum quality score as compared to sun drying with borax.

Thus, room drying was found best with silica gel as embedding media with respect to final quality of dried flowers of calendula, coreopsis and cosmos.

Table 1: Effect of different drying methods and embedding media on quantitative characteristics of different flowers of Asteraceae family

Treatments	Calendula					Coreopsis					Cosmos				
	Dry weight (mg)	Weight loss (mg)	Moisture loss (%)	Time taken for drying (days)	Flower diameter reduction (cm)	Dry weight (mg)	Weight loss (mg)	Moisture loss (%)	Time taken for drying (days)	Flower diameter reduction (cm)	Dry weight (mg)	Weight loss (mg)	Moisture loss (%)	Time taken for drying (days)	Flower diameter reduction (cm)
Factor – 1 (D – Drying conditions)															
D_1	508.94	732.04	58.98	6.33	5.48	121.24	137.89	53.18	3.47	3.86	254.18	368.15	59.16	4.47	4.23
D_2	476.36	768.01	61.72	4.60	5.87	108.92	151.10	58.11	2.42	4.84	243.70	380.60	60.97	2.60	4.64
S.Em±	2.15	2.33	0.17	0.07	0.05	0.52	1.56	0.27	0.04	0.06	0.78	0.82	0.11	0.06	0.04
CD at 5%	6.63	7.17	0.53	0.21	0.15	1.60	4.81	0.84	0.14	0.19	2.40	2.52	0.35	0.18	0.12
Factor – 2 (M - Media)															
M_1	462.71	781.14	62.80	4.30	5.98	108.48	152.41	58.43	2.73	4.85	238.52	384.08	61.69	3.37	4.90
M_2	495.66	749.15	60.18	5.60	5.60	115.65	143.00	55.27	2.97	4.20	248.16	374.60	60.15	3.53	4.35
M_3	519.59	719.78	58.07	6.50	5.43	121.11	138.08	53.23	3.13	4.00	260.13	364.46	58.35	3.70	4.07
S. Em. ±	2.64	2.85	0.21	0.08	0.06	0.63	1.91	0.34	0.05	0.08	0.95	1.00	0.14	0.07	0.05
C.D. at 5 %	8.12	8.78	0.65	0.25	0.18	1.96	5.90	1.03	0.17	0.23	2.94	3.09	0.43	0.22	0.15
Interaction (D × M)															
D_1M_1	477.73	765.67	61.58	5.20	5.80	114.63	148.29	56.40	3.33	4.50	243.59	378.21	60.83	4.33	4.60
D_1M_2	515.46	727.51	58.53	6.60	5.40	121.63	137.32	53.02	3.47	3.60	252.92	368.31	59.29	4.47	4.20
D_1M_3	533.65	702.94	56.84	7.20	5.23	127.46	128.06	50.11	3.60	3.47	266.02	357.95	57.36	4.60	3.90
D_2M_1	447.70	796.62	64.02	3.40	6.17	102.32	156.53	60.46	2.13	5.20	233.45	389.95	62.55	2.40	5.20
D_2M_2	475.86	770.80	61.83	4.60	5.80	109.67	148.68	57.52	2.47	4.80	243.40	380.89	61.01	2.60	4.50
D_2M_3	505.54	736.62	59.30	5.80	5.63	114.76	148.10	56.34	2.67	4.53	254.25	370.98	59.34	2.80	4.23
S. Em. ±	3.73	4.03	0.30	0.12	0.08	0.90	2.71	0.47	0.08	0.11	1.35	1.42	0.20	0.10	0.07
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	1.31	0.93	0.86	3.66	2.49	1.35	3.24	1.48	4.53	4.27	0.94	0.66	0.57	4.99	2.65

Table 2: Effect of different drying methods and embedding media on qualitative characteristics of different flowers of Asteraceae family

Treatments	Calendula					Coreopsis					Cosmos				
	Colour	Shape	Texture	Petal intact-ness	Total quality Score	Colour	Shape	Texture	Petal intact-ness	Total quality score	Colour	Shape	Texture	Petal intact-ness	Total quality Score
D_1M_1(Room drying with silica gel)	4.80	4.60	4.20	4.60	18.20	4.60	4.20	4.20	4.80	17.80	4.60	4.40	4.20	4.80	18.00
D_1M_2 (Room drying with borax)	4.60	3.80	4.00	4.40	16.80	4.40	3.40	4.20	4.40	16.40	4.40	3.60	4.20	4.20	16.40
D_1M_3 (Room drying with sand)	4.40	4.20	3.80	4.60	17.00	4.20	3.80	4.00	4.60	16.60	4.20	4.00	3.80	4.60	16.60
D_2M_1 (Sun drying with silica gel)	4.20	4.40	3.40	4.40	16.40	4.00	3.80	4.00	4.40	12.20	4.00	4.00	4.00	4.40	16.40
D_2M_2 (Sun drying with borax)	4.00	3.60	3.20	4.00	14.80	3.80	3.20	3.20	4.20	14.40	3.80	3.00	3.20	4.20	14.20
D_2M_3 (Sun drying with sand)	3.80	4.00	3.00	4.20	15.00	3.60	3.40	3.40	4.40	14.80	3.60	3.80	3.00	4.00	14.40

Colour and shape recorded on 5 point scale

Excellent (5 points), very good (4 points), good (3 points), poor (2 points) and very poor (1 point)

Texture: smooth (5 points), medium (3 points) and rough (1 point) as expressed in this experiment.

Petal intactness:

Intact petals were allotted 5 points, slightly brittle were allotted 3 points and brittle petals were allotted 1 point.

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